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OF THE

DEPARTMENT OF THE INTERIOR

FOR THE

FISCAL YEAR ENDED JUNE 30, 1899.

TWENTIETH ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY,

CHARLES D. WALCOTT, DIRECTOR.

PART V.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

TWENTIETH ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART V—FOREST RESERVES

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ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., September 15, 1899.

SIR: I have the honor to transmit herewith, for publication as a part of the Twentieth Annual Report, a collection of papers and reports descriptive of the forests of the West, including those of the State of Washington and the reserves of Colorado, the Flathead Reserve of Montana, the Bitterroot Reserve of Montana and Idaho, and the San Gabriel, San Bernardino, and San Jacinto reserves of southern California.

Very respectfully,

HENRY GANNETT,
Geographer.

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

FOREST RESERVES.

HENRY GANNETT, *Chief of Division.*

THE FORESTS OF THE UNITED STATES.

CHANGES IN RESERVES DURING THE YEAR.

During the fiscal year numerous changes have been made in forest reserves, including several modifications of boundary lines, resulting in a considerable net increase to existing reserves and in the addition of new reserves. The boundaries of the Black Hills Reserve, in South Dakota, have been changed by the exclusion of a large area in the south and the inclusion of a much larger area in the north and west, the additions in the west being within the State of Wyoming. These changes have resulted in increasing the area of the reserve from 967,680 to 1,211,680 acres. The Pecos River Reserve, in New Mexico, has been extended by a narrow strip upon the east and a considerable addition upon the north.

The additional reserves created during the year are Fish Lake, in Utah; Gallatin, in Montana; Gila, in New Mexico; Lake Tahoe, Pine Mountain and Zaca Lake, in California, and Black Mesa, Prescott, and San Francisco Mountains, in Arizona.

PRESENT CONDITIONS.

By these changes an area exceeding 11,000 square miles has been added to the reserves during the year.

The following is a list of the reserves as they stood on July 1, 1899, with their areas:

Names, location, and areas of forest reserves, July 1, 1899.

Name.	State.	Area.	
		Acres.	Square miles.
Afognak	Alaska		
Ashland	Oregon	18,560	29
Battlement Mesa	Colorado	858,240	1,341
Bighorn	Wyoming	1,127,680	1,762

Names, location, and areas of forest reserves, July 1, 1899—Continued.

Name.	State.	Area.	
		Acres.	Square Miles.
Bitterroot	Idaho and Montana	4,147,200	6,480
Black Hills	South Dakota	1,211,680	1,893
Black Mesa	Arizona	1,658,880	2,592
Bull Run	Oregon	142,080	222
Cascade	do	4,492,800	7,020
Fish Lake	Utah	67,840	106
Flathead	Montana	1,382,400	2,160
Gallatin	do	40,320	63
Gila	New Mexico	2,327,040	3,636
Grand Canyon	Arizona	1,851,520	2,893
Lake Tahoe	California	136,335	213
Lewis and Clarke	Montana	2,926,080	4,572
Mount Rainier	Washington	2,234,880	3,492
Olympic	do	2,188,800	3,420
Pecos River	New Mexico	431,040	673.5
Pikes Peak	Colorado	184,320	288
Pine Mountain and Zaca Lake.	California	1,644,594	2,569.6
Plum Creek	Colorado	179,200	280
Prescott	Arizona	10,240	16
Priest River	Idaho and Washington	645,120	1,008
San Bernardino	California	737,280	1,152
San Francisco Mountains	Arizona	975,360	1,524
San Gabriel	California	555,520	868
San Jacinto	do	737,280	1,152
Sierra	do	4,096,000	6,400
South Platte	Colorado	683,520	1,068
Stanislaus	California	691,200	1,080
Teton	Wyoming	829,440	1,296
Trabuco Canyon	California	49,920	78
Uinta	Utah	875,520	1,368
Washington	Washington	3,594,240	5,616
White River Plateau	Colorado	1,198,080	1,872
Yellowstone	Wyoming	1,239,040	1,936
Total		46,169,249	72,139

There is, therefore, reserved from settlement at present an area of 72,139 square miles. It is composed mainly of mountainous, rugged country, of no value for agriculture, but especially favorable for tree growth. The locations of the reserves are shown on Pl. I, in pocket at the end of this volume.

Of these reserves examinations have been made by this office of the following: Battlement Mesa, Bighorn, Bitterroot, Black Hills, Flathead, Pikes Peak, Plum Creek, Priest River, San Bernardino, San Gabriel, San Jacinto, South Platte, Teton, Washington, and White River Plateau. Besides these the Mount Rainier, Olympic, and Yellowstone reserves have been examined in part.

The reserves thus far examined comprise an area of 28,236 square miles, or about 39 per cent of the entire area of the reserves.

The following are the areas reserved in each State and Territory, with the proportion which the reserved area bears to the total area and to the wooded area of each State or Territory:

Areas of forest reserves by States, in square miles and in percentages of area and of wooded areas.

State.	Area reserved.	Per cent of total area.	Per cent of wooded area.
	Sq. miles.		
Arizona	6,825	6	27
California	13,509	9	30
Colorado	4,848	5	15
Idaho	6,264	7	18
Montana	7,885	5	19
New Mexico	4,273	3	18
Oregon	7,271	8	13
South Dakota	1,893	2	76
Utah	1,474	2	15
Washington	12,672	19	27
Wyoming	4,994	5	40

Of the total area it appears that a much larger proportion of Washington has been reserved than of any other State or Territory. Of the wooded area the proportion ranges from 13 per cent in Oregon to 76 per cent in South Dakota, where nearly all the woodland has been reserved from settlement.

ABSTRACTS OF REPORTS ON FOREST RESERVES.

PIKES PEAK, PLUM CREEK, AND SOUTH PLATTE RESERVES.

There are in Colorado five reserves, known as Pikes Peak, Plum Creek, South Platte, White River, and Battlement Mesa reserves. Of these the first three were examined by Mr. John G. Jack and the last two by Mr. George B. Sudworth.

The three reserves, Pikes Peak, Plum Creek, and South Platte, are in the central part of the State and lie contiguous to one another. The first comprises an area of 184,320 acres, or 288 square miles, including the summit of Pikes Peak and its slopes and spurs to the north, south, and west. The second comprises an area of 179,200 acres, or 280 square miles, including the rugged, granite country immediately to the west of Pikes Peak, traversed by the South Platte. The third comprises an area of 683,520 acres, or 1,068 square miles, and includes the high mountains upon the east, north, and west of South Park.

The surface of these reserves lies at rather high altitudes, ranging from 7,000 feet in the lowest valleys to 14,000 feet upon the summits of the mountains. It is, in the main, a rugged mountain region, heavily eroded, with thin, coarse soil, mainly of granite detritus, and very little of it is suited for any other purpose than the production of forests.

Owing to the great altitude the climate is rather severe, and even in the most favored localities only very limited agriculture is possible. The crops which can be produced consist only of the hardiest grains and vegetables, while nearly all the land within the area is incapable of supporting any agriculture whatever. The rainfall, however, is ample for the support of forests over nearly the entire region.

Of all the reserves established by the Federal Government these three probably have been most damaged by fire and have been subjected to the greatest depredation by timber cutters. Only a small proportion of the total area of these reserves is without traces of fires, and large areas have been burned over in comparatively recent years. Moreover, timber cutting has been very widespread, the forests having been culled almost everywhere of their largest and most valuable trees. As a result of the fires and of the cutting, the timber is everywhere small, occurring in scattered groves, alternating with open areas. It is nowhere dense, and the older trees are very defective. There is much undergrowth, showing the disposition of the forest to reassert itself, but in the entire area of these reserves there is altogether very little merchantable timber.

The principal timber trees found in these reserves are the following:

Pinus ponderosa (yellow pine).—This is the most abundant, the most widely distributed, and the most valuable species found within this area. It attains a larger growth than other trees, the extreme limit observed being 125 feet in height and exceeding 3 feet in diameter. It is found ranging from the lowest altitude within the reserve up to about 10,000 feet.

Pinus murrayana (lodgepole pine) is abundant, sometimes being found mixed with other pines and spruces, at other times forming pure growths. As everywhere else in the Rocky Mountain region, this species is here increasing its range, being the first to restock burned areas. It is of little commercial value.

Pseudotsuga taxifolia (red fir, Douglas spruce).—This tree is found closely associated with the yellow pine, occupying practically the same belt of altitude. It grows here to a considerable size, although not to be compared in this respect with its development on the Pacific coast. The extreme height observed was 120 feet, with a trunk 4 feet in diameter.

Picea engelmanni (Engelmann spruce).—This tree is abundant at considerable altitudes, reaching its best development between 10,000 and 11,000 feet, where it is sometimes found 120 feet in height, with a diameter exceeding 3 feet.

Picea parryana (blue spruce).—This tree is nowhere abundant and never occurs by itself, being mixed with other species. Its range is from the lowest altitudes up to about 9,000 feet.

Abies lasiocarpa (alpine fir).—This tree is here of rare occurrence, being found sparsely at the greatest altitudes.

Abies concolor (balsam fir).—This also is of rather rare occurrence, and is of little importance from an economic point of view.

Other species found within the reserves which are of little or no economic importance are the piñon pine, two species of juniper, quaking aspen, and cottonwood.

PIKES PEAK RESERVE.

The Pikes Peak Reserve is traversed by the Colorado Midland Railway, on which are several stations, a number of them being in the nature of summer resorts, containing few inhabitants except in the summer season. The northeastern corner of the reserve is touched by the Denver and Rio Grande Railroad, and a considerable town has been built up at Palmer Lake within the limits of the reserve.

Scattered over the reserve are a number of small ranches, as along Bear and North Cheyenne creeks, and upon the Cheyenne Mountain wagon road, between Cheyenne Springs and Cripple Creek. There is little agriculture possible in this reserve, and little has been attempted, the ranches being chiefly devoted to the raising of cattle.

There are no active mines within this reserve, although much prospecting is being done.

There are no sawmills at present at work within the reserve, but much cutting has been done in past years.

PLUM CREEK RESERVE.

A considerable proportion, perhaps a third, of the area of the Plum Creek Reserve is under private ownership, the lands thus held being as a rule those at the lowest altitudes and having the most level surface.

The western side of this reserve has, in recent years, been the scene of intense mining excitement, which resulted in the establishment of a number of small mining towns. The boom, however, having subsided, these towns are largely deserted at present. There are now no paying mines within the reserve, although many prospects are held and work is being done upon them.

Much lumbering is still carried on in this reserve, there being at the time of the examination no fewer than six portable sawmills at work, altogether capable of turning out 60,000 or 70,000 feet of lumber per day. The owners of these mills claim to be cutting timber upon land held in private ownership.

SOUTH PLATTE RESERVE.

In the South Platte Reserve are several towns of considerable magnitude, such as Alma, Park City, and East Leadville. The western portion of the reserve is traversed by a branch of the Colorado and Southern Railway and by the Colorado Midland Railway, which have stations located within it. Altogether, although a comparatively small proportion of the reserve has been alienated, there is a considerable population living within its limits.

Only small portions of this reserve lie at altitudes sufficiently low to permit agriculture, even upon the most limited scale, to be carried on, and but little farming is attempted. Cattle and sheep are grazed to a considerable extent in the margin of South Park, which lies within the reserve.

The northern and western borders of South Park lying within the reserve have in years past been the scene of active placer mining; considerable quartz mining also has been done. At present the mining industry in this region is not in a profitable condition; still there are numerous mining camps, some new and some old, within the region. Among these are Puma, Gold City, Jasper, Alma, Park City, East Leadville, and Sacramento.

Timber cutting, especially in the mountains on the north and west of South Park, has in years past been extremely active for the supply of the mines, especially those at Leadville, but at the time of the examination of this reserve there were only four or five mills at work, probably upon timber owned by private parties.

These reserves can not be regarded as sources of supply of timber at present, or for many years to come, but rather as areas for its cultivation. Through fires and timber cutting nearly all the timber of value has been destroyed, and it will require generations of care and protection before this area can again become a source of supply.

BATTLEMENT MESA FOREST RESERVE.

This reserve was examined by Mr. George B. Sudworth during the months of September and October, 1898. It is situated in western Colorado, between Grand and Gunnison rivers. The area of the reserve is 1,321 square miles, or 858,240 acres.

The surface of this reserve is composed largely of high plateaus, whose summits range from 10,000 to 12,000 feet in altitude. Being mainly a greatly elevated region, it enjoys a rainfall ample for the growth of forests. Still, despite this ample rainfall, it is not by any means a heavily forested region. The trees occur in groves, alternating with areas of open park, and as a rule are small and of a species of no great value for industrial purposes. Altogether the stand of timber upon the reserve is estimated to be not more than 150 million feet B. M.

The most salient features of this reserve are the two high mesas, known as Grand and Battlement mesas. The latter is comparatively small, its summit covering but a few square miles, separating Grand River from the upper waters of Plateau Creek. Its altitude is fully 12,000 feet above the sea. It is composed in the main of sandstones, with a lava cap, which has protected it from erosion.

Grand Mesa is much larger and rises with long slopes from the valley of Gunnison River on the south and west to an altitude of 10,000 to 11,000 feet. Like Battlement Mesa, it is composed mainly of sandstones, with a lava capping, which in parts has been broken away by undermining, leaving here and there lava summits, while at the western part the lava cap still remains intact, covering a considerable area.

The principal trees occurring in this reserve are, in the order of their importance, as follows:

Engelmann spruce and alpine fir, which are always associated together in the forests, are the most conspicuous and abundant and cover the largest areas. Of these mixed forests the spruce forms about three-fourths of the timber. They occur mainly between 8,000 and 10,500 feet above the sea. Neither tree grows to large size, rarely exceeding 70 feet in height and 14 or 15 inches in diameter.

Red fir, or Douglas spruce, is found in small groves and single trees, between the altitudes of 6,500 and 9,800 feet. The extreme size of this tree is 30 inches in diameter and 65 feet in height.

Blue spruce occurs sparingly between altitudes of 6,800 and 8,500 feet. This is one of the largest trees found in the reserve, ranging in height up to 90 feet and in diameter to 30 inches.

Yellow pine is found in this reserve, but it is of very limited occurrence.

There are other species of little commercial value, such as the one-seed juniper, Rocky Mountain juniper and piñon pine.

The aspen is abundant everywhere between altitudes of 6,400 and 10,000 feet, forming dense groves upon old burns.

The timber upon this reserve is of exceedingly poor quality. The stand is everywhere light, the trees are small, branched low down and knotty, and a considerable proportion, 25 per cent to 40 per cent, including all the largest timber, is dead or defective.

The extent of arable land within the reserve is trifling. It is confined to a few hundred acres, widely scattered about on the lower slopes of the plateaus.

But two occupied ranches were found, although there were many others which had been abandoned either temporarily or permanently.

Owing to the poor quality of the timber in this region, most of that used in the towns on the Denver and Rio Grande Railroad is brought in from outside, and the demand for lumber which this reserve may be called upon to supply is at present, owing to the character of the timber, but very slight.

The cause of the condition of the forest in this reserve is the same as in other parts of the Rocky Mountain region—it is the old story of forest fires, which have raged over it for centuries, injuring or destroying the standing timber and killing the undergrowth. It is only through a cessation of these fires that the region will be afforded an opportunity to be reclothed with timber, and this process will necessarily be a very slow one.

WHITE RIVER FOREST RESERVE.

The White River Forest Reserve of Colorado was examined by Mr. George B. Sudworth during the months of July and August, 1898. The reserve is situated in western Colorado, in the region of high plateaus which flank the Rocky Mountains on the west. It includes the heads of White River, an eastern branch of the Green.

The surface of this reserve is composed of high, level, or rolling plateaus, elevated 10,000 to 12,000 feet above sea level, with the broad deep valleys which separate them. Being in the main a greatly elevated region, it enjoys a rainfall ample for forest growth. The lower valleys of the reserve have a climate which permits of agriculture, but the principal valleys and the summits of the plateaus have an almost arctic climate.

The region as a whole is sparsely timbered. The timber grows in patches and groves of various sizes, from a few acres up to square miles in extent. Altogether, the stand of timber upon it is estimated at 1,300 million feet B. M. The principal species of value for lumber consist, in the order of their importance, of the following:

Engelmann spruce, which ranges from 19 to 24 inches in diameter and up to 120 feet in height.

Alpine fir, found at the greatest elevations, where it ranges from 18 to 24 inches in diameter.

Lodgepole pine, which is the most abundant, although not the most important tree. Its timber ranges from 8 to 20 inches, and it reaches a height of 75 feet.

Blue spruce, ranging in diameter from 10 to 24 inches and up to 80 or 100 feet in height.

Red fir, 10 to 20 inches in diameter and from 30 to 60 feet high.

Yellow pine, from 1 to 2 feet in diameter and from 60 to 80 feet in height.

In the lower valleys within the reserve are numerous ranches, and scattered about are a number of summer resorts, especially for hunting purposes. There are no villages within the reserve, but there are four post-offices for the accommodation of the ranchmen.

The timber which has been cut upon the reserve is not great in total amount, and has been cut entirely for local consumption and not in any sense for export.

As in all parts of the Rocky Mountain region, the fires have been, in times past and present, very destructive. To this cause is to be attributed the fragmentary character of the forest. If protected from fires, there is no possible doubt that all of this region, with the exception of the lower valleys, would in time be covered with a fairly dense tree growth.

The open lands upon the reserve are used to a large extent for the pasturing of cattle and horses by the ranchmen upon and near the reserve.

There is at present no mining going on upon the reserve.

FLATHEAD FOREST RESERVE, MONTANA.

This reserve was examined by Mr. H. B. Ayres, who devoted about four months to the work. The area examined is approximately 2,160 square miles, including the reserve and a tract of country extending to the westward as far as Tobacco Plains. The area, which lies entirely north of the Great Northern Railway, consists, in general terms, of two mountain ranges, one in the eastern, the other in the western part of the reserve, separated by a broad valley. The easternmost of the two ranges is the eastern range of the Rocky Mountain system in this latitude, facing the plains. Its peaks have an altitude in the neighborhood of the railroad of from 7,000 to 9,000 feet, rising northward, so that at the northern boundary of the country they reach an altitude of 11,000 feet. All the gorges leading out of this range are of glacial origin, and in the upper parts of these gorges glaciers still remain, covering a large part of the region with snow and ice. It is an extremely rugged range, abounding in points of great scenic interest. West of this range is the valley of Flathead River above the lake, which in the south has a width of about 15 miles, narrowing northward toward the boundary. Succeeding this valley on the west is a broken, irregular mountain range, not as high nor as rugged as the eastern range.

Most of this region is drained southward by the Flathead River into Flathead Lake. Smaller portions are drained by the Kootenai, Saskatchewan, and Missouri rivers.

Taken as a whole, the region is one of fairly abundant rainfall, although, as it has a wide range in altitude, the rainfall differs greatly in different parts. In the valleys irrigation is probably advisable, if not necessary; while upon the mountains the rainfall is ample for tree growth. Owing to the latitude and the elevation the temperature is low, rendering it doubtful whether agriculture can ever be made profitable within it.

The region is generally lightly timbered. This is due not, however, to the climate, which is not unfavorable to tree growth, but to frequent and persistent fires. The merchantable timber in the reserve consists mainly of western larch, red fir, spruce, and yellow pine. The entire stand of timber within the reserve, estimating it upon the basis of the present practice in cutting, is only 300 million feet. Measuring it, however, by Eastern standards, Mr. Ayres finds 851 million feet, and in addition to that 3,628,000 cords of wood suitable for firewood. This amount stands upon an area of 1,942 square miles, leaving only 218 square miles reported as not timbered.

It is plain from the above that this reserve can not be regarded as an important source of timber at present, but rather as a region for the cultivation of timber for future use.

Numerous claims have been taken up in various parts of this reserve, the greater portion of which are apparently abandoned or are occupied only a small part of the time. Indeed, it appears that only 40 or 50 claims are continuously occupied. The probabilities of agriculture in this region are somewhat doubtful, owing to the severity of the climate.

There are no producing mines within the reserve, although many locations have been made upon which assessment work is being done.

BITTERROOT RESERVE (IDAHO PORTION).

This portion of the Bitteroot Reserve was examined by Mr. J. B. Leiberg, who devoted to it the entire season, commencing early in June and concluding work in the beginning of October. The area examined exceeds 5,600 square miles or 3,612,160 acres. The surface is made up of great massive spurs from the main divide of the Bitterroot Range, which forms its eastern limit. These spurs trend westward and separate branches of the Clearwater, excepting the southern part, which is drained by Salmon River and short tributaries from the north. The country is exceedingly rugged and mountainous, the valleys being, in the main, narrow, with precipitous walls rising at steep angles. It is an extremely inaccessible region, being traversed by very few trails and no wagon roads. The elevation of the region ranges from 3,000 feet in the lowest valleys up to 9,500 feet upon the mountain summits.

But little mining is or has been done within the limits of thereserve;

a few placers nave been discovered and worked, and some quartz leads have been discovered, but at present the latter are merely prospects.

Agricultural land is very limited in amount, and is distributed in small areas in the narrow valleys upon the west side of the reserve.

There is considerable land suitable for grazing, both in the stream valleys and high up in the mountains. These areas altogether amount to many thousand acres, but collectively are not large in comparison with the entire area of the reserve.

There are at present no stock or sheep pastured within the reserve, except a few owned by ranchmen.

Settlement is confined to a few valleys in the western part of the reserve, and is very limited in amount. The few settlers have no market at present for their products; indeed, the products are limited in range, owing to the severity of the climate.

The rainfall through this entire region is heavy, being probably sufficient in the average year for cultivation without irrigation.

The aspect of the forests is extremely diversified, a feature which is apparently due, in part, to the great range of altitude, and in part to the great prevalence of fires. The region contains a great number of tree species and exhibits a great range in age of trees. Of the 3,612,160 acres embraced in the region examined, Mr. Leiberg finds that 193,000 acres are naturally treeless. This area is situated mainly upon the higher parts of the mountains, where the ruggedness of the surface precludes tree growth. He finds that within the past seventy-five years 1,442,144 acres have been badly burned, and the remainder of the area, 1,977,016 acres, has been untouched by fire, and is consequently covered with tree growth of considerable size, and therefore of value.

Upon this area he finds 4,899,800,000 feet B. M. of merchantable timber, consisting of the following species in the proportion given:

	Per cent.
Red fir	27
Yellow pine	24
Pacific arbor vitæ	15
Engelmann spruce	10
Silver fir	8
Western white pine	6
Western larch	5
Alpine hemlock	3
Lodgepole pine	2

It must not be understood from the above table that the total amount of lodgepole pine nor the area covered by it is in proportion to the amount here reported as merchantable. On the contrary, this is the most abundant tree in the reserve and occupies by far the largest area, especially among the young growth.

The average stand of timber upon the areas occupied by merchantable timber is about 2,500 feet per acre. The stand, however, shows wide variations with different areas and different species, ranging as high, in some localities, as 100,000 feet per acre over small areas.

FOREST CONDITIONS AND STANDING TIMBER OF WASHINGTON.

In my last report I published a tabular statement, by counties, of the standing timber of Washington, as estimated by cruisers, under the lumber practice prevailing in the State, and detailed statements regarding land classification, the stand of timber, and the amounts of various species in the western counties.

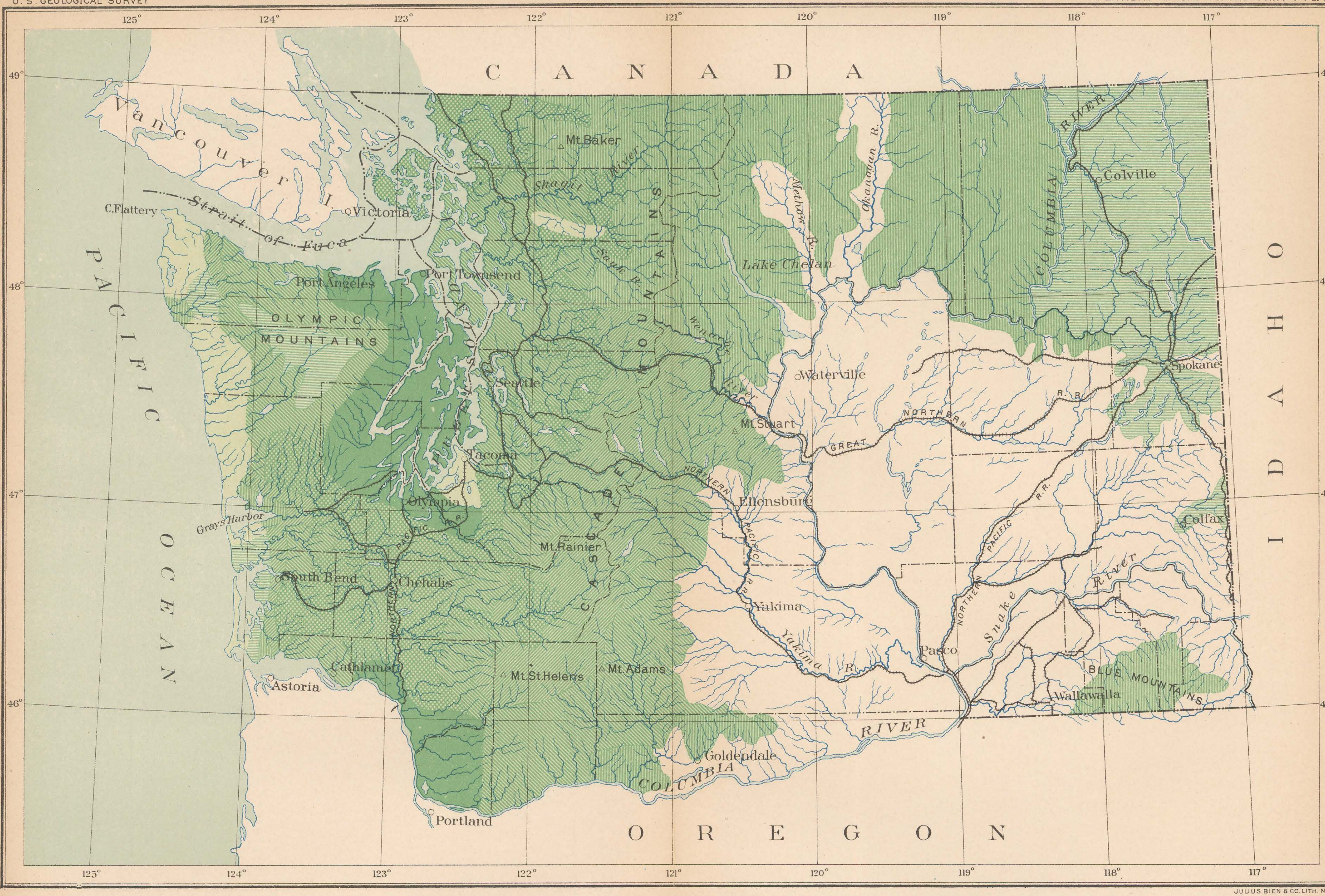
During the past winter the work of collecting cruisings and of preparing detailed estimates has been finished for the entire State, and the results are herewith presented, together with maps showing the classification of lands and the distribution of timber. (Pls. II–VII.)

With the exception of the redwood forests of California, the forests of western Washington are among 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 formerly covered the country as a thick mantle from a line 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.

To obtain an approximation to the true amount, 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 Railway Company, which has made most elaborate cruisings of that part of its land grant situated west of the Cascade Range, has, with great liberality, through its western land agent, Mr. Thomas Cooper, 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 have been prepared by Messrs. John M. Rankine and George H. Plummer, of the Northern Pacific Railway office. The commissioner of the State land office has furnished abstracts of all cruisings made



JULIUS BIEN & CO. LITH. N.Y.

MAP OF WASHINGTON SHOWING THE DISTRIBUTION OF RED FIR

EXPRESSED IN PERCENTAGES OF THE TOTAL FOREST AREA

By Geo. H. Plummer, F. G. Plummer and J. H. Rankine

1898

Scale

50 40 30 20 10 0 50 MILES

Under 1% | 1 to 10% | 10 to 25% | 25 to 50% | 50 to 75% | 75 to 100% | 100%

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.

The collection of data and preparation of estimates for the counties east of the crest of the Cascade Range has been done by Mr. Fred G. Plummer, who has devoted the winter months of 1898–99 to this work.

Altogether, cruisings of more than two million acres have been collected. These are scattered widely over the State and represent thoroughly well the stand of timber under all the different conditions of rainfall, temperature, soil, slope exposure, relief, and altitude.

The other factor necessary for obtaining the total stand of timber, the area of merchantable timber, has been obtained from the same sources in the greatest detail, and with this the areas which have been logged and which have been burned in recent years.

In connection with data regarding the stand of timber, its distribution as to species has been obtained, the classification being that recognized by lumbermen.

From these data the total amount of timber in the State, under the Washington lumbering practice, is estimated at 114,778 million feet B. M. Of this amount more than nine-tenths, or 103,504 million feet, are west of the crest of the Cascade Range, the remainder, 11,274 million feet, being upon its eastern slope and in the northern and eastern portions of the State. This total is less than half that estimated as standing in Oregon, a fact which I explain by the following considerations:

First, the area of merchantable timber is by no means so great in Washington as in Oregon. While the wooded areas do not differ materially, that of Oregon being 54,300 square miles and that of Washington 47,700 square miles, a much larger proportion of the wooded area of Oregon is occupied by timber of merchantable size and species. For instance, the Cascade Range in Washington is much broader than in Oregon and at much greater altitude, thus cutting out on this account a larger part of the wooded area. The Olympic Mountains also subtract another large part of the wooded area.

Second, the lumber industry of Washington has been, especially in recent years, much more important than in Oregon, and consequently a larger area has been cut over. In 1890 the cut of Washington was double that of Oregon.

Third, although the Coast Ranges of Oregon have suffered greatly from fires, the State as a whole, and especially the western portion of it, has not suffered by any means as severely from this source of destruction as has Washington, probably owing to the fact that lumbering has not been as active.

The State of Washington is naturally divided into two parts, which differ from one another widely in respect to timber growth. The line of division is the crest of the Cascade Range, running from the north to the south line of the State. West of it the country is heavily forested, or was before lumbering operations commenced. In this part of the State the areas naturally devoid of timber are few and small and altogether trifling in proportion to the total area. East of it the land is mainly without timber, and where timber exists it is sparse and its quality is inferior.

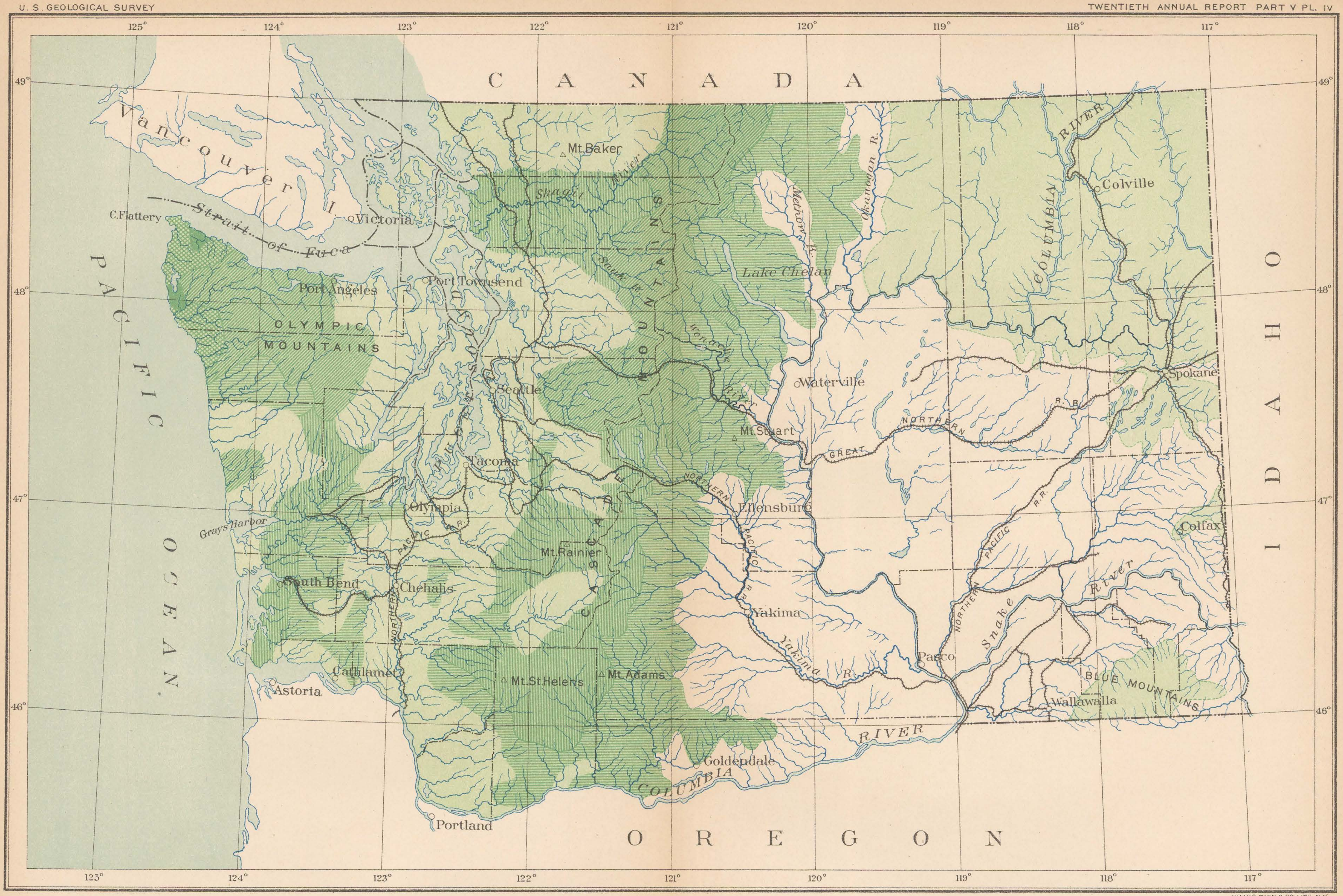
Moreover, there is a great difference in the species. West of the Cascade Range the prevailing species, which forms nearly two-thirds of the entire forest, is red or yellow fir. This, with cedar, hemlock, and spruce, compose the entire forest. Fir is found in almost all parts of this region, and throughout the Sound Valley little of any other species is found, the forests being almost pure fir. East of the Cascade Range the forest consists mainly of pine, principally yellow pine, though in the northeast corner of the State a little white pine is intermingled. Red fir is found scattered through the pine forests in considerable proportion, and in the northeastern part of the State larch is abundant. Small proportions of hemlock and cedar are also found, and a trifling amount of spruce and oak.

The following table gives the stand of timber of the species recognized by the lumbermen, in thousands of feet, board measure, with the percentage which each bears to the total amount:

Standing timber in Washington.

Species.	M feet B. M.	Per cent of total.
Red fir	68,338,421	60
Cedar	16,309,453	14
Hemlock	14,848,259	13
Pine	6,586,520	6
Spruce	6,419,215	5
Larch	2,078,601	2
White fir	24,550	....
Oak	3,700	....

Dividing the State into the two parts above given, the following tables show the distribution of these species in these two sections, with the percentage which each bears to the total forest of that section:



MAP OF WASHINGTON SHOWING THE DISTRIBUTION OF HEMLOCK

EXPRESSED IN PERCENTAGES OF THE TOTAL FOREST AREA.

By Geo. H. Plummer, F. G. Plummer and J. H. Rankine

1898

Scale

50 40 30 20 10 0 50 MILES

Under 1% | 1 to 10% | 10 to 25% | 25 to 50% | 50 to 75% | Over 75%

Standing 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

Standing timber in eastern Washington.

Species.	M feet B. M.	Per cent of total.
Pine	6,586,520	60
Red fir	2,129,560	19
Larch	2,078,601	19
Hemlock	148,500	1
Cedar	117,177	1
White fir	24,550	....
Spruce	16,610	....
Oak	3,700	....

The above figures do not add up to the total given for this part of the State, owing to the fact that a few million feet were not classified by the cruisers.

The table on the next page 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, 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, by which the contents of all species is estimated, 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.

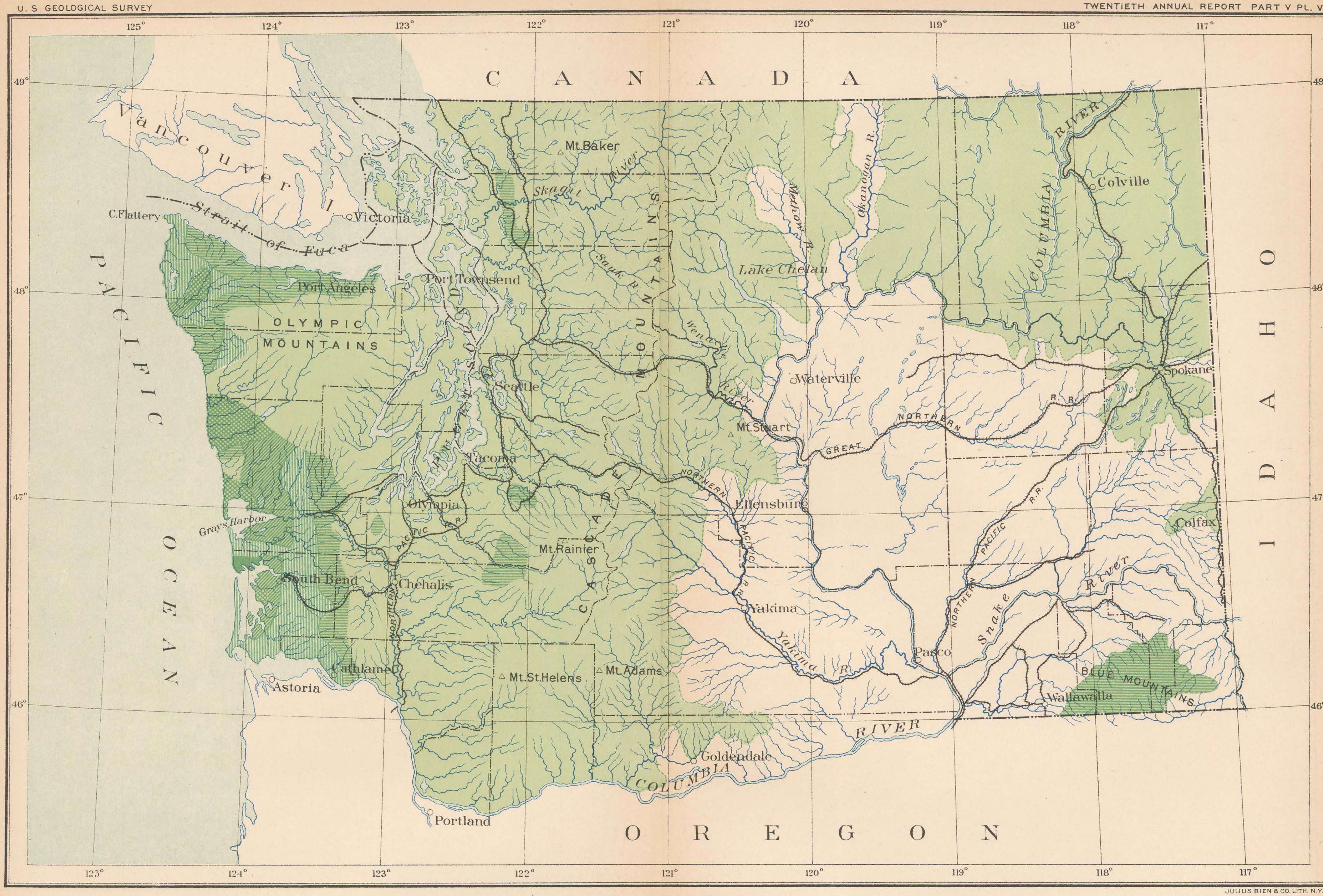
Merchantable timber in the State of Washington, by counties.

County.	M feet B. M.	County.	M 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	1,667	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

The counties omitted contain no merchantable timber.

Average stand of timber per acre on timbered areas.

County.	Feet B. M.	County.	Feet B. M.
Asotin	1,200	Lincoln	300
Chehalis	21,300	Mason	5,600
Clallam	15,700	Okanogan	1,100
Clarke	19,000	Pacific	16,300
Columbia	1,700	Pierce	18,000
Cowlitz	20,400	Skagit	28,000
Douglas	1,000	Skamania	17,000
Ferry	1,200	Snohomish	19,000
Garfield	2,000	Spokane	2,300
Jefferson	15,300	Stevens	1,100
King	20,500	Thurston	11,050
Kitsap	9,000	Wahkiakum	27,000
Kittitas	1,000	Whatcom	24,000
Klickitat	1,400	Yakima	1,900
Lewis	16,500		



JULIUS BIEN & CO. LITH. N.Y.

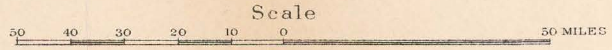
MAP OF WASHINGTON SHOWING THE DISTRIBUTION OF SPRUCE

EXPRESSED IN PERCENTAGES OF THE TOTAL FOREST AREA

By Geo. H. Plummer, F. G. Plummer and J. H. Rankine

1898

Scale



The stand is heaviest in Skagit County, near the northern boundary. The next heaviest is Wahkiakum, in the southwest, near Columbia River. In western Washington the average stand is 18,000 feet; in eastern Washington it is but 1,200 feet B. M.

The entire area of Washington is 66,880 square miles. Of this 23,165 square miles are covered with merchantable timber, or 36 per cent of its area. Only one-half of the wooded area of the State is regarded as containing merchantable timber under present lumbering practice.

The entire area of the nineteen counties of western Washington 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 3,025 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 cut; 22½ per cent has been destroyed by fire, 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.

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 million feet B. M.

If we make the same assumption regarding the burned area, it appears that there has been destroyed by fire, without the least benefit to the world, the enormous amount of 40,000 million feet B. M. of lumber. Anyone who has passed the late summer and early fall in this State realizes the enormous destruction which takes place annually at this season. There are fires everywhere, and for weeks at a time the smoke from them lies as dense as the fog on the New England coast.

These are impressive facts. In less than a generation more than two-fifths of the timber in one of the richest timber regions on this continent has been destroyed, and of that destruction more than half has been caused by fire. Nearly two years' supply of lumber for the United States has been thus 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.

In eastern Washington, out of an entire area of 41,928 square miles, 14,126 square miles only are now covered with merchantable timber, or only one-third of the area. Of the area at one time timbered, 1,385 square miles have been cut over and 244 square miles have been burnt. These figures present a strong contrast with similar figures for western Washington, both in respect to cut and burnt areas. The reason for it lies in the fact that in this part of the State the cutting is done only for local consumption and never for export, and in these open sparse forests of yellow pine fires do not run freely or cause much damage.

The distribution of the different species recognized as lumber in Washington is represented on Pls. III to VII and is seen to follow a few definite and simple laws. The tints represent the proportion which each species bears to the entire forest. The map 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 and in an area or belt 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 disappears.

The distribution of spruce is expressed on the map 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.

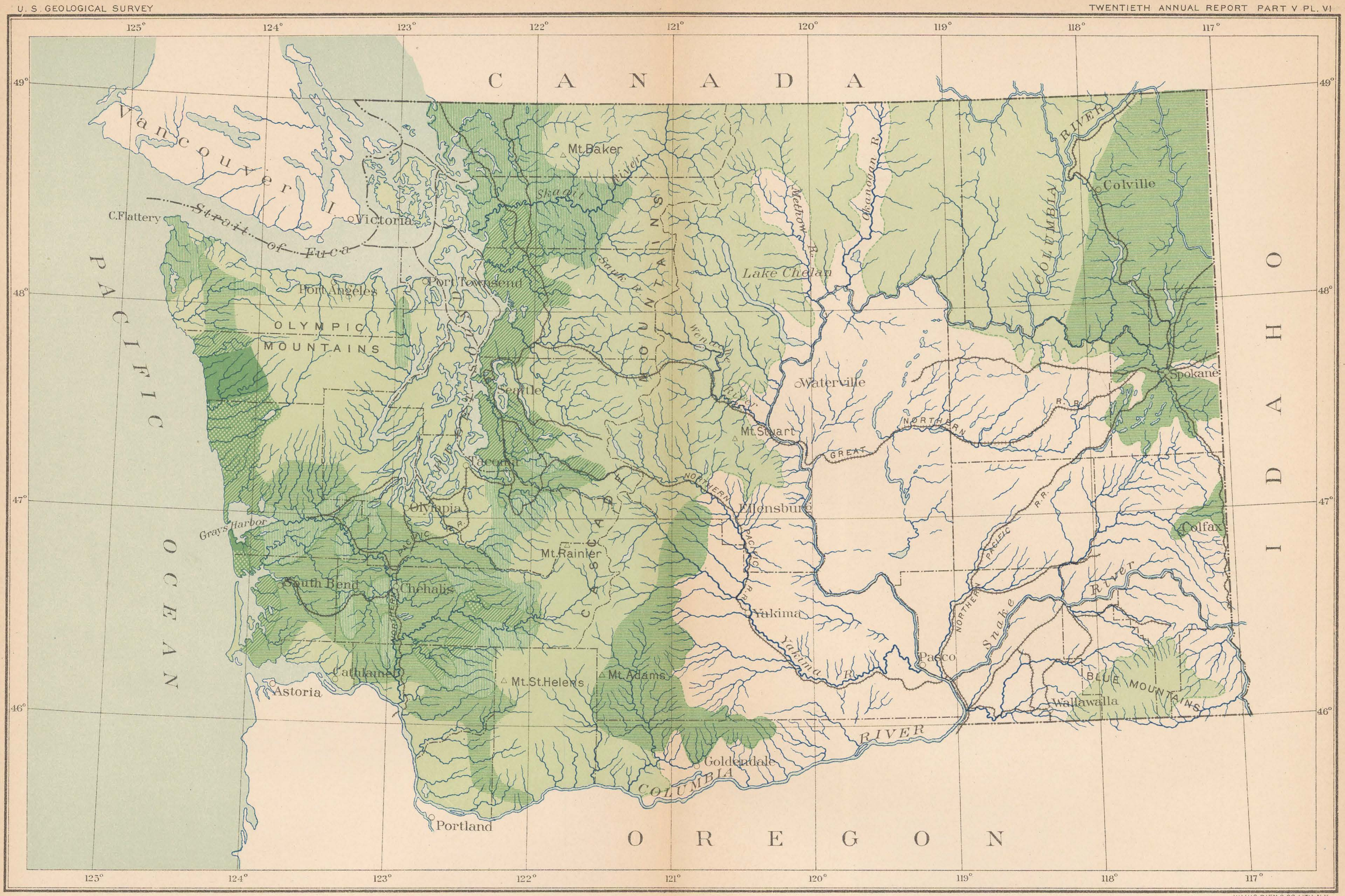
Of cedar there is scarcely any to be found upon the islands and upon the west coast of Puget Sound, and but very little in the valley to the southward. It increases westward toward the coast and reaches a maximum immediately on the coast. The east coast of Puget Sound contains a large proportion of cedar,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

Hemlock is almost entirely wanting upon both shores of Puget Sound and in the valley to the south. It increases westward and forms a quite 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.

ADAMS COUNTY.

This county lies in the southeastern part of the State. Its surface consists of a broadly undulating plateau of basalt, containing few stream courses but many coulees.

The county contains no timber whatever, excepting strips of willows, alders, and aspen along the few streams.



JULIUS BIEN & CO. LITH. N.Y.

MAP OF WASHINGTON SHOWING THE DISTRIBUTION OF CEDAR

EXPRESSED IN PERCENTAGES OF THE TOTAL FOREST AREA

By Geo. H. Plummer, F. G. Plummer and J. H. Rankine

1898

Scale

50 40 30 20 10 0 50 MILES

Under 1% | 1 to 10% | 10 to 25% | 25 to 50% | 50 to 75% | Over 75%

ASOTIN COUNTY.

This is the southeasternmost county of the State. It consists mainly of the undulating, timberless, basalt plain of Snake River, but into its western edge extends the end of a spur from the Blue Mountains which bears some timber.

Area of timber and other lands in Asotin County.

	Sq. miles.
Total area	640
Area timbered	105
Area logged	6

Estimate of timber in Asotin County.

	M feet B. M.
Pine	47,640
Red fir	15,880
Larch	7,940
White fir	7,940
Total	79,400
Average stand per acre in feet B. M.	1,200

Besides the above there is upon the cut area a small amount, estimated at 2 million feet, still standing, which, added to the above estimate, gives a total of 81,400,000 feet for the county.

CHEHALIS COUNTY.

This county borders upon the Pacific Ocean, and on the north extends far up into the Olympic Mountains. The northern portion of the county is high and rugged and contains little or no merchantable timber, and in other portions there 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 greater 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.

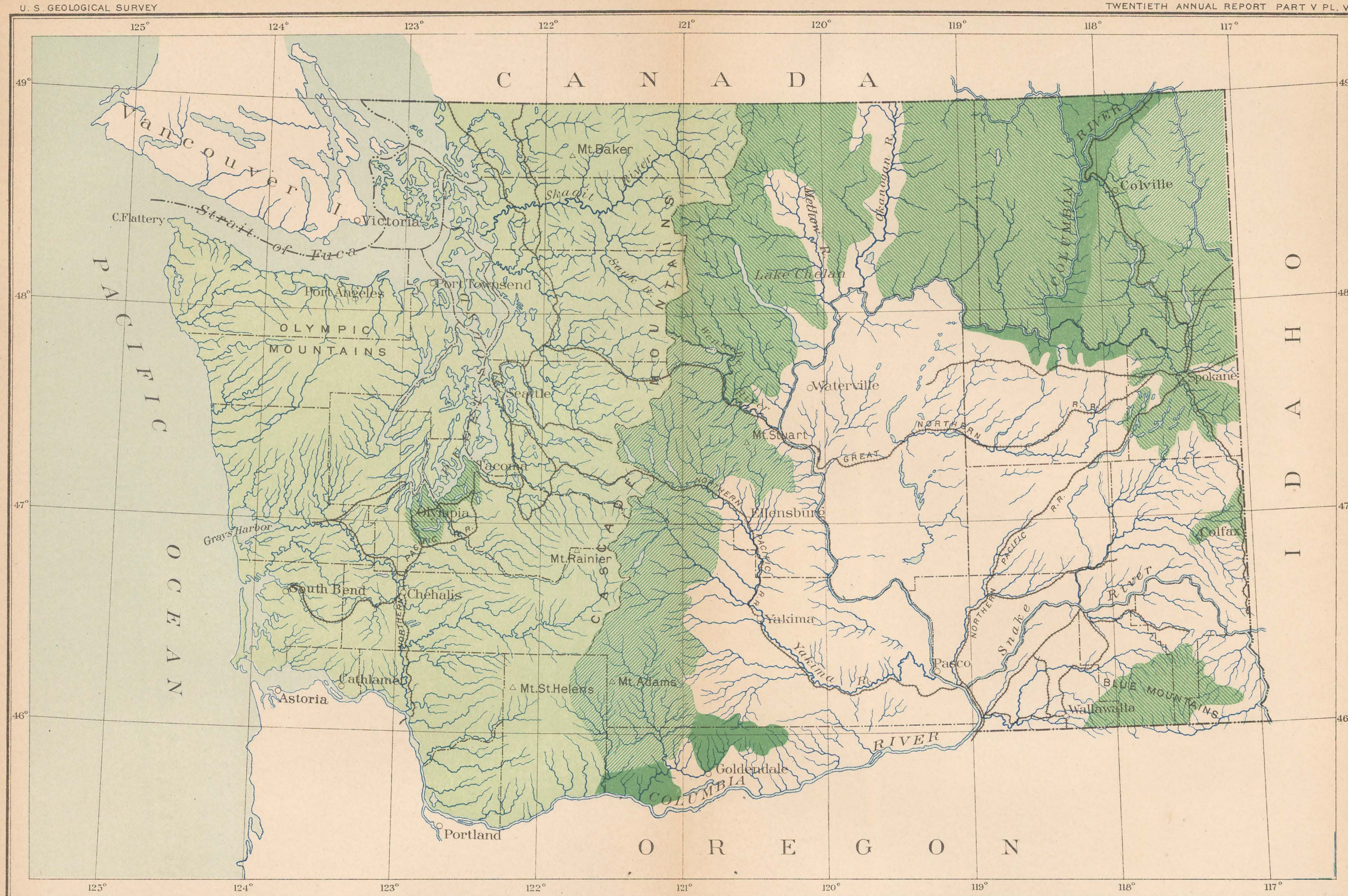
This county lies in the southwestern part of the State, bordering on the south and west upon Columbia River. Originally it was entirely covered with heavy forests with the exception of a few small prairie tracts.

But little timber has been cut in the county, lumbering being principally confined to the line of the Portland, Vancouver and Yakima 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 southern and western 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



MAP OF WASHINGTON SHOWING THE DISTRIBUTION OF PINE

EXPRESSED IN PERCENTAGES OF THE TOTAL FOREST AREA

By Geo. H. Plummer, F. G. Plummer and J. H. Rankine

1898

Scale

50 40 30 20 10 0 50 MILES

Under 1% · 25 to 50% · 50 to 75% · Over 75%

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

COLUMBIA COUNTY.

This county lies in the southeastern portion of the State. Its southern part is occupied by the Blue Mountains, the crest of which runs across the county. Southward they descend rapidly to the canyon of Grande Ronde River and northward to the Columbia Plains. The greater part of the county consists of these plains, which are timberless, with a broadly undulating surface traversed by few streams. The northwest slope of the Blue Mountains was formerly well timbered with pine and fir, but this has mainly been logged off. The summits of these mountains are sparsely timbered, while the southern slopes are timbered quite heavily for this region. There have been no burns in the county.

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

	Sq. miles.
Total area	864
Timbered area	162
Logged area	180
Untimbered area	522

Estimate of timber in Columbia County, Washington.

	M feet B. M.
Pine	109,500
Red fir	36,500
Larch	18,250
White fir	9,125
Spruce	9,125
Total	182,500
Average stand per acre, in feet B. M	1,700

Scattered over the cut area is standing timber to the amount of about 60 million feet, which, added to the above estimate, gives a grand total of 242,500,000 for the county.

COWLITZ COUNTY.

This county lies in the southern part of the State, being limited on the south by Lewis and Columbia rivers. The eastern portion of the county comprises the western slopes of Mount St. Helens, and includes a considerable area on which the timber is not 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 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

DOUGLAS COUNTY.

This county lies a little east of the center of the state, its area being comprised entirely within the Great Plains of the Columbia. It is bordered upon the north and west by Columbia River, flowing in a deep and narrow valley. The surface of the county is broadly undulating, consisting of a basalt plateau, intersected by coulees and stream canyons. It is almost entirely treeless, only about 1 per cent of its area being timbered, the timbered areas lying in narrow strips on the edge of the plateau near Columbia River. Along Columbia River, between Wenache and Virginia, are a few scattered pines and fir.

Area of timber and other lands in Douglas County, Washington.

	Sq. miles.
Total area	4,552
Timbered area	49
Logged area	6
Nontimbered area	4,497

Estimate of timber in Douglas County, Washington.

	M feet B. M.
Yellow pine	23,250
Red fir	7,750
Total	31,000
Average stand per acre, in feet B. M	1,000

FERRY COUNTY.

This is a new county, formed in 1899 from the western part of Stevens County, in the northeastern part of the State. Its surface is almost entirely mountainous and broken, and is throughout covered with timber, although the timber is nowhere dense. But one burn of any magnitude has occurred in the county in recent times, and no appreciable amount of timber has been cut.

Area of timber and other lands in Ferry County, Washingion.

	Sq. miles.
Total area	2,260
Timbered area	2,217
Burned area	5
Nontimbered area	38

Estimate of timber in Ferry County, Washington.

	M feet B. M.
Pine	999,900
Red fir	333,300
Larch	333,300
Total	1,666,500
Average stand per acre, in feet B. M.	1,200

FRANKLIN COUNTY.

This county, which lies in the southeastern part of the State, in the angle between Snake River and the Columbia, is entirely timberless.

GARFIELD COUNTY.

This county lies in the southeastern part of the State, extending from Snake River southward to the Oregon line. The southern part includes a narrow section of the Blue Mountains. These are forested except on the northern slope, which has been largely cut over. The northern portion of the county is comprised in the undulating plain of Snake River and is timberless.

Area of timber and other lands in Garfield County, Washington.

	Sq. miles.
Total area	672
Timbered area	115
Cut area	70
Nontimbered area	487

Estimate of timber in Garfield County, Washington.

	M feet B. M.
Pine	89,820
Red fir	29,940
Larch	14,970
White fir	7,485
Spruce	7,485
Total	149,700
Average stand per acre in feet, B. M	2,000

Scattered over the cut area is standing timber to the amount of about 20 million feet, which, added to the above figures, gives a total for the county of 169,700,000.

ISLAND COUNTY.

This comprises a group of islands in the northern part of Puget Sound, including Whidbey 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 Ocean. 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 largely destroyed either by the ax or by fire, mainly by the latter. The timber in the western portion of the county has as yet suffered little from either cause.

The forests of this county are remarkable because of the large proportion of cedar, 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 Railway, 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 escaped injury. 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

KITTITAS COUNTY.

This county lies in the middle of the State north and south, and streches from Columbia River to the crest of the Cascade Range. The southeastern portion of the county is within the plains region, while the western portion comprises high and rugged mountain spurs. The plains portion is without timber excepting in a narrow strip along the Yakima River. The mountain portion is timbered, but by no means heavily, with yellow pine, fir, and larch. Some timber has been cut from this area, especially west of Ellensburg, and in patches in the mountains in the neighborhood of the Northern Pacific Railway. The burnt areas are trifling in extent.

Area of timber and other lands in Kittitas County, Washington.

	Sq. miles.
Total area	3,344
Merchantable-timber area	2,000
Logged area	67
Burnt area	10
Untimbered area	1,267

Estimate of timber in Kittitas County, Washington.

	M feet B. M.
Yellow pine	504,000
Fir	504,000
Larch	252,000
Total	1,260,000
Average stand per acre in feet B. M	1,000

KLICKITAT COUNTY.

This county occupies a long, narrow strip bordering upon Columbia River. Its western end is in the foothills of the Cascade Range, whence it stretches far eastward into the plains. The western portion of the county is timbered, and in certain small areas quite heavily timbered. The eastern portion, comprising by far the largest part of the county, is without forests. A few small areas have been cut, and at the western end of the county the great burns of the adjoining county, Skamania, have extended into it. These burns have occurred in recent years, and restocking is only just commencing upon them.

Area of timber and other lands in Klickitat County, Washington.

	Sq. miles.
Total area	2,176
Timbered area	840
Logged area	23
Burnt area	33
Untimbered area	1,280

Estimate of timber in Klickitat County, Washington.

	M feet B. M.
Red fir	336,300
Pine	321,100
Hemlock	71,400
Larch	10,500
Oak	3,700
Total	743,000
Average stand per acre in feet B. M	1,400

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 Railway, 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

LINCOLN COUNTY.

This county lies in the eastern portion of the State, upon the Great Plain of the Columbia, and is bordered on the north by Columbia and Spokane rivers. Its surface is a broad, undulating, basalt plain, traversed by a few stream courses and numerous coulees. The timber consists mainly of yellow pine, and is found in the northern part of the county, near Columbia and Spokane rivers. Formerly it extended in a continuous belt across the county in the neighborhood of these streams, but most of it has been cut away for cord wood and saw logs. The stand is very light.

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

	Sq. miles.
Total area	2,296
Timbered area	63
Logged area	200
Nontimbered area	2,033

Estimate of timber in Lincoln County, Washington.

	M feet B. M.
Pine	10,200
Fir	1,800
Total	12,000
Average stand per acre, in feet B. M.	300

Scattered over the cut area is a little standing timber, amounting to about 2 million feet, which, added to the above estimate, gives a total of 14 million feet for the county.

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

OKANOGAN COUNTY.

This large county lies in the northern part of the State, against the Canadian boundary, and about midway between the east and west boundaries. A large part of this county is comprised within the limits of the Washington Forest Reserve, and is not considered as containing any merchantable timber under present standards. Most of the remaining part of the county is timbered but little. It is, in the main, a mountainous region, containing, however, the broad valley of Okanogan River, which traverses it from north to south, while along the southern edge flows Columbia River in a narrow valley. No lumbering has been carried on in the county, and the forests have not suffered in recent times by fire.

Area of timber and other lands in Okanogan County, Washington.

	Sq. miles.
Total area	7,258
Area outside of Washington Forest Reserve	4,500
Merchantable-timber area	3,650
Nontimbered area	850

Estimate of timber in Okanogan County, Washington.

	M feet B. M.
Yellow pine	1,599,300
Fir	533,100
Larch	533,100
Total	2,665,500
Average stand per acre in feet, B. M.	1,100

PACIFIC COUNTY.

This is the southwesternmost county of the State, bordering upon the Pacific Ocean and Columbia River. In the interior its surface 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 western counties of the State, 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 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 the 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 almost entirely of fir 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

SPOKANE COUNTY.

This county borders upon the Idaho boundary and lies about midway between the north and south boundaries of the State. The eastern part is somewhat hilly and broken, while the western part consists of a portion of the great basaltic plain of the Columbia, intersected by numerous coulees, but traversed by few flowing streams.

Much of the area of this county was formerly timbered, but the timber has been, in great part, cut away to supply the needs of the city of Spokane and other towns. Very little of the timber has suffered from fire.

Area of timber and other lands in Spokane County, Washington.

	Sq. miles.
Total area	1,680
Timbered area	494
Cut area	605
Burnt area	4

Estimate of timber in Spokane County, Washington.

	M feet B. M.
Pine	532,400
Larch	121,360
Red fir	32,680
Cedar	29,560
Total	716,000
Average stand per acre, in feet B. M.	2,300

Scattered over the cut area there is still standing scattered timber estimated altogether at 50 million feet, which, added to the above, gives a total of 766 million feet for the county.

STEVENS COUNTY.

This is the northeastern county of the State. It is bordered on the west by Columbia River, while much of its southern boundary is formed by Spokane River. It is, in the main, a mountainous region, but is intersected by the broad valleys of Clark Fork and other streams. Nearly all of its area is timbered, but nowhere densely. Burned areas are more extensive here than in any other of the eastern counties, and there has been considerable cutting in scattered localities.

The species of timber found in the county consist of pine, in which is included both yellow and western white pine, which are not distinguished, red fir, larch, and cedar. In the western portion of the county, along Columbia River, the timber consists almost entirely of pine, only 4 per cent being fir and 1 per cent larch. In the neighborhood of Colville River the proportion of pine diminishes to 75 per cent, and that of fir and larch increases to 10 per cent each, while the proportion of cedar reaches 5 per cent. In the southeastern part of the county the proportion of pine is still further reduced to 60 per cent, while larch increases to 30 per cent, the remainder being made up of equal proportions of fir and cedar. Along the line of the Great Northern Railway, in the southern corner of the county, the proportion of larch is still greater, reaching 50 per cent in certain small areas.

Area of timber and other lands in Stevens County, Washington.

	Sq. miles.
Total area	4,000
Timbered area	3,713
Cut area	23
Burned area	159
Nontimbered area	105

Estimate of timber in Stevens County, Washington.

	M feet B. M.
Pine	2,026,260
Larch	351,218
Red fir	297,185
Cedar	27,017
Total	2,701,680
Average stand per acre, in feet B. M	1,100

THURSTON COUNTY.

This county lies in the western part of the State, 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	11,050

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 Gray 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

WALLAWALLA COUNTY.

This county lies in the southern part of the State, being bordered on the north by Snake River and on the west by Columbia River. Its surface is an undulating plain, sloping northward and westward from the Blue Mountains.

The amount of timber in this county was originally small, and this has been entirely logged off, with the exception of about 4,500,000 feet left standing after logging operations. Of this about half is pine, one-fourth fir, and one-fourth larch.

WHATCOM COUNTY.

This is the most northern county of the State west of the Cascade Range. It extends west from the summit of the range to the shores of Puget Sound. In the eastern half of the county are found Mounts Baker and Shuksan, 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 Nooksak 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

WHITMAN COUNTY.

This county is in the eastern part of the State, bordering upon Idaho. Its surface is a broadly undulating plain, with a surface of basalt sloping to the eastward.

It formerly contained a few small areas of timber land in the eastern and northern parts, but these have been logged over, leaving, however, a small amount of timber still standing.

Area of timber and other lands in Whitman County, Washington.

	Sq. miles.
Total area	2,124
Logged area	110
Nontimbered area	2,014

In the cut areas there is still standing a little timber, estimated at 35 million feet, consisting mainly of yellow pine.

YAKIMA COUNTY.

This county lies in the middle southern portion of the State, being bordered upon the east by Columbia River, and extending on the west to the crest of the Cascade Range. The western portion of the county is included within the Mount Rainier Forest Reserve. The estimates of area and of stand of timber do not include the reserve portion.

The eastern portion of the county consists of a broadly undulating plain, and is without forests. The western portion lies in the Cascade Range, is mountainous and broken, and is timbered throughout, but for the most part not heavily. There has been considerable cutting in the lower edges of the mountain forests, particularly upon the Naches River, where a large area has been logged. There are no burns except in the southwest corner of the county.

Area of timber and other lands in Yakima County, Washington.

	Sq. miles.
Total area	5,700
Area outside of Mount Rainier Forest Reserve	4,587
Timbered area	723
Logged area	95
Burnt area	33
Nontimbered area	3,736

Estimate of timber in Yakima County, Washington.

	M feet B. M
Fir	434,838
Pine	320,900
Hemlock	77,100
Cedar	60,600
Total	893,438
Average stand per acre in feet B. M	1,900

PIKES PEAK, PLUM CREEK, AND SOUTH PLATTE RESERVES.

By JOHN G. JACK.

SITUATION.

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

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

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

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

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

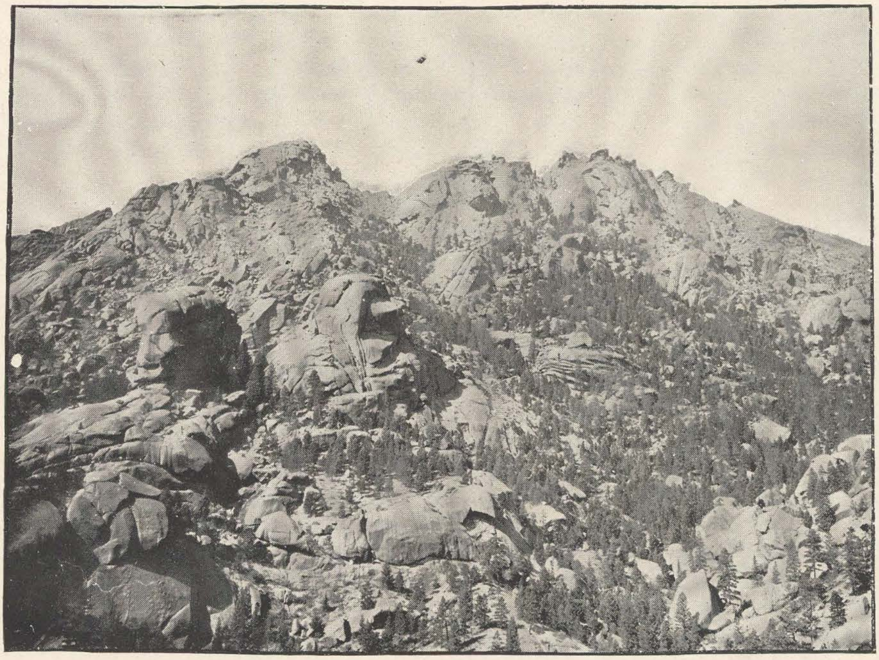
River itself separates the reserve from the Plum Creek Reserve on the east, and a large unreserved tract 16 miles in width lies between its southern portion and the Pikes Peak Reserve. Between the main body of the South Platte Reserve and its extreme western portion lies South Park, an extensive, comparatively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

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

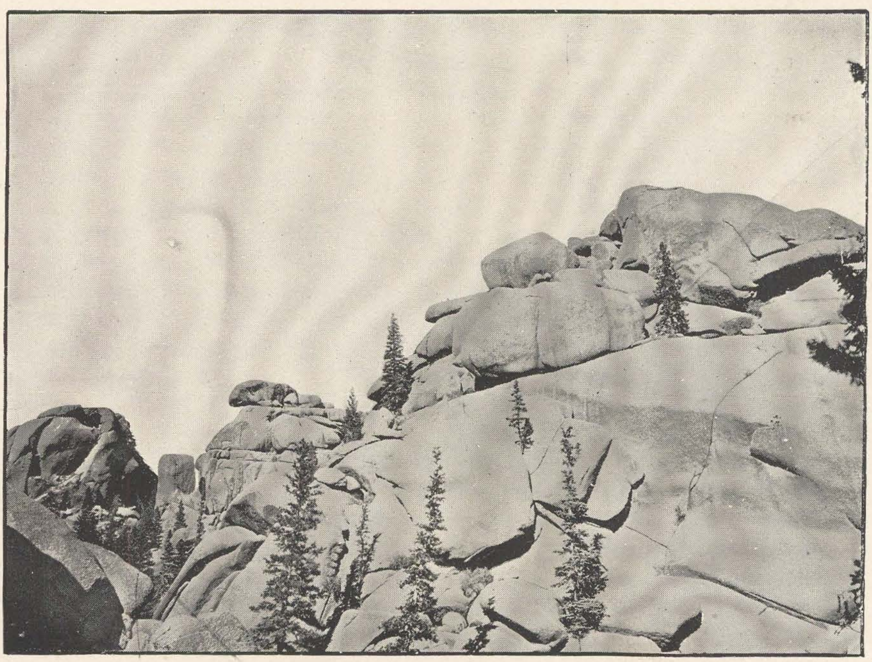
GENERAL SOIL CONDITIONS.

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

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



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



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

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

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

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

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

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

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

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

CLIMATE AND RAINFALL.

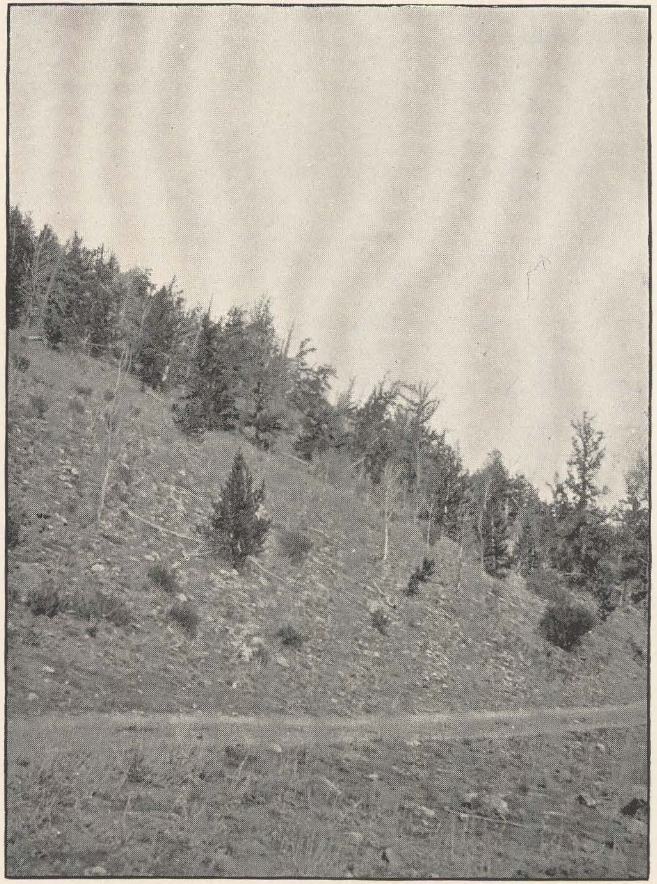
The great elevation of this whole region gives it a comparatively cool summer, with liability of nightly frosts near the timber line. On the so-called agricultural areas, mostly devoted to grazing, snow sometimes falls in midsummer and frosts are not very rare. On this account the variety of crops it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

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

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

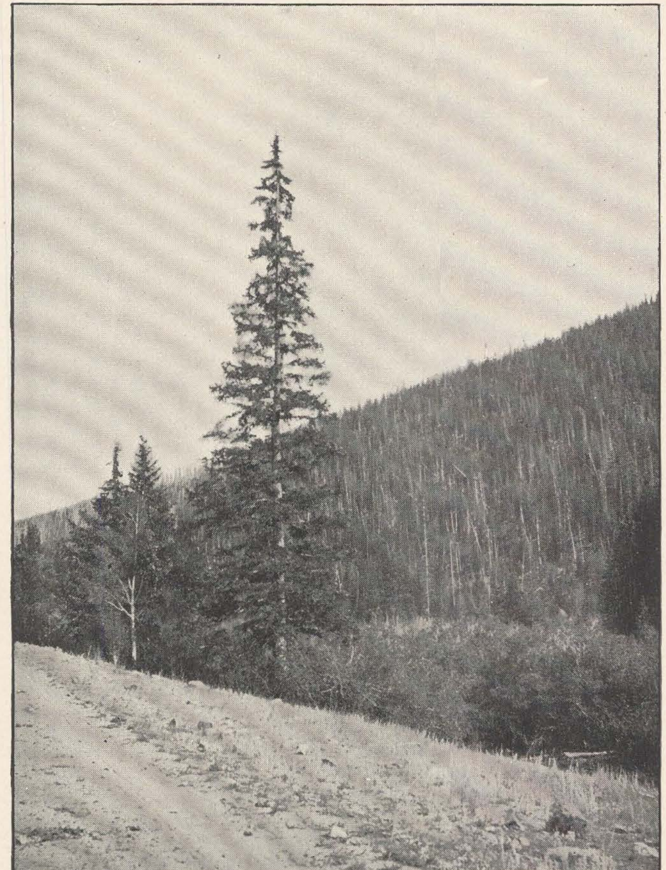
This small rainfall, combined with the dry atmosphere, poor soil, and cool climate, causes nearly all the natural vegetation to be of relatively slow development, and nowhere can there be said to be a strong, rank growth, such as would be found in more fertile, warmer, and more freely-watered regions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

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



A CHARACTERISTIC SOUTH SLOPE ALONG WESTON PASS ROAD.

Growth of scrubby pines.



B. CHARACTERISTIC NORTH SLOPE ALONG WESTON PASS ROAD.

Good growth of Engelmann spruce and some lodgepole pine.

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

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

FOREST CONDITIONS.

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

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

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

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

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

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

FIRES.

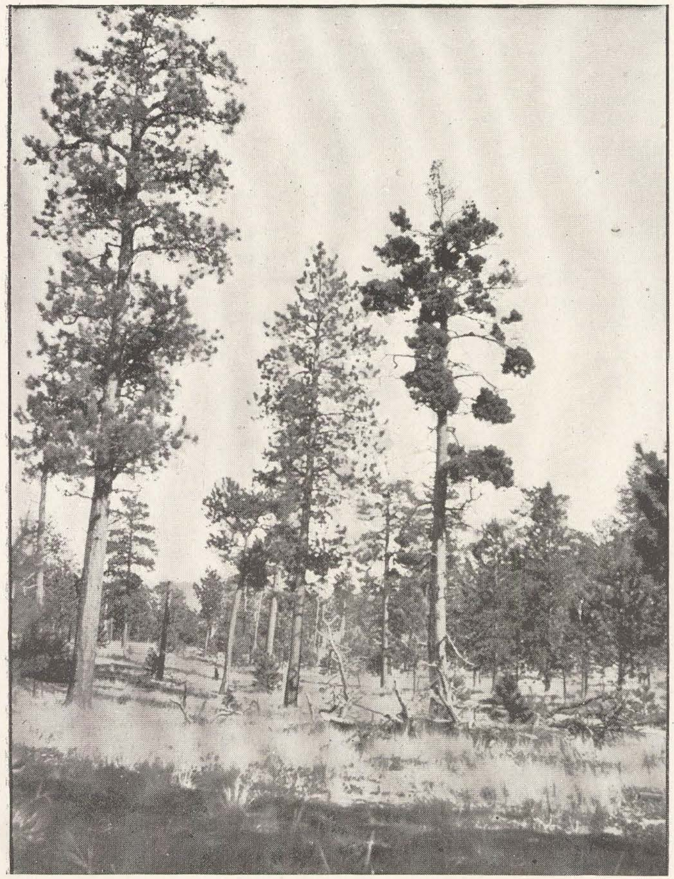
Probably at least 75 per cent of the total area of the reserves clearly shows damage by fire, much of it within the last half century or since the advent of white settlers in the region; and a great deal of ground shows traces of fires, which must have occurred prior to that time, and the forest has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

LUMBERING.

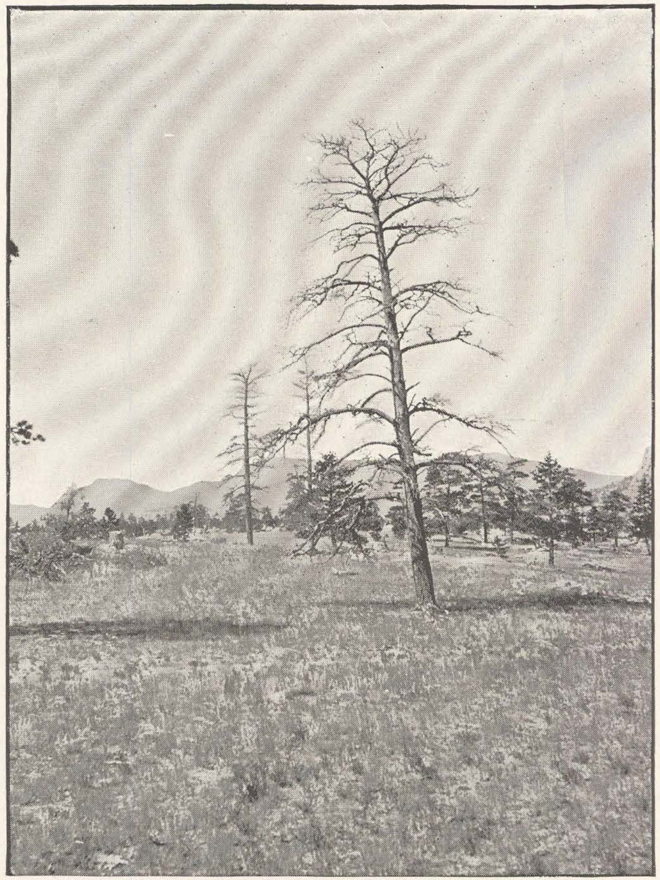
Lumbering is carried on at all seasons of the year, although it is generally stated that cutting in autumn and winter is preferable. The trees furnishing the lumber are almost exclusively yellow pine, red fir, and Engelmann spruce, while some lodgepole pine and blue spruce are also used when found large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

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

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



A. MISTLETOE INJURING YELLOW PINE IN SOUTN PLATTE RESERVE.



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

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

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

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

DISEASES AND ACCIDENTS TO TIMBER TREES.

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

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

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

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

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

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

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

FOREST TREES IN THE RESERVES.

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

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

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

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

A. CHARACTERISTIC GROWTH OF SMALL YELLOW PINE ON MANY PARTS OF SOUTH PLATTE RESERVE.

B. FOSSIL STUMP NEAR FLORISSANT, COLORADO.

Nearly 50 feet in circumference at ground; about 8 feet high.

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

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

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

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

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

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

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

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

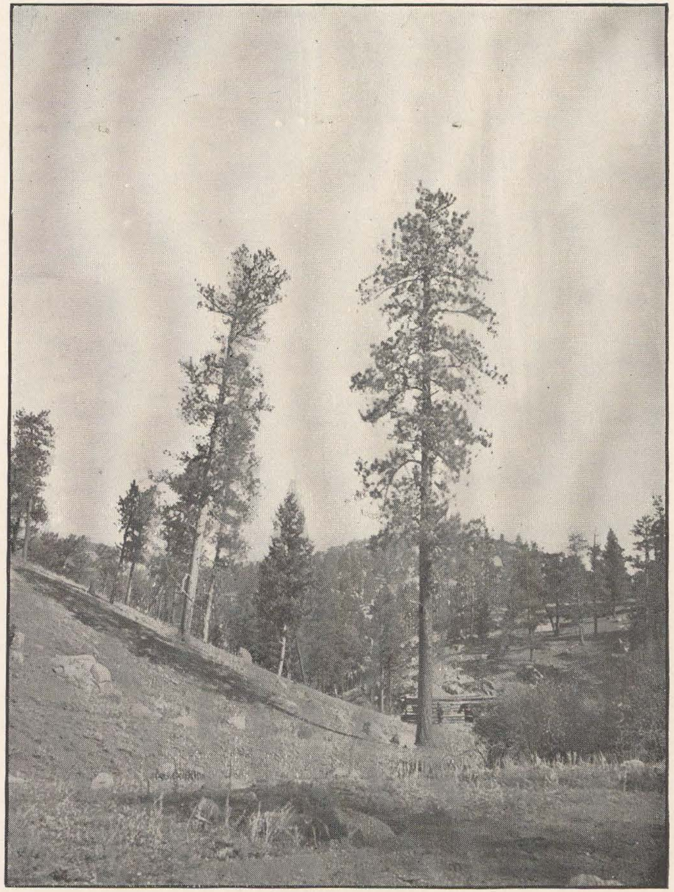
Another, 70 feet high, measured 15 inches in diameter at 5 feet from the ground and 12 inches in diameter at 40 feet from the ground. First 25 feet free from limbs excepting a few small, dead branches. Annual rings showed about 200 years of age.

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

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

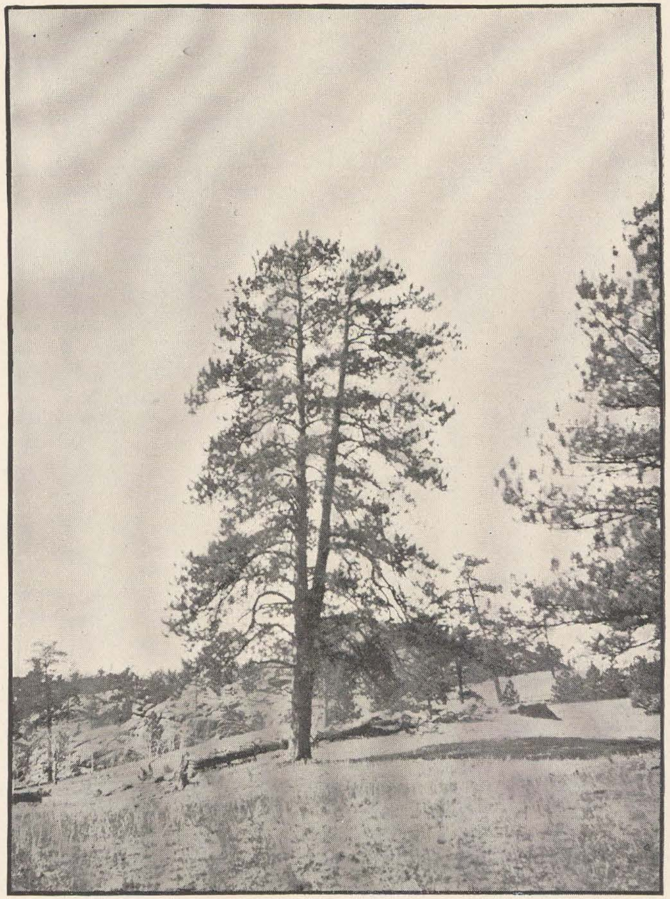
What to the eye of the botanist appears to be, and is considered, as one species is in this case divided by the lumberman into what he calls yellow pine and black pine, the former being most valued, having a wood lighter in weight and with less sapwood, while the latter is claimed to be of poor quality,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

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



A. YELLOW PINE, SOUTH PLATTE RESERVE.

About 100 feet high; 30 inches in diameter. Exceptionally large for this region.



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

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

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

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

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

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

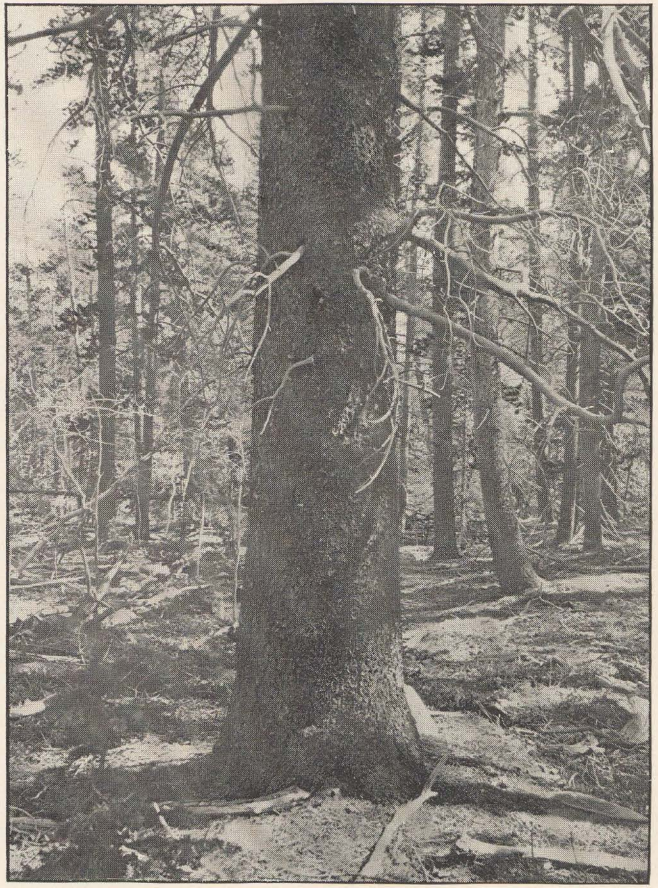
PINUS MURRAYANA Engelm. (Lodgepole pine, white pine, spruce pine.)

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

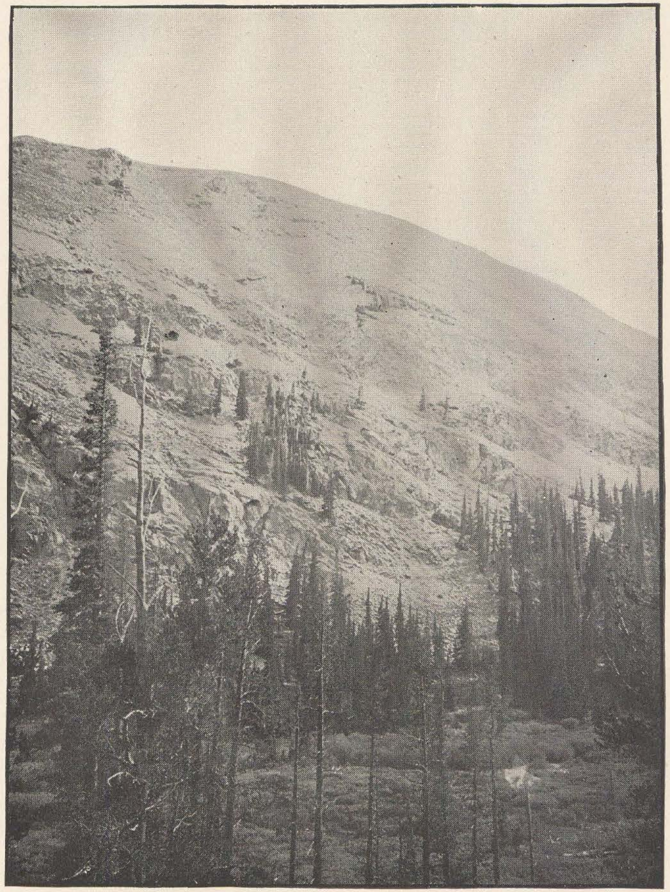
In the Lost Park region, north of the Tarryall Mountains, at an altitude of about 10,000 feet, two saw logs cut on a cold slope facing north measured, respectively, 12½ and 15 inches in diameter at the butt and showed 260 and 310 rings of annual growth. These trees were growing with Engelmann spruce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

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

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



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



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

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

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

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

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

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

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

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

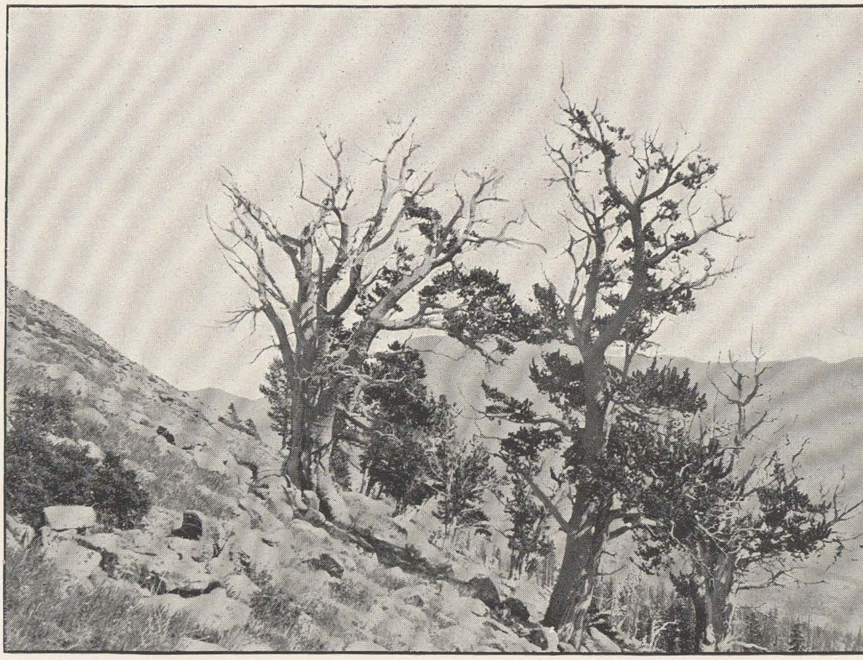
The range pine is common on the slopes of Pikes Peak, where it was originally discovered, and on the higher ridges in that region; it appears local and uncommon in the Plum Creek Reserve, it is plentiful through a large portion of the South Platte Reserve, particularly on the south slopes of unburned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

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

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

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

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



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

B. LODGEPOLE PINE IN SOUTH PLATTE RESERVE.

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

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

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

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

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

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

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

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

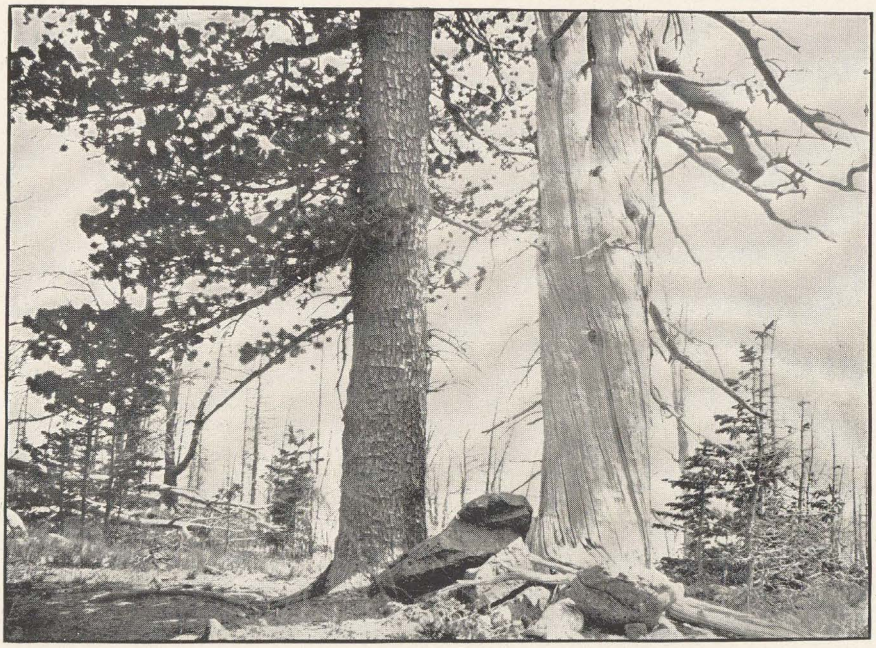
Trees with trunks 4 feet in diameter at the stump and 110 or 120 feet in height, with a clear trunk of 50 or 60 feet, are very rare and apparently never were common, even before the coming of sawmills. A trunk diameter of 2 feet at 3 or 4 feet from the ground and a total height of 100 or 110 feet, giving,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

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

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

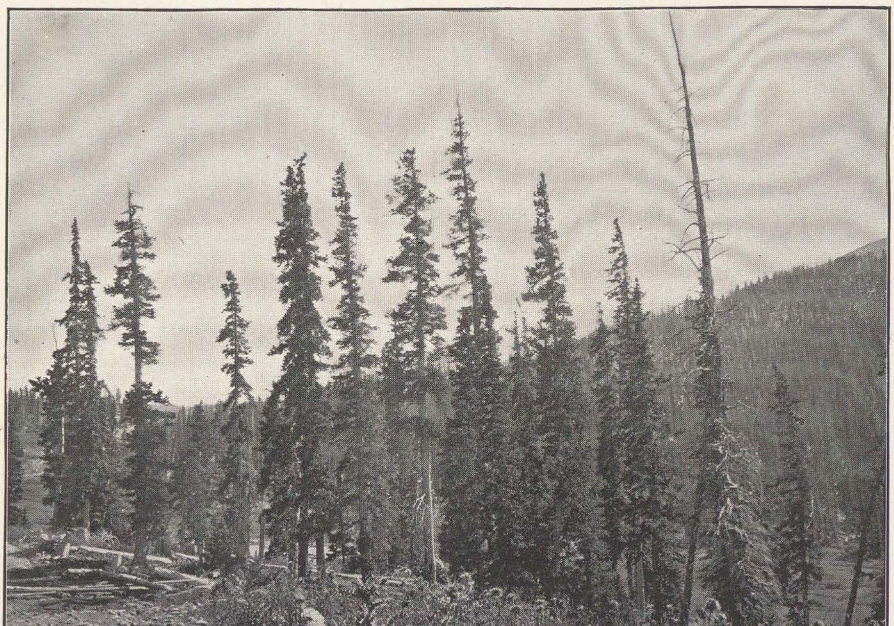
The Douglas spruce is distributed through the main body of the South Platte Reserve, but, like the yellow pine, it seems strangely absent from the Lost Park region lying north of the Tarryall Mountains and east of South Park, although the lower part of this region has an altitude decidedly lower than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

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



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

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



B. ENGELMANN SPRUCE ON BRECKENRIDGE PASS, WEST SLOPE.

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

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

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

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

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

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

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

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

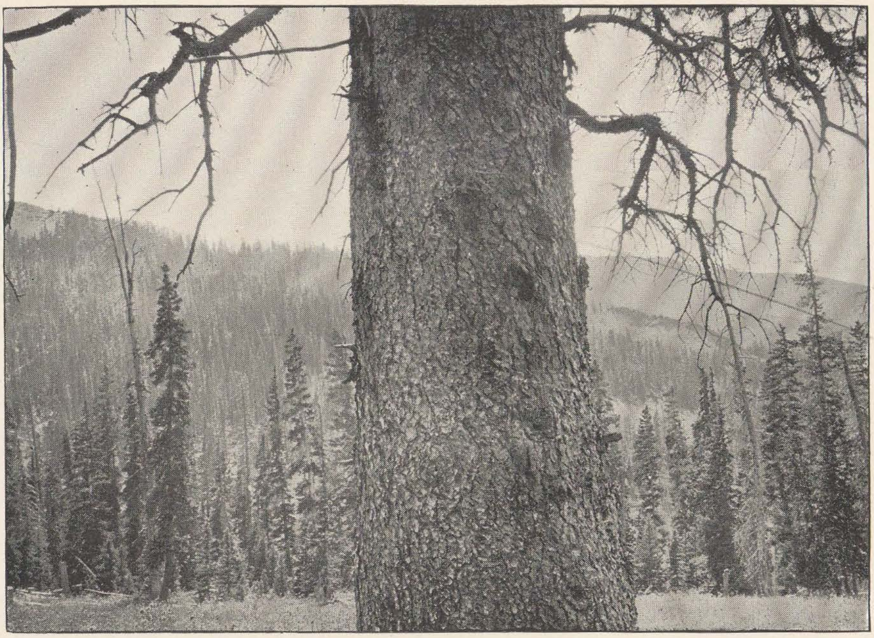
Often extending down cool northern mountain slopes and following cold canyons and gulches in small numbers to 6,000 or 7,000 feet altitude it is most abundant, and seems most at home. It reaches its best development at an elevation between 10,000 and 11,500 feet, covering the tops of mountains under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

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

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

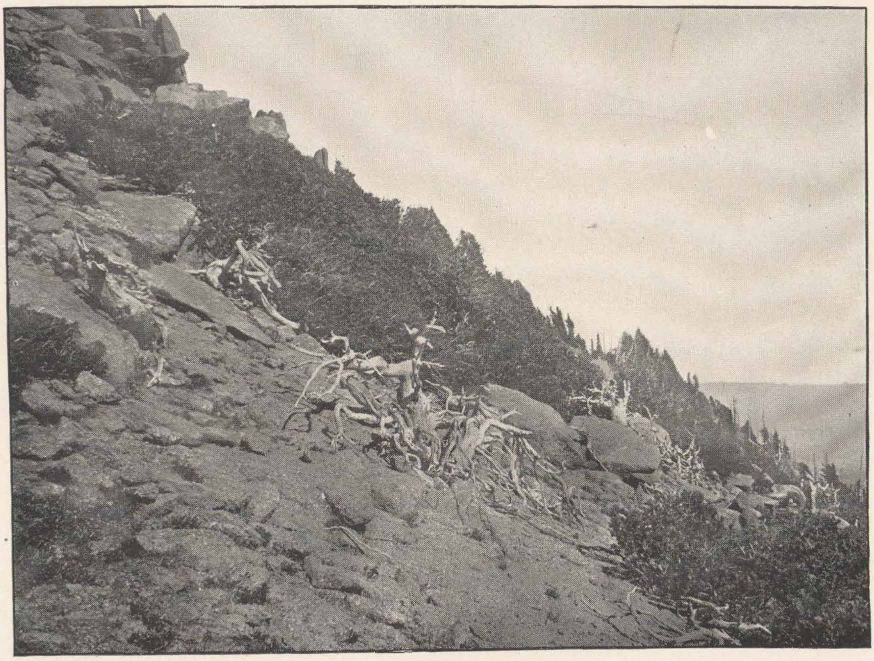
As might be expected on the poor granite soils on which the Engelmann spruce generally grows, and the cool high altitudes at which it reaches its best development, where frosts are common and snows not very rare throughout the summer, the growth of the trees is slow, and a great many years are required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

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



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

Altitude above 11,000 feet.



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

Altitude nearly 12,000 feet.

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

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

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

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

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

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

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

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

Picea parryana (André) Parry (Picea pungens, Engelm.). (Colorado blue spruce.)

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

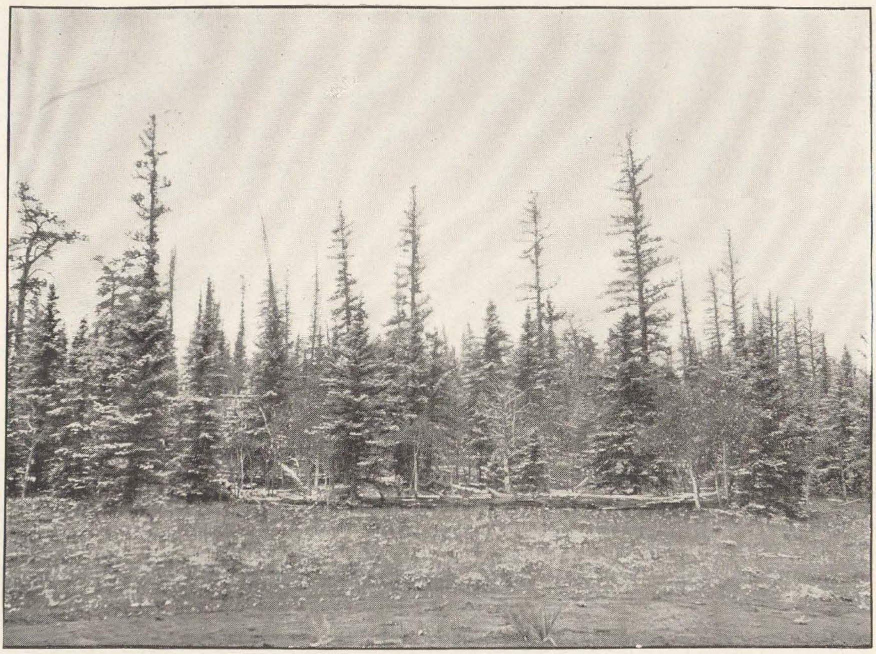
In its best condition, as found in these reserves, the blue spruce may attain a height of 110 or 120 feet and a diameter of trunk of about 3 feet near the base. It is a more horizontally branched, broader spreading, more symmetrical tree than the Engelmann spruce and grows much more rapidly, especially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

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

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

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

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



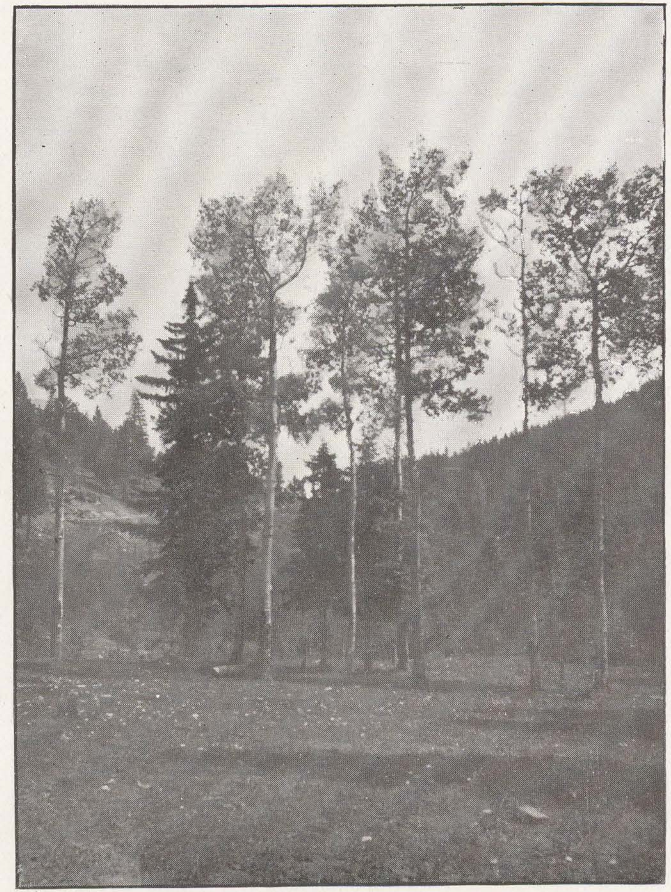
A. BLUE SPRUCE (PICEA PARRYANA), NEAR BUFFALO SPRINGS, SOUTH PARK.

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

Prostrate trees burnt fifteen or twenty years before.

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

Three feet in diameter at 4 feet from ground; 90 to 100 feet high.



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

Aspen 10 inches in diameter; about 50 feet high.

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

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

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

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

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

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

Abies concolor (Gord.) Parry. (Colorado white fir, balsam fir, blue fir.)

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

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

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

Abies lasiocarpa (Hook.) Nutt. (Abies subalpina, Engelm.). (Alpine fir, balsam.)

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

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

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

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

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

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

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

JUNIPERUS SCOPULORUM Sargent. (Cedar.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Populus angustifolia James. (Cottonwood, narrow-leaved cottonwood.)

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

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

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

POPULUS DELTOIDES Marsh. (P. MONILIFERA Ait.)

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

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

PIKES PEAK FOREST RESERVE.

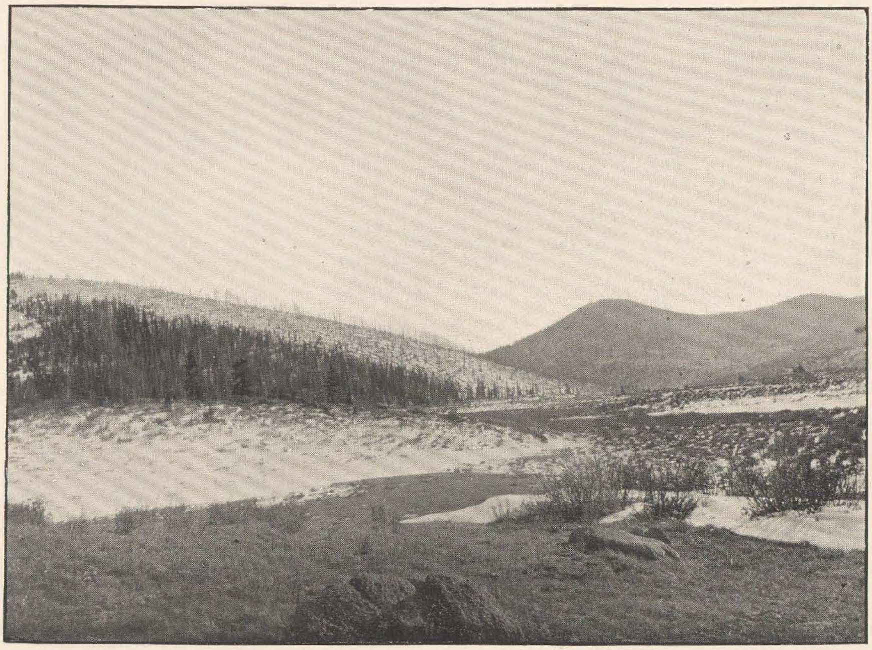
BOUNDARIES.

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

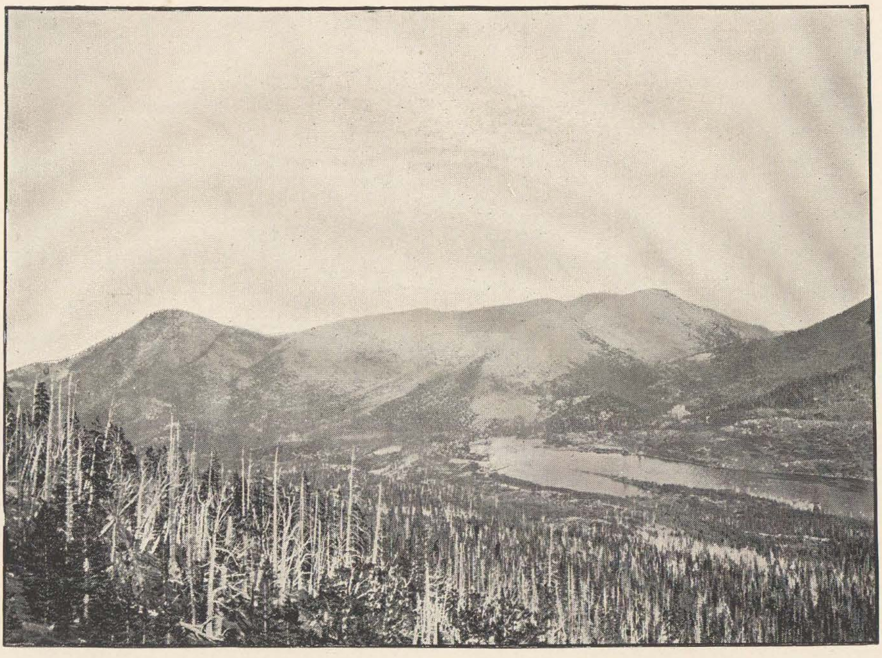
Beginning at the northeast corner of section four (4), township eleven (11) south, range sixty-seven (67), west of the sixth (6th) principal meridian; thence westerly along the second (2nd) correction line south, between townships ten (10) and eleven (11) south, to the northwest corner of section six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

TOPOGRAPHY AND DRAINAGE.

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



A. VIEW AT SEVEN LAKES, PIKES PEAK RESERVE LOOKING SOUTH.



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

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

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

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

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

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

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

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

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

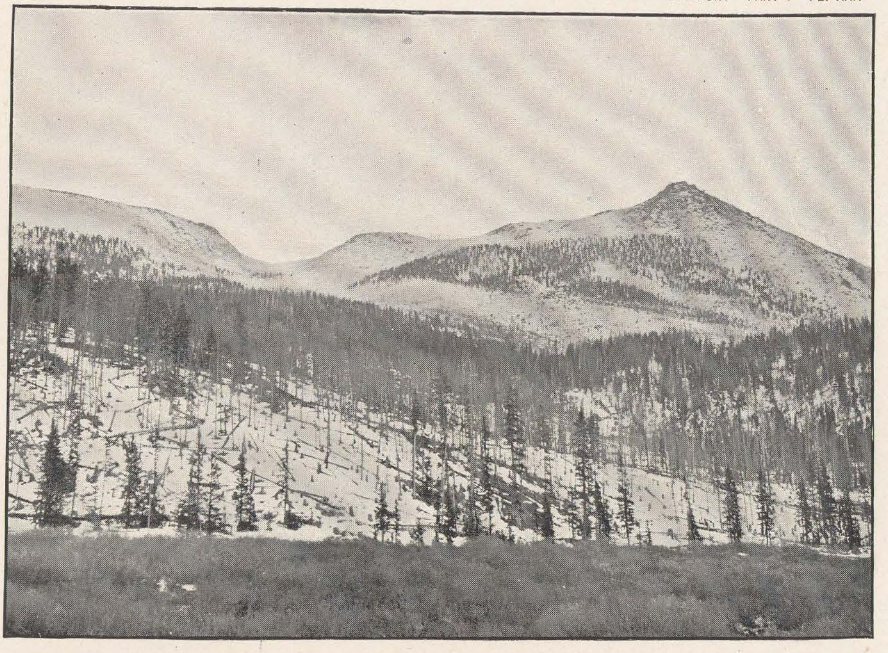
Considering the ranching, manufactures, and especially the large transient and permanent health-seeking population at Colorado Springs, Manitou, and other places along the eastern slope of this reserve, the importance of preserving a pure and undiminished water supply can not be overestimated; and, as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

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

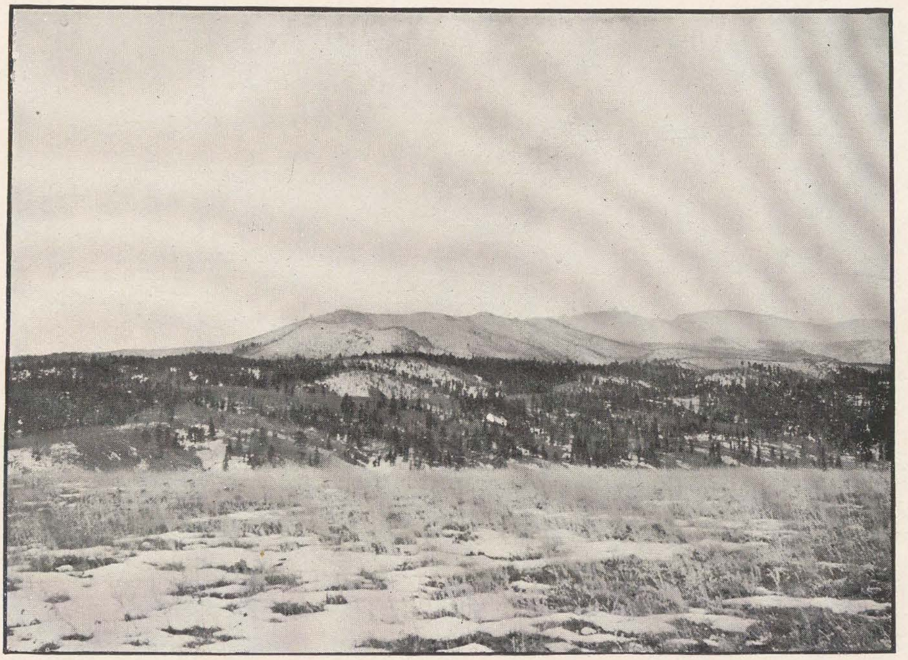
TIMBER.

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

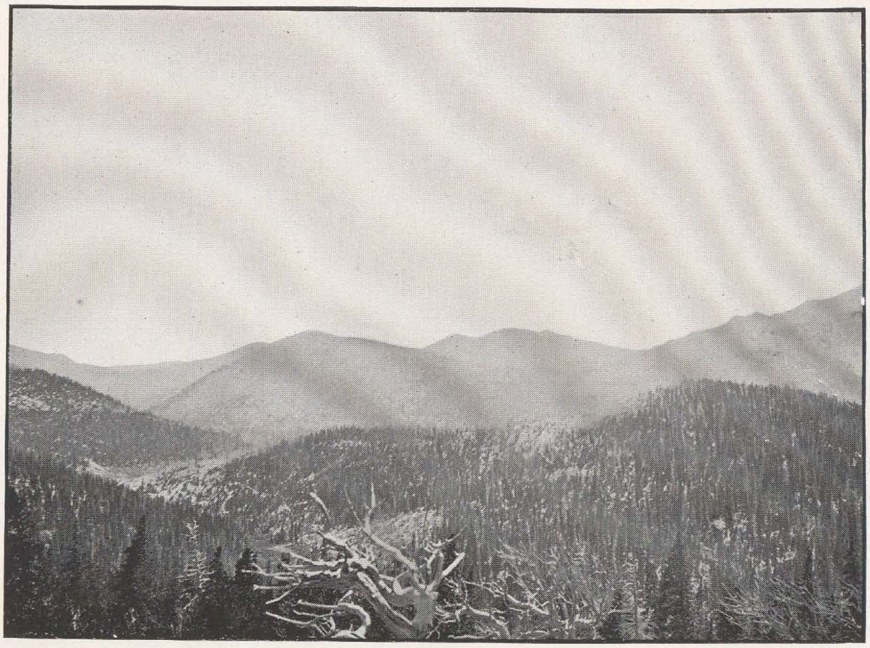
A considerable portion of the Black Forest district, situated between Glen Cove and Midland Station, lies outside the reserve boundaries. It has nearly all been cut over and the best of the timber taken out, although much still remains of sufficient size for immediate use. The activity of sawmills is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



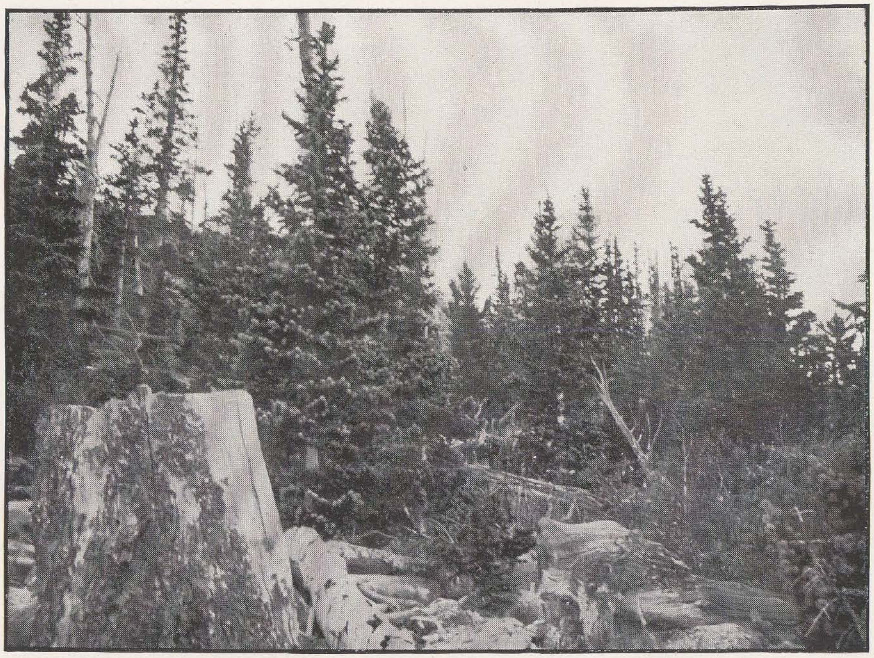
A. BLACK FOREST, LOOKING SOUTH TO SENTINEL POINT, WEST OF PIKES PEAK; MUCH CUT OVER AND BURNT.



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



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



B. ENGELMANN SPRUCE IN PIKES PEAK RESERVE.

Burnt probably over fifty years ago, enough old trees escaping to seed the ground; the old trees since cut.

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

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

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

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

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

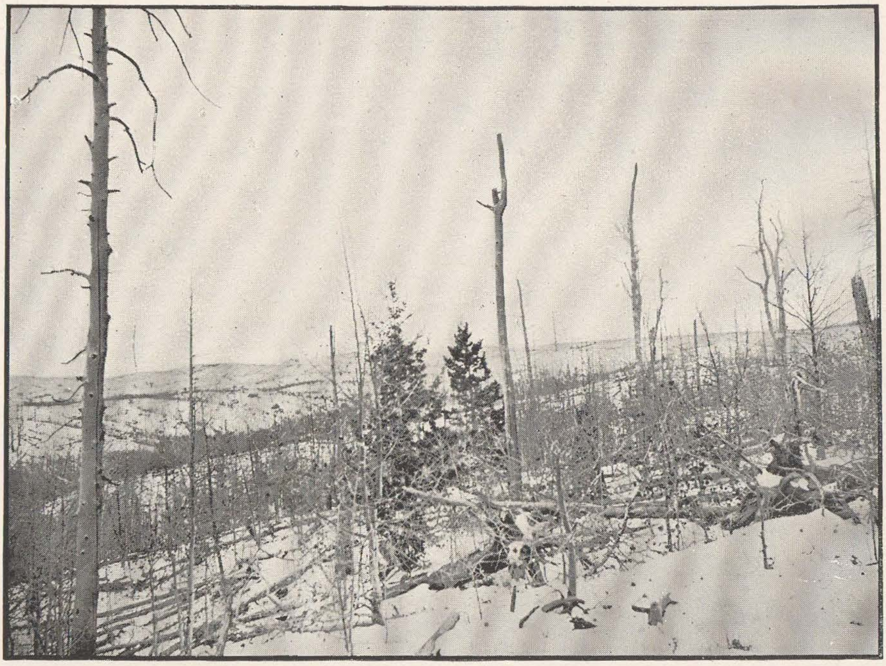
In all the remaining part of the reserve, lying to the north of the Manitou and Pikes Peak Railway, and comprising about 120,000 acres, or two-thirds of its entire area, there is no timber worthy of the name. Between the Pikes Peak Railway and Fountain

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

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

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

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



A. NORTHERN PART OF PIKES PEAK RESERVE, BURNT ABOUT 1880.

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

Burnt probably about fifty years ago

FIRES.

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

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

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

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

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

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

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

SETTLEMENTS.

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

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

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

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

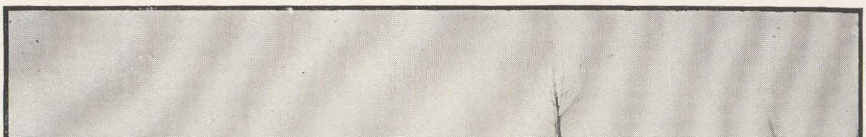
Along Bear Creek and North Cheyenne Creek are two or three small so-called ranches, and several are on the Cheyenne Mountain wagon road between Colorado Springs and Cripple Creek, the largest and most important being located at Beaver Creek and consisting of four or five occupied buildings, forming a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

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

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

A. BEAR CREEK CANYON, PIKES PEAK RESERVE.

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



B. VIEW ON LINE OF MANITOU AND PIKES PEAK RAILWAY

Aspen burnt about five years ago, new growth of aspen coming.

AGRICULTURE AND GRAZING.

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

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

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

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

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

MINING AND LUMBERING.

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

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

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

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

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

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

The fires, which occurred in June, 1896, have left a great deal of standing dead, but sound, timber, which is now being utilized for mine timbers. The trees are cut in the forest into various convenient lengths and hauled to the Midland Station of the Midland Terminal Railway, where they are loaded upon flat cars and shipped to Cripple Creek and other mining camps. The logs are shipped without squaring or dressing, or even the removal of bark. Delivered at the cars, logs 16 feet long are paid for at the rate of 2½ to 3 cents per inch of diameter, measured at the small end, and logs from 4 inches in diameter and upward are taken.

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

SUGGESTIONS.

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

On large areas which were completely burned over, and where no conifers escaped destruction, it is probable that, left to natural conditions, two or three centuries must elapse before the ground again bears a scanty covering of medium-sized trees such as formerly grew upon it. Meanwhile aspen and various shrubs will occupy the ground in part. In places where a few trees or groves escaped, or in the neighborhood of unburned areas, the ground is likely to be much sooner filled with a new growth.

The northern part of the reserve may be regarded as of little or no present value as a timber reserve or for agriculture, and on account of the poverty of the soil the grazing is poor and meager. Moderate pasturage here, however, will not seriously affect the returning forest conditions, which will naturally be very slow.

That these conditions could be supplemented and aided artificially and economically by dissemination of seed would seem probable. Certain it is that this territory is fit for little else than the growth of such trees as will exist upon it.

If practicable, it might be well to modify the boundaries of the reserve so that Palmer Lake should not be included within them. It is also important that the actual boundaries should be more clearly marked, and the persons living near them be better informed in regard to them. This is particularly desirable along the boundaries where there is timber, especially in the Black Forest region, in the western part of the reserve, where inquiries were made, and ignorance was professed in regard to the boundaries by persons who were removing dry timber from what was probably Government land.

Without injury to any private rights, at least 15 or 20 square miles lying to the west and southwest of Pikes Peak could be added to the reserve with great advantage. This would include Sentinel Point and other territory above timber line, and the springs or sources of various small streams flowing westward or southward.

The irregular boundary line in the southeastern part of the reserve is inconvenient and without any apparent geographical or topographical significance.

PLUM CREEK TIMBER LAND RESERVE.

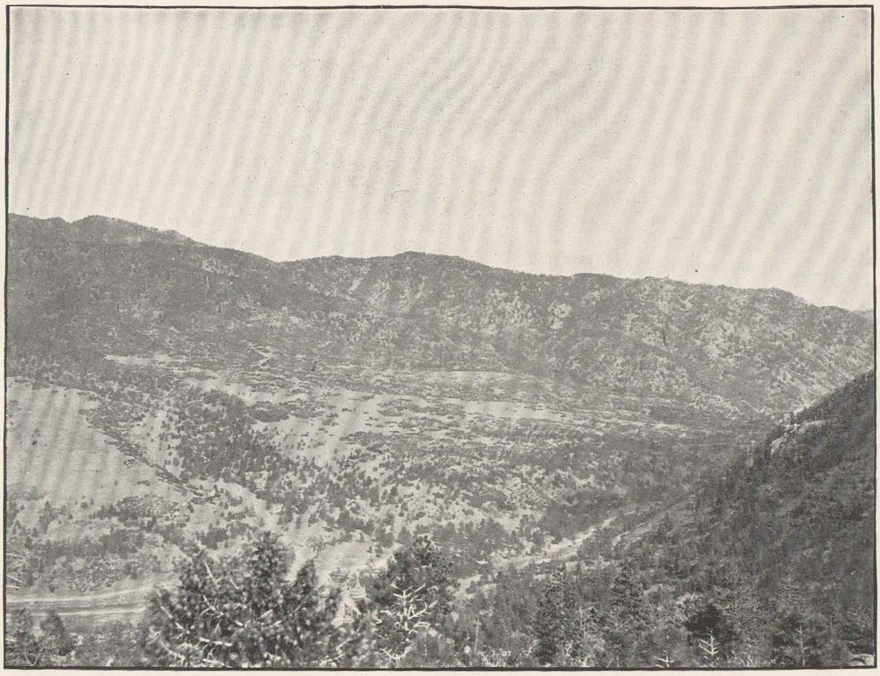
BOUNDARIES.

The boundaries of this reserve, as established by Executive order of June 23, 1892, are as follows:

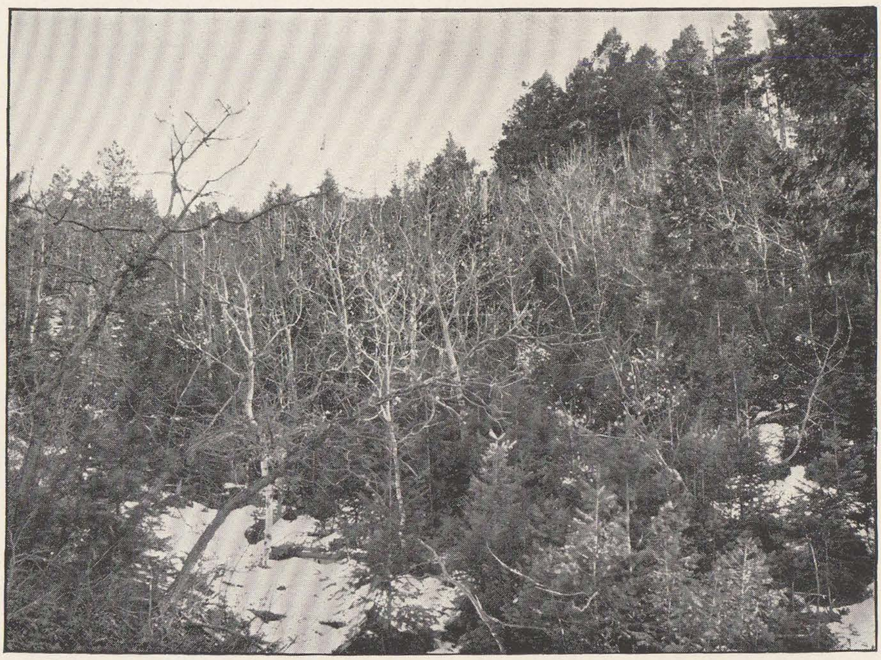
Township ten (10) south, of ranges sixty-eight (68), sixty-nine (69), and seventy (70) west; township nine (9) south, of ranges sixty-eight (68) and sixty-nine (69) west; township eight (8) south, of range sixty-nine (69) west; and so much of township ten (10) south, of range seventy-one (71) west; township nine (9) south, of range seventy (70) west; township eight (8) south, of range seventy (70) west, and township seven (7) south, of range sixty-nine (69) west, as lie to the eastward of the South Platte River.

TOPOGRAPHY AND DRAINAGE.

This reserve is situated directly to the north of the Pikes Peak Reserve, which adjoins it for 6 miles along its southern boundary. It is located entirely within Douglas County, and the area is given as 179,200 acres. The average altitude is much lower than that of any of the three reserves examined, the highest point reaching to less than 9,800 feet, in Thunder Butte, near West Creek, in the southwestern portion; the lowest falling below 5,600 feet in the extreme northeast corner. The reserve as a whole might be likened to a high, hilly plateau, having a diminishing slope northward, and cut by many gulches or canyons having a general easterly or westerly direction. The greater part of the area lies at an altitude between 7,000 and 8,000 feet. Irregular ridges, extending from north to south through the central



A. VIEW LOOKING OVER CASCADE TO NORTH SLOPES OF HILLS ALONG UTE PASS, PIKES PEAK RESERVE.



B. EXCEPTIONALLY GOOD STAND OF YOUNG DOUGLAS SPRUCE ON NORTH SLOPE IN PLUM CREEK RESERVE AMONG ASPEN AND SCRUB OAK.

Altitude 7,500 feet.

part of the reserve throw the waters in an easterly direction into Plum Creek, which falls into the South Platte River below the reserve boundaries, or in a westerly direction into small streams, which also flow into the South Platte along the reserve boundary.

The most important stream flowing through this reserve is West Creek, with its important tributary known as Trout Creek. These really have their sources and some of their most important feeders outside the reserve limits, in the high comparatively level and partly open country lying to the west of the northern part of the Pikes Peak Reserve. They pass through and drain the southwestern portion of the reserve, coming together and forming what is locally called Horse Creek, which runs 4 or 5 miles before entering the South Platte River. The eastern slope of the reserve is drained by several small branches of Plum Creek, the most important of which are West Plum Creek and Jackson Creek, which falls into it.

There are practically no lakes or ponds or important natural reservoirs in the Plum Creek Reserve, but there are several small private storage reservoirs and numerous situations where such could be economically constructed, as they are especially necessary to ranches along the eastern slope.

The amount of water flowing from this reserve is not large, and it is liable to great variation. On account of its relatively low altitude and the absence of dense forest covering, the snows disappear early in the season, so that during summer the smaller creeks sometimes become dry or have a very much diminished flow.

On the west side the extended area of the watershed of West Creek and its tributaries enables this stream to maintain a fair flow of water throughout the year, although much diminished in summer, when many of the smaller tributary creeks and springs become dry.

While passing through the reserve very little of the water is changed from its course for irrigation purposes, although much is used on the lands below.

TIMBER.

The trees of chief economic value in this reserve are yellow pine (*Pinus ponderosa*) and Douglas spruce (*Pseudotsuga taxifolia*), and with these are associated a small amount of blue spruce, Engelmann spruce, *Pinus aristata* and *Pinus flexilis;* while in the southeastern portion, south of Devils Head or Platte Mountain, there is an abundance of lodgepole pine (*Pinus murrayana*). North of Devils Head Mountain a large proportion of the hills or ridges are practically destitute of timber, at best only a few scattered trees being found upon them, although along the intervening gulches or creeks there is or has been a fair growth of small-sized or medium-sized timber trees. These nearly treeless hills generally do not show many indications of ever having borne any heavy forest. They support several species of shrubs, which partly cover the coarse granitic soil.

In the southern portion, which largely has an altitude of from 500 to 1,000 feet greater than the territory to the north of Devils Head Mountain, the country has much more of the appearance of a forest, although the trees are nowhere large or would produce over 2,000 feet of good sawed lumber to the acre on any average measured section of land.

The local demand for lumber and the facility with which it could here be taken out has caused nearly the whole of this reserve to be very thoroughly gone over by lumbermen, and the best has been removed. In some places a second or third culling out of the best trees has taken place. Notwithstanding the activity of sawmills, however, there are still a good many million feet of coarse lumber procurable from yellow pine and Douglas spruce in the southern and southwestern part of the reserve. This fact is well known to the sawmill men, and three or four portable steam sawmills are at work upon what timber remains. Trees 3 feet in diameter of trunk are very rare and most of the logs cut range between 12 and 20 inches in diameter at the stump. With the trees fit for cutting profitably into lumber there is a very large proportion of material of various ages and sizes which will not be servicable for many years to come and which should receive greater consideration and protection than is usually accorded by wood choppers when taking out the trees which they consider worth cutting.

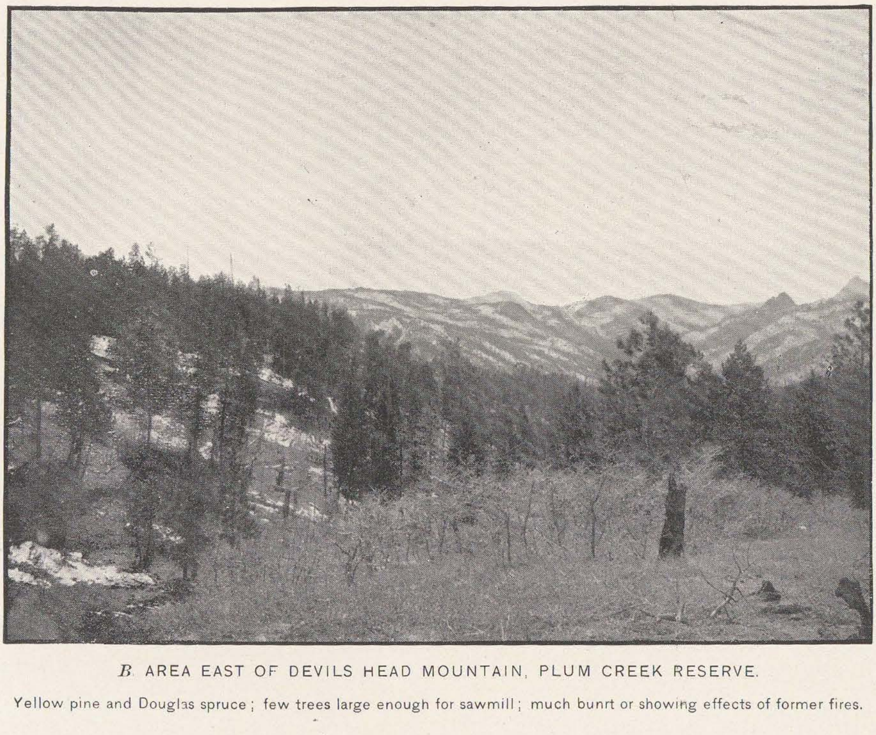
As in most other parts of this region, it is common to find the slopes facing the south almost bare or producing a very scattered growth of yellow pine, while the opposite northern slopes are much more closely timbered with Douglas spruce and yellow pine, although that which remains is chiefly of small size.

On account of great variation in the conditions and quality of the standing timber, the extensive culling out of the best over all parts, and the numerous practically bare tracts or those which have been burned over, it is extremely difficult to give any close approximate estimate of the quantity of ready available sawmill or railroad-tie timber still standing upon the reserve. From as careful observations and estimates as could be hurriedly made, however, it is probable that, by taking trees above 8 or 10 inches in diameter, at least 50 million or 60 million feet of rough sawmill lumber could still be gleaned from the wooded parts of the reserve.

The clear trunk furnished by the ready sawmill timber is very short, probably not over 25 or 30 feet, but a considerable portion of the limb-bearing parts of the trunks are used. Douglas spruce 100 feet high, with 50 feet of clear trunk, and 20 inches in diameter at the stump, is still found in sheltered locations in canyons, but such good

A. LOOKING WEST, ABOUT 2 MILES ABOVE FOOT OF HILLS ON JACKSON CREEK ROAD, PLUM CREEK RESERVE.

Timber long ago cut off or burnt.



B. AREA EAST OF DEVILS HEAD MOUNTAIN, PLUM CREEK RESERVE.

Yellow pine and Douglas spruce; few trees large enough for sawmill; much bunrt or showing effects of former fires.

A. SOUTHWEST PART OF PLUM CREEK RESERVE.

Exceptionally favorable condition of timber; not yet entered by lumbermen. Yellow pine and Douglas spruce.

B. VIEW ALONG FOURMILE CREEK, WEST OF THUNDER BUTTE, PLUM CREEK RESERVE.

Remnants of yellow pine and Douglas spruce left by lumbermen.

trees are rare. Some lodgepole pine is fit for use, but most of it is undersized.

In some of the gulches quaking aspen occasionally attains a height of 50 or 60 feet or more with the trunk a foot in diameter, but timber of this species and size is too rare to be of much commercial importance.

FIRES.

Throughout this reserve there are in different parts large areas which have in past years been visited by forest fires, and over much of the territory there are evidences of ground fires which have destroyed the humus, leaving only the bare granite sand. The forest fires have not swept any such extensive continuous areas as in the Pikes Peak Reserve; though they have burned over considerable tracts, they have left intervening groups or belts of living timber, especially in the northern and eastern parts. On some of the burned ground a new growth of conifers is gradually coming in and has already attained good size and density; in others the ground is practically bare, excepting for aspen and various shrubs. Chief among these latter are scrub oak (*Quercus gambelii*), *Ribes cereum*, *Cercocarpus parvifolius*, *Holodiscus discolor*, *Rubus deliciosus*, *Prunus pennsylvanica*, *Ceanothus fendleri*, *Jamesia americana*, and *Arctostaphylos uva-ursi*.

The best timber remaining is in the southern and southwestern part of the reserve and along the South Platte River, and fortunately these parts have not been seriously devastated by fire.

Small burned areas which were set on fire by sparks from sawmill engines are occasionally seen. Several cases of fires started by lightning were reported. No railroad crosses the reserve, but the Colorado and Southern Railway, commonly called the South Park Line, follows the course of the South Platte River along the northern boundary.

North of Devils Head Mountain there are large areas of nearly bare hills which have been swept by fire, although they do not appear to have ever had a dense growth upon them. Upon these hills are a few scattered yellow pines, but little else which can be called arborescent, as the aspen on these dry exposures apparently never grows large. Recovery from the burns must be exceedingly slow, especially on southern slopes. On northern slopes seeds appear to germinate more freely and seedlings more easily get a foothold. South and southwest of Devils Head Mountain the young lodgepole pine is of various sizes, according to the age of the burns, and it sometimes forms almost impenetrable thickets.

The lodgepole pine, on account of its dense growth and resinous character, burns more freely than the other species, and, apparently, small strips are sometimes burned, the fires eventually dying out, so that it is not uncommon to find different areas with trees of two or three distinct ages or periods growing upon a tract of a few hundred acres.

In the more open woodland evidences of surface or ground fires are common, and on these areas there are few or no seedling trees, and older trees sometimes show blackened bark, or destruction of the bark on one side, as evidence of damaging fires which did not reach up among the limbs of the trees, nor were hot enough to destroy the entire bark at the base, and so cause death.

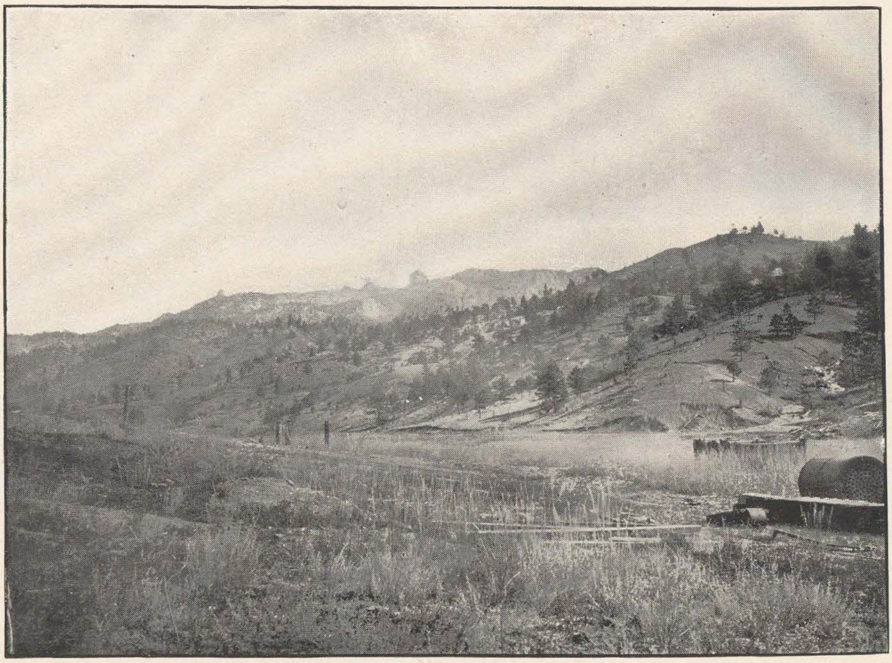
SETTLEMENTS.

A larger proportion of the total area of this reserve is in private ownership, under patent and homestead laws, than in any of the three reserves examined. At least one-third of the territory is claimed under the provisions of these laws. The largest proportion of these lands is situated in those parts having the lowest altitude and most level surface, as at the northern end, and also the middle eastern side, including Perry Park, where there is a solid contiguous block of about 20 square miles of patented land included within the reserve lines. A considerable portion of the patented land is not used or occupied by the owners.

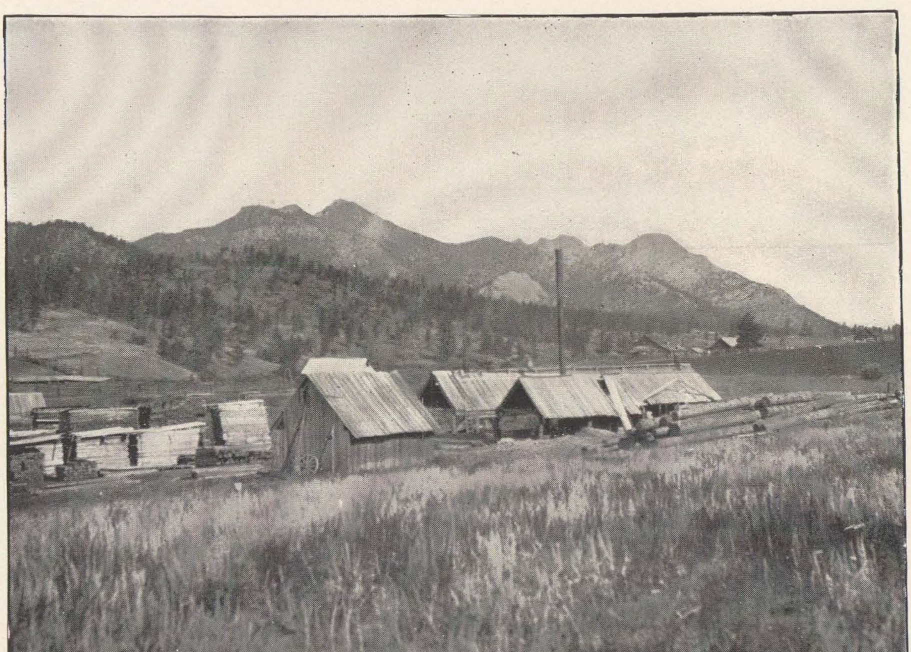
The western side of the Plum Creek Reserve has been the scene of intense mining excitements within the past four or five years, resulting in the establishment of half a dozen small settlements or "town sites." The boom having passed, on account of disappointing expectations as to the richness of the discoveries, the so-called towns are partially deserted for other fields, so that many of the hastily constructed buildings are now without tenants.

The largest of these mining camps is Pemberton, sometimes called West Creek, located on West Creek 9 or 10 miles above its junction with the South Platte River and near the southern boundary of the reserve. Probably two-thirds of the hundred or more habitable buildings were vacant in the summer of 1898, but the population here is liable to considerable fluctuation, from time to time, according to the activity of sawmills in the vicinity or the development of mines or mining prospects.

Other small settlements are Given, about 2 miles above the mouth of West Creek; Daffodil or Trumbull, near the junction of West Creek and the South Platte River; Dunaway and Nighthawk, at intervals of 3 or 4 miles down the South Platte River. These last three places are in part located across the river in the South Platte Reserve, in Jefferson County. They are each composed of merely a few occupied buildings of very cheap construction, and are liable to have their populations depleted or increased any day, according to the rise of mining excitements in other places or developments in the immediate vicinity. At present they derive most of their life from prospectors,



A. VIEW AT DUNAWAY, LOOKING NORTHEAST ACROSS SOUTH PLATTE RIVER.



B. VIEW ABOVE PEMBERTON (WEST CREEK), PLUM CREEK RESERVE, LOOKING NORTHWEST OVER SAWMILL TO THUNDER BUTTE.

or from those employed in the lumber business, as much lumber is hauled by team through these places on the way down the valley of the South Platte River to South Platte Station on the South Park Line, whence it is shipped by rail to Denver and other points.

Besides these "town sites," other settlements, mostly abandoned or with but a single occupied dwelling, and prospectors' cabins or ranches are scattered through the reserves, chiefly along the more important creeks. The largest and best ranches are located in the comparatively low region toward the northern end and about Perry Park on the eastern side of the reserve, where there are five or six considerable ranches chiefly devoted to the raising of cattle. Perry Park itself was originally designed as a summer resort by its owners, but at present contains only two or three occupied dwellings, and the hotel is not in use. As the situation is a very picturesque, interesting, and attractive one, it is probable that at some future time a considerable population will be centered here.

At Daffodil, on the South Platte, are so-called mineral springs, which are visited by a varying number of people during the summer, who occupy inexpensive cabins or cottages put up for their accommodation.

The only expensive buildings on the reserve, or those costing more than a few hundred dollars, are located outside of the hills, about Perry Park.

AGRICULTURE AND GRAZING.

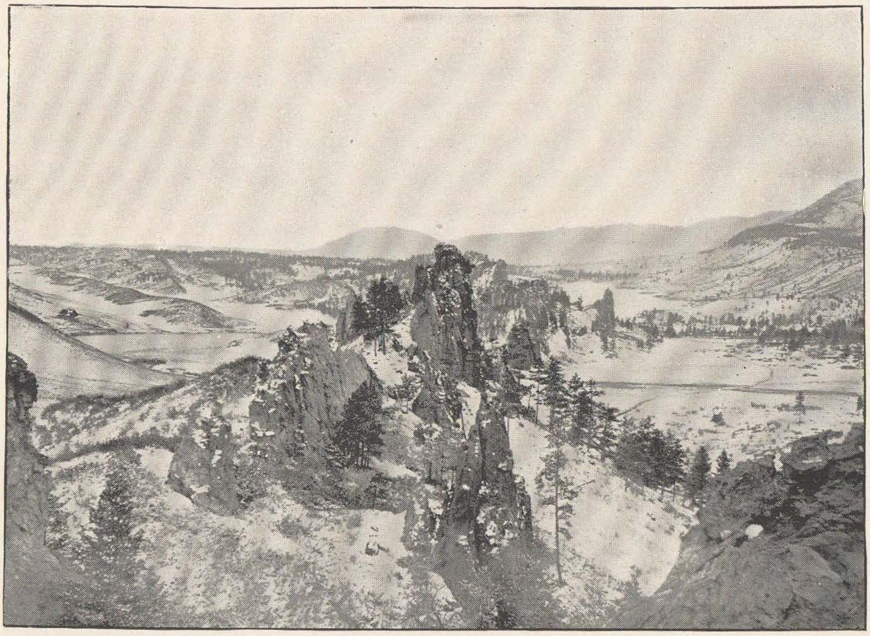
Timber, and possibly mining, must ever remain the chief considerations of commercial value in this reserve. Incidentally, grazing for several thousand cattle may be furnished, but much development of pure agriculture is out of the question. At the lowest altitudes, at the northern end of the reserve and the extreme eastern side, as represented by the vicinity of Perry Park, lying southwest of Dawson Butte, it is possible to raise the hardier cereals and forage crops, potatoes, and other hardy vegetables. Attempts have been made to raise some of the hardier fruits, but as yet with uncertain success. The areas suited to such crops are, however, limited to a comparatively few acres of irrigable land. Oats, rye, potatoes, and other hardy crops are also grown on the narrow strips of fertile or irrigable land bordering the creeks in some places and along the South Platte River. There is a ready local demand for anything that can be raised, and, in fact, most of the food supplies used in the reserve have to be brought in from outside. Grain and fodder are the chief interests cultivated, and are used on the ranches for the cattle and horses in winter.

The so-called ranches vary much in size and value. Some are deserted, some merely prospectors' cabins, others comprise perhaps an acre or two of arable land and three or four head of stock, while the largest may have 300 head of cattle grazing both on patented and reserve Government lands. Two of the largest of these ranches, estimated to graze about 300 head of cattle each, are located in the northern and western slopes of the reserve, and another large one is in the extreme south, near Manitou Park. The size of herds is no indication of proportionate territorial ownership. In summer the cattle on these ranches are usually allowed to roam at large over any part of the reserve and are brought into sheltered places at the approach of severe winter weather.

There may be 50 or 60 persons having ranches upon the reserves, who, in the aggregate, probably have between 1,500 and 2,000 cattle and horses. This, however, does not represent the total number of cattle grazed on the reserve in summer, because a great many are annually sent into the reserve from ranches outside of the boundaries, sometimes at a considerable distance from them. By thus grazing on the public lands the ranchmen are enabled to keep a much greater herd than would be possible on their own comparatively small ranches. On their patented areas they commonly allow the native grass to grow for winter grazing or harvest it, and also raise other forage where irrigation is possible.

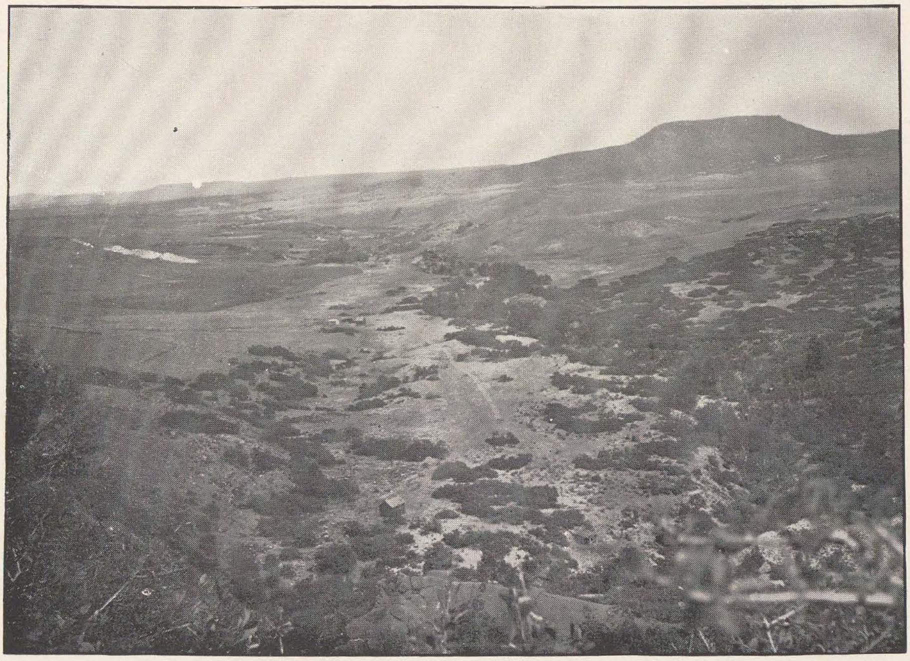
As the forested lands are rarely densely covered, some grasses, furnishing scattered and limited grazing, are found almost everywhere; but it is naturally along the creeks that the best and only important pasturage is found. As it is here that cattle find necessary water, and as it is customary to furnish them with salt in such localities in order to keep them together as much as possible, it naturally follows that these regions are most closely grazed. That the grazing is often excessive and too localized is apparent to anyone following many of the streams, particularly the tributaries of Trout Creek and West Creek, in the southwestern part. The consequence is that the pasturage has deteriorated greatly, the ground produces much less food for animals than it did a few years ago, and the conditions are yearly becoming worse. The best forage grasses, having no chance to reproduce themselves by seed, and being constantly cropped almost to the very roots, and crushed or displaced by hoofs, must inevitably become greatly weakened or die out. Moreover, the shrubs and herbaceous vegetation bordering the streams are constantly cropped, trampled upon, and eventually destroyed. These served to protect the banks of the creeks, and prevent them from washing, and also served to check and hold the flow of water in times of unusually heavy precipitation.

The slender streams themselves are trampled and the waters are so polluted as to be unfit for human use, if, indeed, the streams are not practically dry, as they are very apt to be during the late summer season, owing to the unnatural conditions which prevail. Moreover, the excessive number of cattle in some localities is more or less damaging



A. PERRY PARK, LOOKING SOUTHEAST FROM HIGH ROCK.

Reservoir and C. A. Roberts's house on left.



B. DAKAN (PERRY PARK), LOOKING NORTH; DAWSON BUTTE ON RIGHT

Dark patches are chiefly scrub oak.

to young forest growth, as even young conifers like Douglas spruce are occasionally browsed upon, and many seedlings are destroyed by trampling.

Unless the grazing is restricted and regulated the pasturage must certainly grow even poorer than it is now. Under proper regulations and limitations a considerable number of cattle might be pastured on the reserve without serious injury, but it would in the end be of greater benefit to the State and Government to prohibit grazing altogether than to allow it to be overdone.

Sheep grazing does not appear to be carried on in or about the reserve.

MINING.

No well-established paying mines are yet in operation, although it is claimed that numerous promising "prospects" have been discovered and only lack capital for their proper development.

Two or three small mills are in course of construction in the Trout Creek Valley north of the southern boundary of the reserve. These are intended to treat by cyanide process low-grade ore-bearing rock or the gravel or sand so abundant in this region and which is said to contain a sufficient percentage of gold to make the workings profitable. Should this prove to be the case, it is likely that it will mean a considerable and permanent addition to the population of this locality. Prospectors are busily engaged in developing shafts or tunnels, constantly having before them the hope that they may make discoveries which will lead to the building up of a second Cripple Creek. That gold exists here there is ample evidence, and it is chiefly a question of the abundance of mineral-bearing rock and of the employment of capital necessary to get it out economically. Persons having ranches or cattle in the reserve, or in other kinds of business, besides professional miners and prospectors, give some time to prospecting when not otherwise employed.

While the principal mining or prospecting has been developed in the West Creek and Trout Creek regions and along the South Platte River, there are men in other parts of the reserve who are prosecuting the search for the precious metals. On the eastern side of the reserve, in Spring Creek Canyon near Perry Park, a tunnel 170 feet in length was found, from which it was stated that pay ore had been taken which assayed about $35 in gold and 300 ounces in silver to the ton. The statements of prospectors are not always to be implicitly relied upon, however, as they are likely to be biased by their hopes.

In the Perry Park territory, on the eastern edge of the reserve, a small mill has been started for the manufacture of plaster and similar products from gypsum and other rock suitable for such purposes, which is plentiful in this locality. The product is shipped by railroad to Denver, Colorado Springs, or wherever a market can be found. The work is yet largely experimental, but may develop into a considerable business.

LUMBERING.

A good deal of lumbering is still carried on in this reserve, no doubt largely illegally, although usually claimed to be under the provisions of existing laws. At the time the reserve was examined six portable steam sawmills were in operation upon it, altogether capable of turning out between 60,000 and 70,000 feet of lumber a day when running full time. The largest of these mills was located on Fourmile Creek, west of Thunder Butte, and was stated to be able to produce from 15,000 to 18,000 feet a day. This mill had exhausted the adjacent supplies and was preparing for removal to another location within a few miles. It was claimed that the mill was located on private holdings of land and that the cuttings were from a purchased school section.

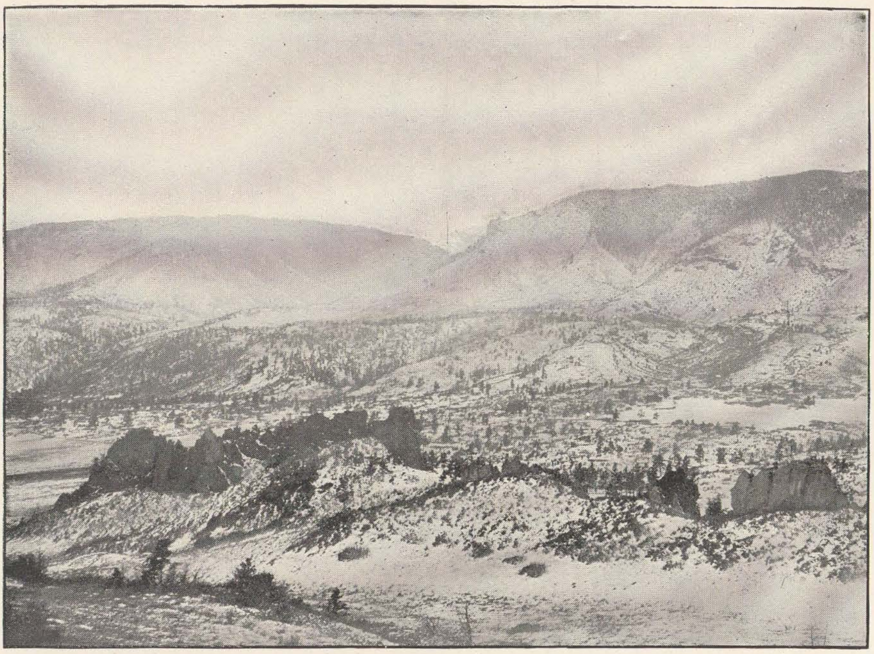
Another mill is situated about a mile south of Pemberton. Its reported capacity was 12,000 or 13,000 feet of lumber a day, and it had been located on the same site for over a year and a half, a longer time than the average period for an active mill to remain in the same place.

A large mill with a capacity of about 15,000 feet of lumber a day had been at work near the mouth of West Creek but was in process of removal to a location outside of the reserve, where a more abundant timber supply was obtainable.

A mill capable of cutting 8,000 or 10,000 feet a day had been recently relocated at the head of Jackson Creek, to the west of Devils Head Mountain, cutting from what was claimed to be homestead and school-section land. It had previously been located farther down Jackson Creek. About 3 miles east of Nighthawk, on the road to Sedalia, a small sawmill was at work, and another was located on the eastern slope south of Perry Park.

Along rivers and creeks throughout the reserve, piles of sawdust and sawmill refuse are frequently met, each one indicating the base of active operations of some lumberman for a time. These piles are commonly left to sink gradually into decay, but at Given the great accumulation of sawdust left by a recently removed mill was burning and probably continued to burn for several weeks.

The lumber cut and sold by these mills is practically all yellow pine and Douglas spruce, the pine constituting decidedly the larger proportion. It is used locally for buildings, mines, and other uses, and commonly sells for $8 or $9 per 1,000 feet at the sawmill. The lumber sold for use in the reserve, however, constitutes but a very small fraction of the total amount cut, most of it being shipped to markets far outside the reservation limits. This involves long hauls by team



A. PERRY PARK, LOOKING SOUTH-SOUTHEAST FROM HIGH ROCK.

B. PERRY PARK, LOOKING EAST FROM HIGH ROCK.

to distant railroad stations. The chief shipping point for lumber from this reserve is South Platte, on the South Park Line. Florissant, on the Colorado Midland Railway, also receives some of it, and lumber from the Jackson Creek region is hauled to Sedalia for sale and shipment.

At South Platte it was estimated that from 25,000 to 50,000 feet of lumber was loaded on cars and shipped daily, the points to which it was consigned being Denver and other commercial or demand centers. The lumber here is usually hauled by teams of four horses drawing two wagons together, and carrying 3,000 or 4,000 feet of lumber. Delivered at the railroad station it is worth $11 or $12 per 1,000 feet, pine and spruce generally being sold together and not sorted. Sometimes Douglas spruce is kept separate and cut into planks for bridges.

The lumber roads are in fair condition, especially along the South Platte River, where the present wagon road was once graded for a railroad, but upon which the rails were never laid.

Nearly all parts of the reserve are comparatively easy of access, and roads are sought or cut as the encroachments and demands of the sawmill necessitate in order to obtain fresh supplies of logs. Some of the ground has been cut over a second time, and even a third time, the first cuttings having taken only the larger trees, the last taking whatever can be found of sufficient size to yield a cash profit. Sticks not more than 8 inches in diameter are sometimes used by the smaller mills.

Whenever possible it is the custom to locate the sawmill on patented or homestead land, the timber thereon, and perhaps also the timber upon a school section, being purchased. But the tree cutter knows no boundaries, and the best timber is taken wherever found so long as there is no interference by Federal authorities.

The excuse is made by lumbermen and inhabitants that the cutting and shipping of lumber is necessary to give employment to people settled in the reserve, who may be prospecting part of their time, and who practically depend upon what they may earn at lumbering for subsistence. But at the present rate of cutting the ready lumber will soon be exhausted, although such considerations give little trouble to the men who think only of themselves and their immediate welfare—a class too common in the region of mining camps.

Should important mining industries ever be developed here all the timber in the region around would be needed for local use, but if it is allowed to be shipped to other parts of the State at the present rate the time may come when lumber will be brought in from outside, at a much higher cost to the miner.

Among other schemes for illegally getting timber from Government land, both in and outside the reserve, is the practice of staking out a mining claim on some heavily timbered spot, cutting and selling the timber, and then abandoning the claim without attempting to get final deed or patent for it. As a mining claim includes about 10 acres, it is apparent that by frequent repetition of this scheme upon the very localized areas of good timber much of the best would very speedily be removed.

Besides the sawmills found at work within the reserve, several are or were located on unreserved Government land to the south, procuring their timber largely from ground upon which they had secured no right to trespass. There were rumors of the coming of other mills to this section, in which much good timber is still to be found, better in fact than now exists within the boundaries of the reserve. It is altogether probable that other mills will locate within the reserve unless prevented by legal action. As it is generally considered more economical to move the mill from place to place as the local supply of timber is exhausted, instead of hauling the logs to the mill from any considerable distance, most of the active mills occupy a given site for only a few months.

Great quantities of railroad ties have in the past been cut in the reserve and sold to the various railroads having stations within hauling distance. The cutting of ties is still carried on, although only locally and in comparatively small numbers. The work has been done under certain rights and privileges claimed by the railroads, by cutting upon homestead and patented lands, upon mining claims, or the timber has been boldly taken from Government land wherever trees of suitable size were found. Most of the cutting, however, has been done under cover of concessions claimed to have been granted to the railroads, but about the legality of which there appeared locally to be doubt and dispute. Douglas (locally called red) spruce is the species almost exclusively used. Standard ties are cut 8 feet long and dressed or hewn on two opposite sides to 7 inches in diameter, the other two sides being allowed the full diameter of the tree stripped of bark. All sticks must be large enough to square 7 inches when dressed, but no limit is placed upon the maximum size or diameter of the tie in the broadest or undressed direction. This usually regulates itself, as very large trees involve too much hewing and are too heavy and bulky for hauling most economically, inasmuch as the railroads pay no more for extra large ties than for those coming just within acceptable minimum dimensions. Such standard railroad ties are worth 35 cents each, delivered at a railroad station.

From some of the best of the Douglas spruce to be found, which are trees about 20 inches in diameter at the stump and 100 feet in height, 8 good ties may be cut, making a total length of 64 feet. Such trees are rare, and are found in only a few favored canyons; and, as a rule, not more than three or four ties are procured from each tree.

The cutting is done by outsiders, who come in for the sole purpose of getting out ties, or by persons owning ranches or land in the reserve, or by prospectors who, in many cases, having spent all their capital in sinking shafts or tunneling, cut ties as almost their only means of obtaining subsistence to prosecute their mining work in their particular locality. The cutting of ties is often very wasteful of good Douglas spruce, which could be made to yield fine sawmill timber.

Dry yellow pine or Douglas spruce which has died or been killed by fire is sometimes collected, hauled to railroad stations, and shipped for fuel. Such wood delivered at South Platte Station was paid for at the rate of about $2.75 per cord. It involved a haul of 6 or 8 miles.

SUGGESTIONS.

This reserve must be considered as essentially a timber reserve, rather than one likely to furnish very important water supplies. The timber should be much more rigidly protected from inroads by thieves and damage by fire. On thinly-wooded areas no trees should be allowed to be cut, even although mature, because they are essential as seed producers and give shelter and shade to the ground while the seed is germinating and young trees are getting established.

Such treatment would apply to nearly all the territory to the north of a line drawn east and west of Devils Head Mountain and much other to the south. South of Devils Head Mountain is located nearly all the timber which has an immediate marketable value and which could be cut without great damage to the forest covering. Much of this, however, is second-rate or third-rate in size and could advantageously be allowed to remain for many years. When cut, it should be under the general supervision of someone who would see that the young growth remaining was not needlessly injured.

All the lumber grown on the reserve may yet be necessary for consumption within or near it, and, as a means of conservation, a rule prohibiting the shipping of lumber to distant points might be beneficial. The exclusion of sawmills altogether from the reserve for a term of years would certainly be no injury to the forest crop and would eventually be a gain to bona fide residents. At present the lumber is chiefly taken by outside lumber companies which, after taking out what they are allowed to or can conveniently find, move out to other places, leaving the country deprived of its best crop, for which little or no return has been given. One or two licensed sawmills conscientiously managed could be worked with profit and would yield some return to the Government, but the wholesale indiscriminate destruction, carried on as in the past, should be stopped.

Pasturage, too, should be regulated and restricted, and it is believed that a tax, however small or nominal, on all cattle allowed to range on Government land or found thereon, would have a beneficial effect. As all cattle are branded, the collection of such a tax or the registering of licenses should be practicable.

The boundaries of the reserve include some nearly treeless and purely agricultural or grazing lands along the eastern side, which are almost entirely held in private ownership. For this reason it may be considered best to eliminate a strip which includes Perry Park, and is 6 or 7 miles in length by about 3 in width. This portion of the reserve is traversed by about 5 miles of the direct public road between Palmer Lake, Sedalia, and Denver. Perry Park itself is a very interesting and attractive locality, chiefly on account of the peculiar tilted sandstone rocks and cliffs which are the distinguishing features of its surface and which in some respects are not excelled by the similar formations of the Garden of the Gods, near Manitou.

The laws regarding the cutting of railroad ties and sale of them to railroads, also the rights of railroads to timber from the reserves, should be better known among the people. The laws regarding lumbering are also imperfectly understood.

If copies of rules and regulations and some plan of description of the reserve boundaries could be served upon property owners in the reserve, and posted in public places in the country about it, there would be less excuse for trespass than now exists.

Where there are no guideposts or natural features to indicate boundaries notices posted along roads or trails crossing them should also serve for the same purpose.

The considerable area of land in private ownership is likely to be a constant source of trouble in maintaining the integrity of the reserve for timber production.

Of the three reserves examined the Plum Creek Reserve is the least important for the general welfare of the community, and at least the northern half could be eliminated without appreciably affecting the present or future water or timber supplies.

THE SOUTH PLATTE FOREST RESERVE.

BOUNDARIES.

The boundaries of the reserve as established by Executive order of December 9, 1892, are as follows:

Beginning at the confluence of the North Fork of the South Platte River with the South Platte River; thence up the middle of the channel of the North Fork of the South Platte River to the range line between township seven (7) south, ranges seventy-four (74) and seventy-five (75) west of the sixth (6th) principal meridian; thence northerly on said range line to the northeast corner of township seven (7) south, range seventy-five (75) west; thence westerly on the township line between townships six (6) and seven (7) south to the northwest corner of township seven (7) south, range seventy-six (76) west; thence southerly on the range line between ranges seventy-six (76) and seventy-seven (77) west to the northeast corner of section thirteen (13), township seven (7) south, range seventy-seven (77) west; thence westerly on the section line between sections twelve (12) and thirteen (13) to the northwest corner of section thirteen (13) of said township and range; thence southerly on the section line between sections thirteen (13) and fourteen (14), twenty-three (23) and twenty-four (24), and twenty-five (25) and twenty-six (26) to the northeast corner of section thirty-five (35) of said township and range; thence westerly on the section line between sections twenty-six (26) and thirty-five (35), and twenty-seven (27) and thirty-four (34) to the northwest corner of section thirty-four (34) of said township and range; thence southerly on the section line between sections thirty-three (33) and thirty-four (34) of said township and range, and sections three (3) and four (4), nine (9) and ten (10) and fifteen (15) and sixteen (16), township eight (8) south, range seventy-seven (77) west to the northeast corner of section twenty-one (21) of said last-named township and range; thence westerly on the section line between sections sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19) to the northwest corner of section nineteen (19) of said township and range; thence southerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west to the northeast corner of section thirteen (13), township nine (9) south, range seventy-eight (78) west; thence westerly on the section line between sections twelve (12) and thirteen (13) and eleven (11) and fourteen (14) to the northwest corner of section fourteen (14) of said township and range; thence southerly on the section line between sections fourteen (14) and fifteen (15) to the southwest corner of said section fourteen (14); thence westerly on the section line between sections fifteen (15) and twenty-two (22) and sixteen (16) and twenty-one (21) to the northwest corner of section twenty-one (21) of said township and range; thence southerly on the section line between sections twenty (20) and twenty-one (21) and twenty-eight (28) and twenty-nine (29), to the southwest corner of section twenty-eight (28) of said township and range; thence easterly on the section line between sections twenty-eight (28) and thirty-three (33), to the southeast corner of said section twenty-eight (28); thence southerly on the section line between sections thirty-three (33) and thirty-four (34) of said township and range, and sections three (3) and four (4), nine (9) and ten (10), and fifteen (15) and sixteen (16), township ten (10) south, range seventy-eight (78) west, to the northeast corner of section twenty-one (21) of said last-named township and range; thence westerly on the section line between sections sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19), to the northwest corner of section nineteen (19) of said township and range; thence southerly on the range line between ranges seventy-eight (78) and seventy-nine (79) west, to the southwest corner of township ten (10) south, range seventy-eight (78) west; thence westerly on the second (2nd) correction line south to the northwest corner of section one (1), township eleven (11) south, range seventy-nine (79) west; thence southerly on the section line between sections one (1) and two (2), eleven (11) and twelve (12), thirteen (13) and fourteen (14), twenty-three (23) and twenty-four (24), twenty-five (25) and twenty-six (26), and thirty-five (35) and thirty-six (36) of said township and range, and sections one (1) and two (2), eleven (11) and twelve (12), and thirteen (13) and fourteen (14), township twelve (12) south, range seventy-nine (79) west, to the southwest corner of section thirteen (13) of said last-named township and range; thence easterly on the section line between sections thirteen (13) and twenty-four (24) of said township and range, and sections eighteen (18) and nineteen (19), seventeen (17) and twenty (20), sixteen (16) and twenty-one (21), and fifteen (15) and twenty-two (22), township twelve (12) south, range seventy-eight (78) west, to the quarter section corner between said sections fifteen (15) and twenty-two (22); thence southerly through the middle of sections twenty-two (22), twenty-seven (27), and thirty-four (34) to the quarter section corner on the south boundary of section thirty-four (34) of said township and range; thence easterly on the township line between townships twelve (12) and thirteen (13) south, range seventy-eight (78) west, to the northwest corner of township thirteen (13) south, range seventy-seven (77) west; thence southerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west to the southwest corner of section six (6), township thirteen (13) south, range seventy-seven (77) west; thence easterly on the section line between sections six (6) and seven (7), five (5) and eight (8), and four (4) and nine (9) to the southeast corner of section four (4) of said township and range; thence northerly on the section line between sections three (3) and four (4) of said township and range and sections thirty-three (33) and thirty-four (34), township twelve (12) south, range seventy-seven (77) west, to the northeast corner of section thirty-three (33) of said last-named township and range; thence easterly on the section line between sections twenty-seven (27) and thirty-four (34), to the southeast corner of section twenty-seven (27) of said township and range; thence northerly on the section line between sections twenty-six (26) and twenty-seven (27), twenty-two (22) and twenty-three (23), fourteen (14) and fifteen (15), ten (10) and eleven (11), and two (2) and three (3) of said township and range, and sections thirty-four (34) and thirty-five (35), township eleven (11) south, range seventy-seven (77) west, to the northeast corner of section thirty-four (34) of said township and range; thence westerly on the section line between sections twenty-seven (27) and thirty-four (34), to the northwest corner of said section thirty-four (34); thence northerly on the section line between sections twenty-seven (27) and twenty-eight (28), to the northeast corner of section twenty-eight (28) of said township and range; thence westerly on the section line between sections twenty-one (21) and twenty-eight (28), twenty (20) and twenty-nine (29), and nineteen (19) and thirty (30), to the northwest corner of section thirty (30) of said township and range; thence northerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west, to the northeast corner of township eleven (11) south, range seventy-eight (78) west; thence easterly on the second (2d) correction line south, to the southeast corner of township ten (10) south, range seventy-eight (78) west; thence northerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west, to the southwest corner of section eighteen (18), township nine (9) south, range seventy-seven (77) west; thence easterly on the section line between sections eighteen (18) and nineteen (19), seventeen (17) and twenty (20), sixteen (16) and twenty-one (21), and fifteen (15) and twenty-two (22), to the southeast corner of section fifteen (15) of said township and range; thence northerly on the section line between sections fourteen (14) and fifteen (15), and ten (10) and eleven (11), to the southwest corner of section two (2) of said township and range; thence easterly on the section line between sections two (2) and eleven (11), and one (1) and twelve (12), to the southeast corner of section one (1) of said township and range; thence northerly on the range line between ranges seventy-six (76) and seventy-seven (77) west, to the southwest corner of township eight (8) south, range seventy-six (76) west; thence easterly on the township line between townships eight (8) and nine (9) south, range seventy-six (76) west, to the southeast corner of section thirty-one (31), township eight (8) south, range seventy-six (76) west; thence northerly on the section line between sections thirty-one (31) and thirty-two (32), to the southwest corner of section twenty-nine (29) of said township and range; thence easterly on the section line between sections twenty-nine (29) and thirty-two (32), to the southeast corner of said section twenty-nine (29); thence northerly on the section line between sections twenty-eight (28) and twenty-nine (29) and twenty (20) and twenty-one (21), to the southwest corner of section sixteen (16) of said township and range; thence easterly on the section line between sections sixteen (16) and twenty-one (21), to the southeast corner of said section sixteen (16); thence northerly on the section line between sections fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4) of said township and range, and sections thirty-three (33) and thirty-four (34), township seven (7) south, range seventy-six (76) west, to the southwest corner of section twenty-seven (27) of said township and range; thence easterly on the section line between sections twenty-seven (27) and thirty-four (34), twenty-six (26) and thirty-five (35), and twenty-five (25) and thirty-six (36) of said township and range, and sections thirty (30) and thirty-one (31), twenty-nine (29) and thirty-two (32), twenty-eight (28) and thirty-three (33), and twenty-seven (27) and thirty-four (34), township seven (7) south, range seventy-five (75) west, to the northwest corner of section thirty-five (35) of said township and range; thence southerly on the section line between sections thirty-four and thirty-five (35) of said township and range, and sections two (2) and three (3), ten (10) and eleven (11), fourteen (14) and fifteen (15), twenty-two (22) and twenty-three (23), twenty-six (26) and twenty-seven (27), and thirty-four (34) and thirty-five (35), township eight (8) south, range seventy-five (75) west, to the southwest corner of section thirty-five (35) of said township and range; thence easterly on the township line between townships eight (8) and nine (9) south, range seventy-five (75) west, to the northwest corner of township nine (9) south, range seventy-four (74) west; thence southerly on the range line between ranges seventy-four (74) and seventy-five (75) west to the southwest corner of township ten (10) south, range seventy-four (74) west; thence easterly on the second (2nd) correction line south to the northwest corner of township eleven (11) south, range seventy-three (73) west; thence southerly on the range line between ranges seventy-three (73) and seventy-four (74) west to the northeast corner of section thirteen (13), township twelve (12) south, range seventy-four (74) west; thence westerly on the section line between sections twelve (12) and thirteen (13), and eleven (11) and fourteen (14) of said township and range, to the quarter-section corner between said sections eleven (11) and fourteen (14); thence southerly through the middle of sections fourteen (14), twenty-three (23), and twenty-six (26) to the center of section twenty-six (26) of said township and range; thence easterly through the middle of sections twenty-six (26) and twenty-five (25) to the quarter section corner on the range line between section twenty-five (25), township twelve (12) south, range seventy-four (74) west, and section thirty (30), township twelve (12) south, range seventy-three (73) west; thence southerly on said range line to the southwest corner of township twelve (12) south, range seventy-three (73) west; thence easterly on the township line between townships twelve (12) and thirteen (13) south, to the southeast corner of township twelve (12) south, range seventy-three (73) west; thence southerly on the range line between ranges seventy-two (72) and seventy-three (73) west, to the northeast corner of section twenty-four (24), township thirteen (13) south, range seventy-three (73) west; thence westerly on the section line between sections thirteen (13) and twenty-four (24), fourteen (14) and twenty-three (23), fifteen (15) and twenty-two (22), sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19), to the northwest corner of section nineteen (19) of said township and range; thence southerly on the range line between ranges seventy-three (73) and seventy-four (74) west, to the quarter section corner on the west boundary of section eighteen (18), township fourteen (14) south, range seventy-three (73) west; thence easterly through the middle of sections eighteen (18), seventeen (17), sixteen (16), fifteen (15), fourteen (14), and thirteen (13), township fourteen (14) south, range seventy-three (73) west, and sections eighteen (18) and seventeen (17), township fourteen (14) south, range seventy-two (72) west, to the quarter section corner between sections seventeen (17) and sixteen (16) of said last-named township and range; thence northerly on the section line between sections sixteen (16) and seventeen (17), and eight (8) and nine (9), to the northeast corner of section eight (8) of said township and range; thence easterly on the section line between sections four (4) and nine (9), three (3) and ten (10), two (2) and eleven (11), and one (1) and twelve (12), to the southeast corner of section one (1) of said township and range; thence northerly on the range line between ranges seventy-one (71) and seventy-two (72) west, to the southwest corner of township thirteen (13) south, range seventy-one (71) west; thence easterly on the township line between townships thirteen (13) and fourteen (14) south, to the southeast corner of section thirty-three (33), township thirteen (13) south, range seventy-one (71) west; thence northerly on the section line between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4) of said township and range, and between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4), township twelve (12) south, range seventy-one (71) west, and between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and (4), township eleven (11) south, range seventy-one (71) west, to the northeast corner of section four (4) of said last-named township and range; thence easterly on the second (2nd) correction line south, to the southeast corner of section thirty-three (33), township ten (10) south, range seventy-one (71) west; thence northerly on the section line between sections thirty-three (33) and thirty-four (34) of said township and range, to the middle of the channel of the South Platte River; thence down the middle of the channel of the said river to its confluence with the North Fork of the South Platte River, the place of beginning.

TOPOGRAPHY AND DRAINAGE.

The South Platte Reserve includes 683,520 acres, an area nearly twice that of the combined extent of the Pikes Peak and Plum Creek reserves. The main body of it lies directly west of the Plum Creek Reserve and South Platte River, a small portion extending south of the latter stream. A long, narrow strip or arm extends from the northwest corner of the main part of the reserve along the eastern base of the Park Range of mountains, forming a western boundary to the district known as South Park.

Most of this reserve lies at a much greater average altitude than the Plum Creek Reserve, and the extremes of altitude are much greater. The lowest point is in the northeast corner, at the junction of the North Branch of the South Platte with the South Platte River, where the altitude is a little above 6,000 feet for some distance along the shores of these streams. From this point the area within the reserve rises abruptly and rapidly in irregular ridges, hills, and mountains, divided by innumerable ravines, gulches, or canyons. In the main body of the reserve, which lies between South Platte River and the unreserved area known as South Park, there are a number of mountains and ranges which rise well above timber line, reaching an altitude of 12,400 or 12,500 feet. These nearly surround the regions known as Lost Park and Craig Park or Mountain Meadows, which have a minimum elevation of about 9,000 feet and form most important feeders to the streams which flow out of them.

South of Tarryall Creek the average altitude is much less than to the north, and there are no mountains reaching the timber-line limit. The larger portion of the important territory of the reserve lies between 8,000 and 10,000 feet altitude.

West of the main body of the South Platte Reserve is the agricultural or grazing country known as South Park, the free limits of which are not generally locally known and which, topographically, can not be distinguished from considerable areas included within the reserve. It is in part composed of a nearly level, treeless plain, having an altitude mostly between 8,500 and 9,500 feet or higher, and in part of irregular, thinly-timbered hills or ridges with open treeless areas or "parks" between them. It serves for the pasturage of many thousands of cattle and sheep, the grass being good and much hay being raised where irrigation from the Platte River and Tarryall Creek is possible, these streams crossing it in a southeasterly direction.

North and west of South Park lies the western branch or arm of the South Platte Reserve, a narrow strip over 40 miles long and varying in width from 1½ to 11 miles, with an average width of perhaps 4 or 5 miles. It is mainly composed of high, broad hills or mountains, and practically forms the lower eastern slope of what is known as the Park Range. Some of these mountains included in the reserve rise above timber line, but most of them bear trees to the summits.

The highest peaks and the highest parts of the Park Range of mountains lie to the west, outside the limits of the reserve, and conspicuously above timber line. In the ravines and gulches near the summits of some of these there are huge drifts of snow which do not disappear during the summer, and it is from these perpetual snow banks that many of the streams start which cross the narrow western arm of the reservation, and which form the South Platte River and Tarryall Creek, these streams draining the entire eastern slope of the Park Range, and also the South Park.

The main body or eastern portion of South Platte Reserve is chiefly drained by the South Platte River itself and the very numerous streams which fall into it, the most important of which is Tarryall Creek, while the tributary known as Goose Creek or Lost Park Creek carries the waters from an extensive area most valuable as a water reservoir. This area is also partly drained by Craig Creek, the waters of which, and also of Buffalo Creek, flow into the north branch of the South Platte River, which drains a small watershed sloping to the north.

While South Platte River and Tarryall Creek drain most of the reserve, their true sources are many miles to the west, in the higher Park Range, just outside the limits of its western arm of the reserve. The South Platte is a comparatively small stream, rarely more than a few rods in width, and easily forded at many points, but it is very important to the region through which it flows.

The largest and practically the only large natural body of water in the reserve is known as Jefferson Lake, located at an altitude between 10,500 and 11,000 feet, at the head of Jefferson Creek; one of the branches of Tarryall Creek. This lake is more than half a mile across in its widest part, and soundings are said to have shown a depth of 850 feet. A few feet of its waters are now artificially drawn off to supply the necessities of a number of ranchmen along Jefferson Creek, in South Park, below. It is a very valuable natural reservoir, chiefly fed from perpetual snow banks, lying west of and outside the reserve lines.

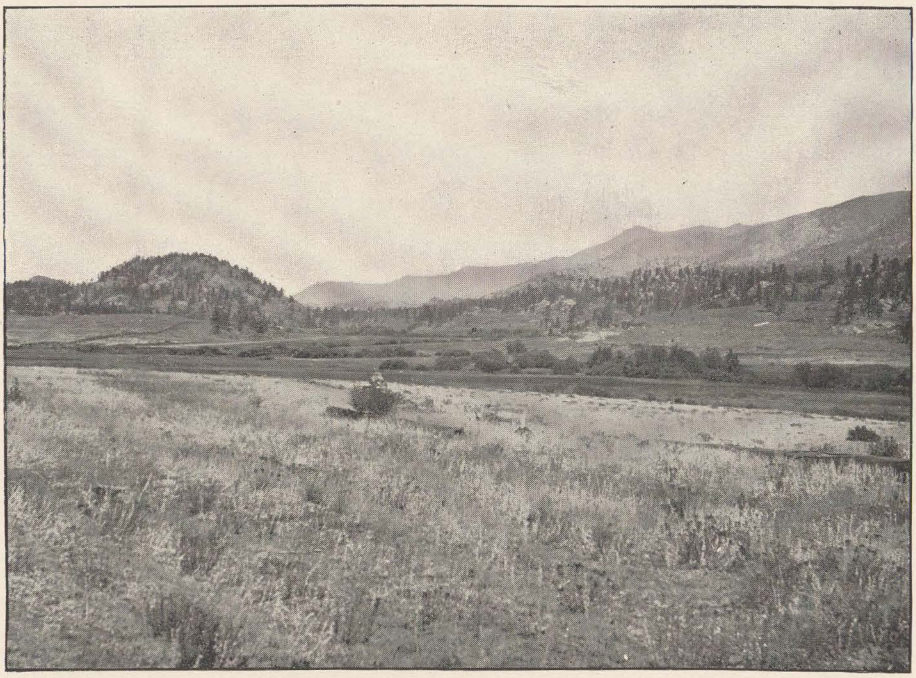
Lake George is merely an artificial reservoir formed by damming the South Platte River, and Wellington Lake was made by building a dam near the head of Buffalo Creek. The altitude of each of these reservoirs is about 8,000 feet.

There are various reservoirs projected or in course of construction in this reserve, the most important being on the South Platte River, on Goose Creek (also known as Lost Park Creek), and on Tarryall Creek. Near the outlet of the latter active preparations were being made during the summer of 1898 for the construction of a reservoir which would have a maximum depth of over 100 feet of water and cover over 2,000 acres. The conservation of these waters is primarily intended for the supply of the city of Denver, about 50 miles away.

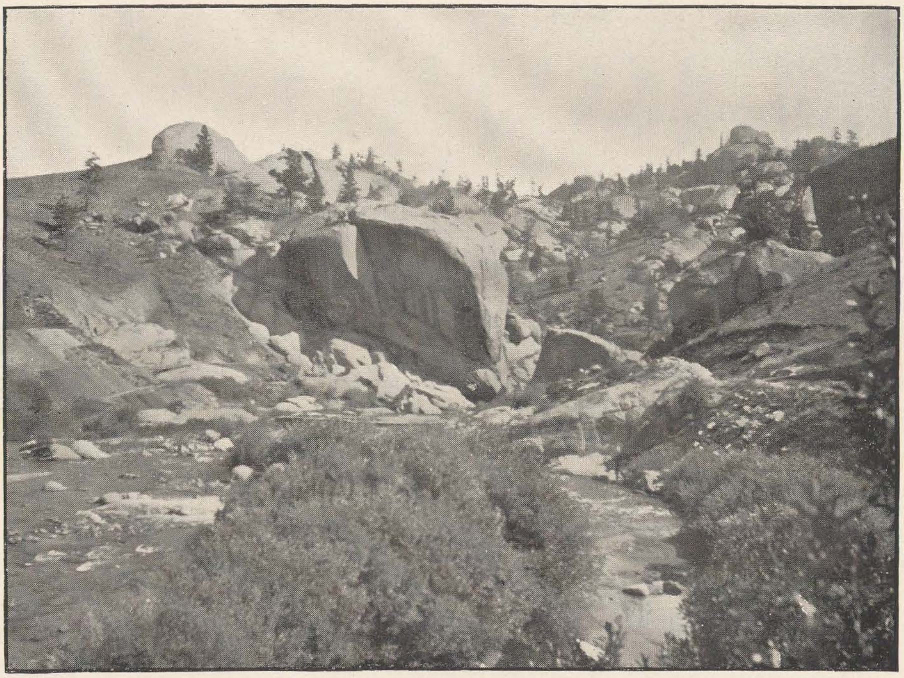
Throughout the reserve, especially in the higher altitudes, there are innumerable springs, most of which maintain a good flow of the finest water in the driest seasons. In the Lost Park and Craig Park district there are large areas of treeless, boggy, or peaty ground which are practically reservoirs holding and gradually giving out large and perpetual supplies of pure and very cold water to the streams which run through them. These boggy areas are commonly covered with low shrubby willows from 2 to 8 feet high, and mixed with them are various grasses, sedges, and mosses which, with the accumulated humus of centuries, hold and but slowly release the water which stands beneath or among them. These areas might properly be likened to slowly-flowing reservoirs or lakes which are concealed by the subalpine vegetation growing over them. As a feeder of streams, this region, giving its waters to Lost Park Creek and Craig Creek, is the most valuable of any found within any of the three reserves examined, and no effort should be spared to preserve or improve the present conditions existing there.

On account of its limited area and topographical position, much of the extreme western section of the reserve contributes comparatively little water to the streams, most of it coming from farther to the west, from the eastern slope of the high Park Range, several of the summits of which exceed Pikes Peak in altitude.

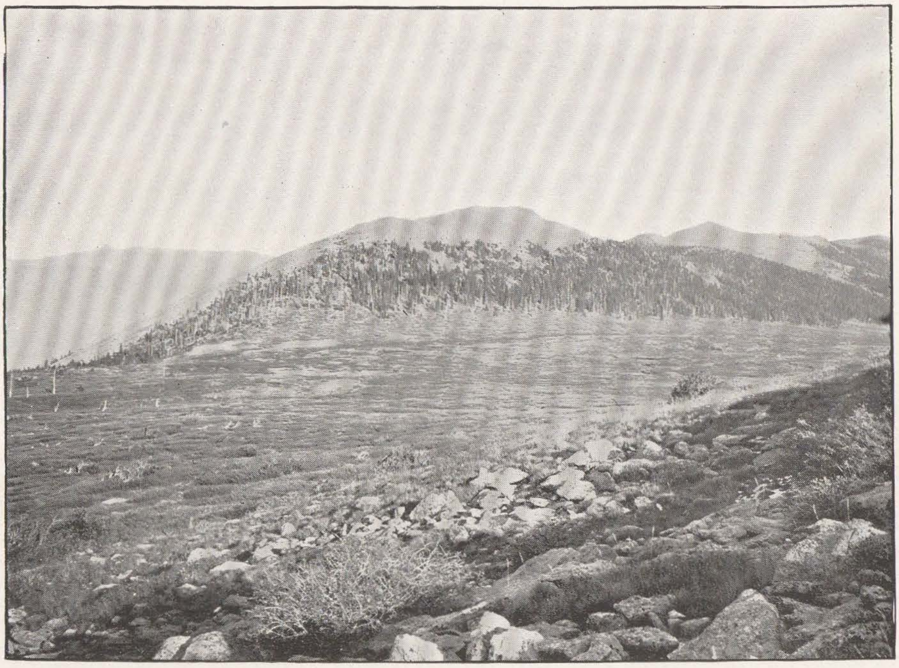
A number of small natural ponds or artificial storage reservoirs



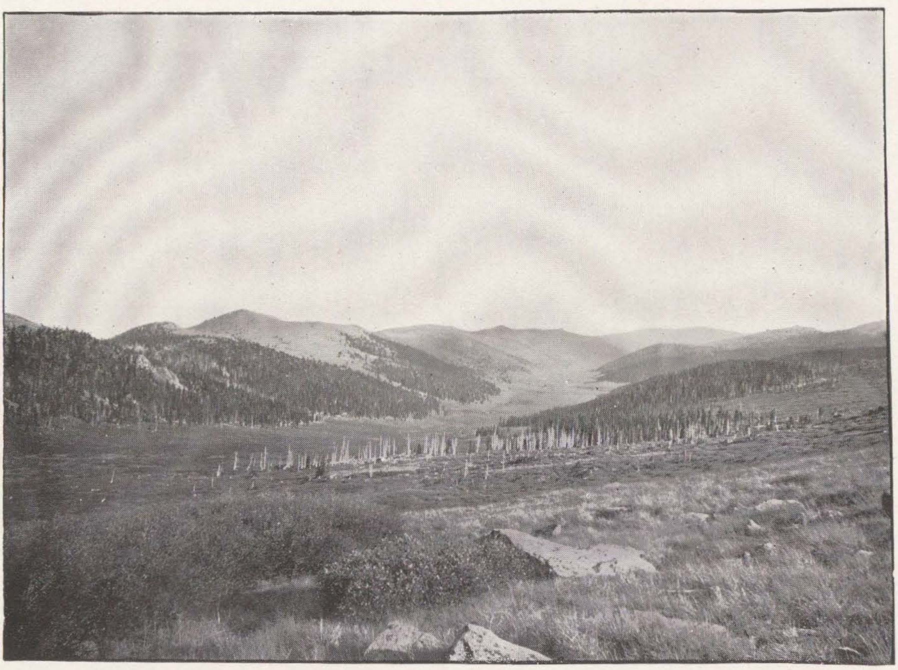
A. SITE OF PROPOSED RESERVOIR ON SOUTH PLATTE RIVER, ABOVE MOUTH OF TARRYALL CREEK.



B. SITE OF PROPOSED DAM ON SOUTH PLATTE RIVER, 2 OR 3 MILES ABOVE SOUTH PLATTE STATION.



A. BOGGY GROUND OR NATURAL RESERVOIRS AT HEAD OF CRAIG CREEK.



B. CRAIG CREEK AND PARK (MOUNTAIN MEADOWS), FROM NORTHERN END OF KENOSHA MOUNTAINS.

occur at various points along this range. The broader southern end of this part of the reserve is the most valuable as a stream-feeder, as it includes the apex of the watershed and the beginnings of the creeks.

TIMBER.

The South Platte Reserve contains a varied assortment of forest conditions, and, like most parts of the country accessible to markets or railroads, the surface has been very largely deprived of its most valuable timber by the rapacity of sawmill men and of railroad-tie hunters; many thousands of acres also having been cleared by manufacturers of charcoal for smelting purposes.

What remains of unmolested primeval forest is chiefly located farthest away from local markets or shipping stations, or is situated in limited areas on slopes not easily accessible. The timber in which the operations of lumbermen have not yet been very destructive comprises but a few thousand acres, mostly located north of the Tarryall Mountains, about the head waters of Lost Park Creek, Wigwam Creek, and Craig Creek, in and about the vaguely defined region generally known as Lost Park, having an altitude of from above 9,000 to 11,500 feet or more.

The valuable timber here is almost all Engelmann spruce, but some good lodgepole pine, range pine (*Pinus aristata*), and *Pinus flexilis* also occur, although rarely used.

The spruce attains a larger size than the other trees in this region. The largest specimens seen and measured showed a total height of 110 or 115 feet and a diameter of 3 feet at the stump. This size is exceptional, however, and the mature timber obtained would probably not average more than 15 inches in diameter at the stump and 70 to 80 feet in height, furnishing 35 or 40 feet of saw logs.

The large trees or those immediately available for the sawmill are interspersed with many too small for present profitable use, but selected acres may be found which would yield 10,000 feet of lumber to the acre by taking trees above 10 inches in diameter at the stump. But when a square mile is taken as a unit the average is greatly reduced on account of lightly timbered areas, burned strips, and the treeless ground or "parks" along the creeks and on the tops of the higher ridges and mountains.

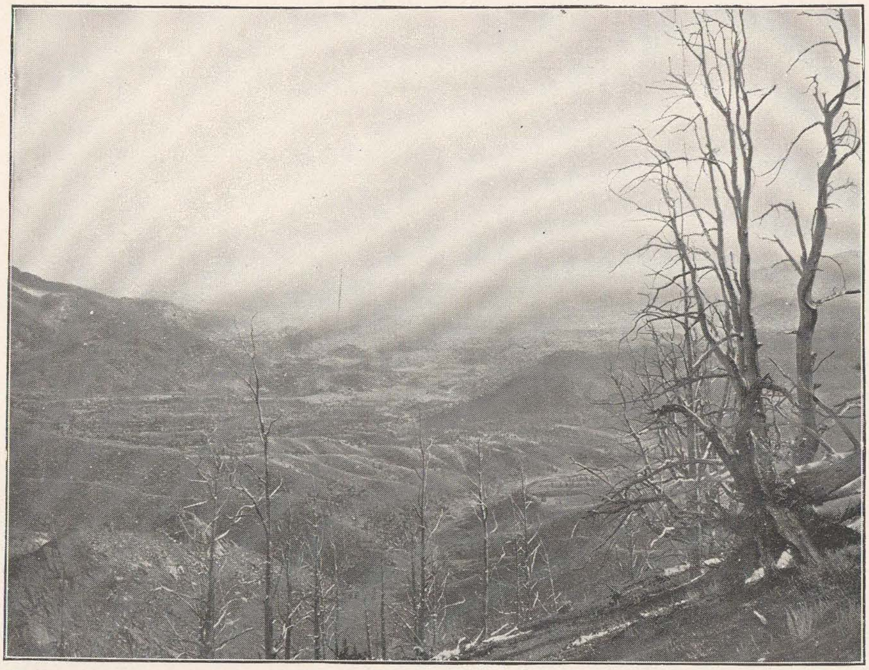
Throughout the remainder of the reserve the best of the timber has already been removed or is in process of removal. A little fair timber occurs at various places along the western arm of the reserve, west of South Park, about Jefferson Lake, on the slopes of Mount Silverheels, and at other points, although the best and most valuable parts of the forest actually lie to the westward, among the mountains, well outside the present boundaries of the reserve. On these outside slopes some very good timber still remains, although in no very extended areas without interruption by poor, burned, cut-over, or open tracts intervening. In this region also the prevailing useful tree is Engelmann spruce, although there is much lodgepole pine mixed with it in some places, or this pine may occupy the ground in some localities almost to the complete exclusion of other species.

Fully three-fourths of the total territory upon which trees grow is occupied by yellow pine and Douglas spruce, among which a small proportion of blue spruce is found along or near creeks, while some lodgepole pine, range pine (*Pinus aristata*), and *Pinus flexilis* occur on the hills. The yellow pine and Douglas spruce prevail over all the eastern half of the reserve and the portion lying south of the Tarryall Mountains. As this ground has nearly all been cut over at various times during the past thirty years, some of it having been twice or even three times searched for suitable sawmill trees, there are few trees of large size remaining. Some of the best trees of these species seen were found north of Lost Park Creek, a few miles from its mouth or junction with the South Platte River, where trees which would furnish from 500 to 1,000 feet of lumber each were scattered over a few hundred acres which had escaped fire and had not been entered by lumbermen, although some had been cut for local ranches. These exceptionally fine trees were surrounded by much timber of undersize or poor quality, and indications seemed to show that forest fire had many years ago burned out smaller trees, leaving a scattered growth of larger ones.

Upon a good deal of the area the yellow pine is more plentiful than the Douglas spruce, and it commonly occurs in very open or scattered growth and well furnished with branches, so that there is but a short, clear trunk. Some trees are ready to be culled out for the sawmill now according to the present standard accepted by the lumbermen, this standard being modified so as to include smaller material as the trees become scarcer and the ground is repeatedly gleaned. A large proportion, however, is too small for any present purpose. In some parts the soil is so rocky, poor, or dry that it is unlikely that the trees upon it will ever reach a large size.

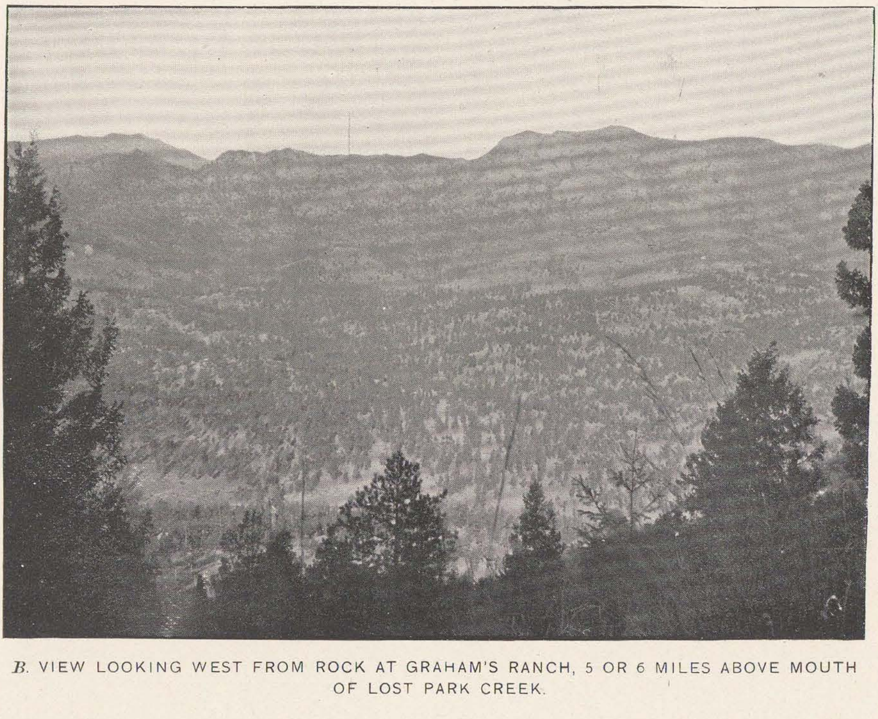
In the southern part of the reserve, west of Florissant, a considerable percentage of blue spruce occurs with the other trees found there, and it is also plentiful in some parts of the reserve bordering South Park.

The lodgepole pine occurs in great abundance on the north and west slopes of the Platte River Mountains, in places through the Park Range, and on some parts of the slopes of Stormy Peak, Freeman Peak, etc. It often occurs almost pure, but it is also frequently mixed with Engelmann spruce, as in the Lost Park region, among the Puma Hills, and along the Park Range. Trees 2 feet in diameter of trunk and 100 feet in height are considered rare throughout this region and although the species is plentiful, or even extremely abun-



A. VALLEY OF TARRYALL CREEK.

View southeast from trail from Mountaindale to Bison Peak, at about 11,000 feet altitude.



B. VIEW LOOKING WEST FROM ROCK AT GRAHAM'S RANCH, 5 OR 6 MILES ABOVE MOUTH OF LOST PARK CREEK.

dant in certain sections, there is very little of it large enough to be manufactured into the ordinary kinds of sawmill lumber, as now accepted by the lumbermen. If preserved from damage in future the existing lodgepole pine should eventually yield a considerable amount of medium-sized merchantable timber. This pine seems to be especially susceptible to damage from forest fires, which apparently sweep through a forest of these trees more readily than through growths of any of the other species in this reserve. This is, no doubt, largely due to the resinous character of the tree, to its thin bark and slender twigs, and especially to its dense or close growth when young, several living plants sometimes standing to the square foot until they are several feet high. Standing thus relatively close, the flames easily pass from tree to tree as among dry grass in a meadow.

The lodgepole pine reproduces itself more easily and generally forms a better stand of young trees than any other species. In the case of the yellow pine and the spruces the stand of seedling or young trees is commonly insufficient to produce what would be considered good, clear timber in other regions. Locally, however, as in some gulches and on north slopes, good, fair stands of young trees are found, although they do not cover any very extended continuous areas.

The range pine (*Pinus aristata*) occurs abundantly on many ridges or ranges, particularly on south slopes, but the trunks are generally so short, divided, or covered with large branches, that this tree is seldom cut to be sawed into ordinary lumber, although it is sometimes used for mine timbers.

Pinus flexilis, the limber pine, or white pine, or sugar pine, as it is sometimes called, is not abundant enough anywhere to obtain commercial consideration, although it becomes a much better timber tree than *Pinus aristata*.

Probably at least one-fifth of the total area of this reserve is practically destitute of trees of any kind, excepting in parts where a few widely-scattered pines and small aspens grow in situations where they will not attain arborescent proportions. This treeless area includes bare mountain tops, valleys, or parks between the mountains and along streams, grazing lands included within the present reserve lines, and areas so completely burned that they are not likely to be recovered for a century or two. These irregular treeless areas, the frequent burned tracts, those covered with practically useless kinds of timber (as range pine), the depredations of lumbermen, and the varied character of the so-called wooded ground, make it extremely difficult or almost impossible to get any clear idea of the approximate amount of timber remaining on the reserve. Where lumbermen have already been at work once or twice, they may yet find a good many saw logs of medium or small size, and doubtless several small movable steam sawmills would continue to find employment for several years to come before the available supplies were totally exhausted. Such close cutting, however, would be injurious to true forest interests, because, in open growth of yellow pine and Douglas spruce, the mature trees, or those simply large enough for the mill, should be allowed to remain until the ground has a sufficient number of seedlings upon it for proper restocking of the land. The destruction of necessary seed-bearing trees is often a serious loss in this country, where, in the struggle for existence, so much of the seed is taken by birds and rodents for food, and the conditions of germination are so unfavorable that a smaller percentage of plants results from any given quantity of seed than is the case in other regions, where the conditions are more favorable.

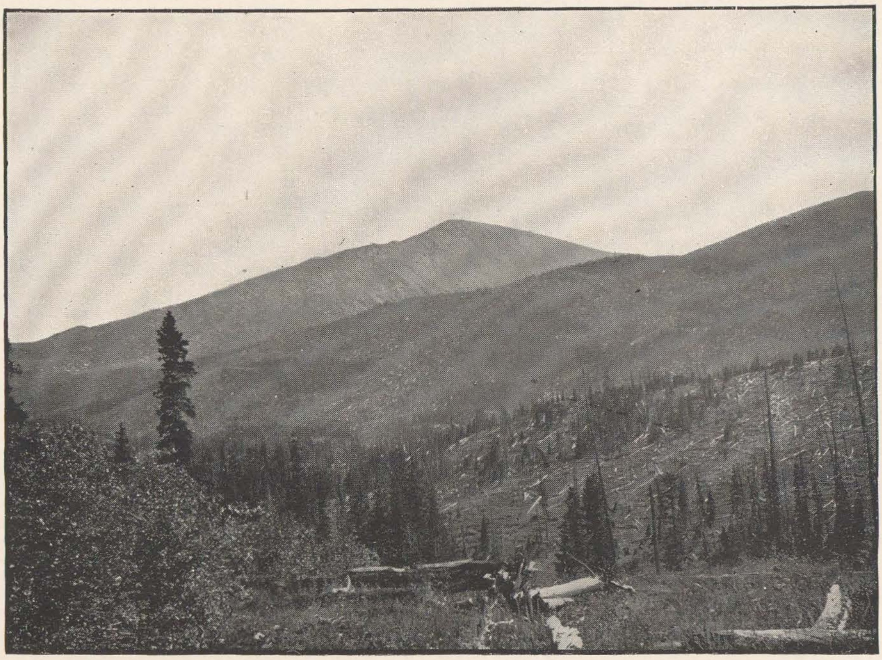
In the region north of the Tarryall Mountains, including what is known as Lost Park and the Kenosha Range and Platte River Mountains, it is probable that 50 million feet of lumber could be taken without serious injury to the forest covering if the work were properly conducted, with due regard to the preservation of the immature growth and the prevention of forest fires. This forest is the best on the reserve and is chiefly composed of Engelmann spruce, which also occurs in considerable quantity on the western arm of the reserve.

The remainder of the ready timber is chiefly yellow pine and Douglas spruce, and altogether the supplies of all properly grown sawmill lumber in the reserve may be placed at 150 million to 200 million feet, although such an estimate is largely guesswork, necessitated by the strangely unequal conditions met with everywhere; and yet it would be impossible to estimate more nearly without a careful measuring and study of each section of ground containing merchantable timber. Doubtless more than the above amount could be immediately cut if the reduced standard of the size of trees taken by the smaller sawmills should be accepted; but a too close and early cutting is often hurtful to the forest and the adjacent country, and is certainly not always the most economical timber management.

FIRES.

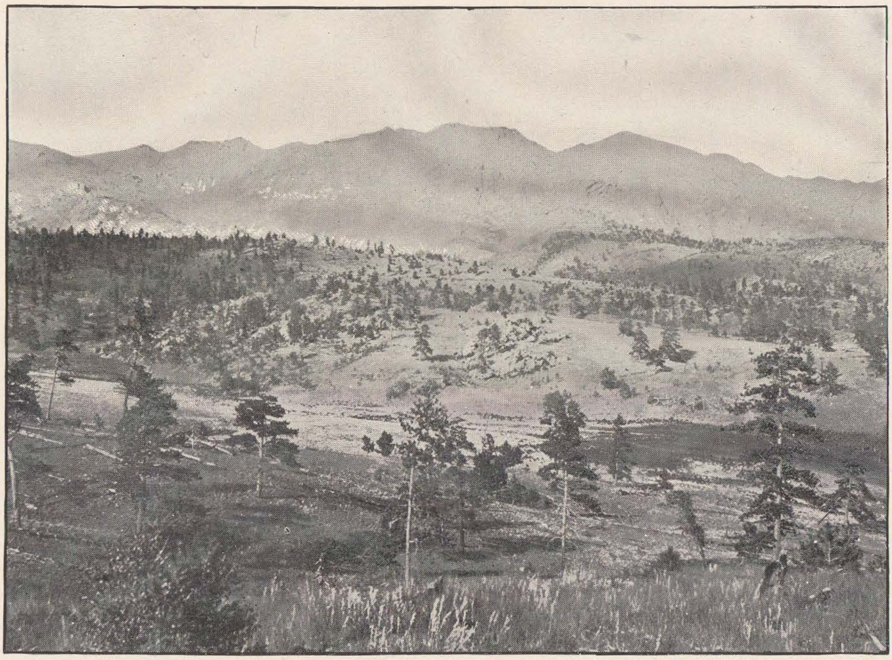
Probably between 60 and 70 per cent of the total forested area of this reserve has damage by fire very clearly marked, and on a larger area there are evidences of ground fires or of forest fires which occurred so long ago that traces of them have become nearly obliterated and a natural forest growth has almost recovered the ground.

The damage by fire is confined to no particular section of the reserve, but spots, streaks, or extended areas of burned ground are frequent on most parts, especially on those longest settled or near routes most traveled, such as long passes through the mountains. The burned tracts are often comparatively small and frequent; but there



A. EAST SIDE OF BRECKENRIDGE PASS, LOOKING SOUTH TOWARD MOUNT SILVERHEELS.

Engelmann spruce and lodgepole pine; mostly burnt.



B. VIEW AT MOUNTAINDALE.

Looking north across Tarryall Creek to mountains; burnt in 1868 or 1869.

are three or four areas upon which the burnings have been very extensive.

The most widespread of these conflagrations occurred in 1868 or 1869 and burned over the larger portion of the Tarryall Mountains, which extend northwest and southeast through the central part of the reserve. The burning here was very complete over many thousands of acres, where barely a conifer has yet started to reforest the ground, and the only living woody vegetation consists of small quaking aspen and scattered shrubs of various species.

Sometimes groups or belts of trees escaped, or a whole mountain side was passed unharmed by the flames, and it is from seeds of these living pines and spruces that a new natural forest must be derived.

This fire covered a stretch of mountains over 20 miles in length and 6 or 8 miles wide at the widest parts, although sometimes quite narrow and generally very irregular. It was said to have originated from the burning of a heap of brush by one of the early settlers; but other information placed the responsibility for the fire upon the Indians, who probably are charged with more than their share of such occurrences.

The forest of this burned region consisted chiefly of yellow pine (*Pinus ponderosa*), range pine (*Pinus aristata*), limber or white pine (*Pinus flexilis*), Douglas spruce, and Engelmann spruce.

Lesser fires have more recently occurred in the woods north of the Tarryall Range, many within a few years or since the advent of sawmills.

Large tracts have also been burned on the western arm of the reserve, especially along the slopes east of Weston Pass, and other routes into or over the range.

A great deal of ground shows traces of fire, which must have occurred from thirty to one hundred or more years ago, and upon this is a more or less dense growth of small timber of various ages and sizes, according to the length of time since the fire and the time elapsing before fresh seed stocked the ground. As many of these fires appear to have been comparatively small and local, or to have left living individuals or many intervening strips of living trees which soon produced seed for the burned areas, the ground has become fairly well re-covered, much sooner than is possible when many thousands of acres are burned over and no living trees escape. Almost the only exception to this general rule is found in the case of the lodgepole pine, which, if burned under certain conditions, leaves seed enough unharmed to restock the ground with the same species.

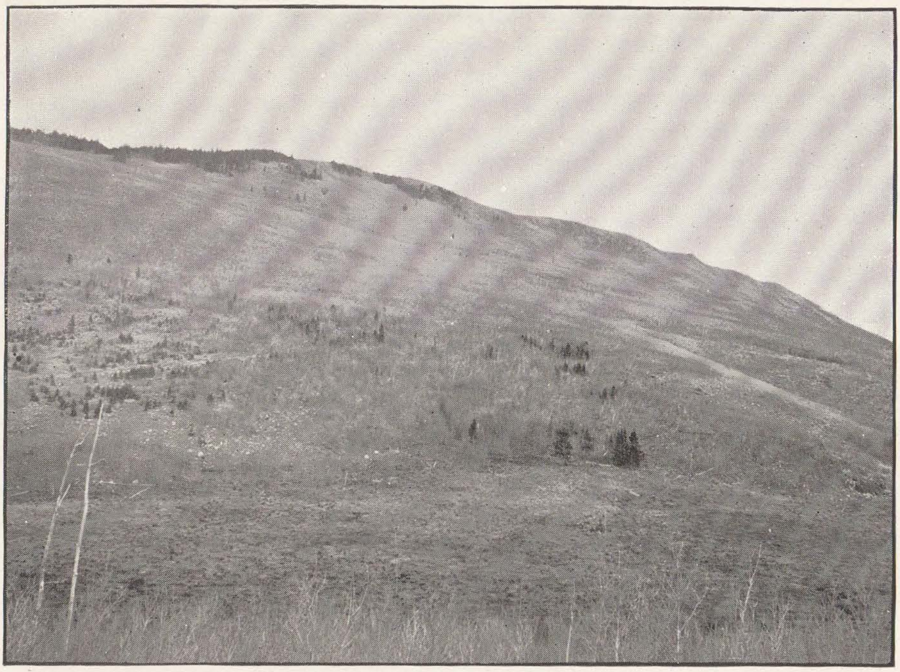
No very extensive fires have occurred on this reserve during the past four or five years, and only one, covering considerable area, was noted during the season when this examination was made. This occured on Breckenridge Pass, on the Colorado and Southern Railway, generally known as the South Park Line, which crosses the reserve at this point. The fire was supposed to have originated from sparks from a locomotive, and it burned one of the snowsheds belonging to the railroad, besides several hundred acres of woodland, in some of which no trace of former fires was evident, although the best of the timber had long since been cut out. This fire burned to timber line or to an altitude of over 11,500 feet, the trees here being chiefly Engelmann spruce, and it reached down to considerable tracts of lodgepole pine. A number of other small fires were burning at this time (October 8) among the timber on both the slopes east and west of the pass. Some of these were presumably started by sparks from locomotives, others perhaps from other causes. They were burning slowly and soon afterwards were extinguished by snowstorms. The railway employees were making no effort to extinguish the fires on the woodland, but the snowsheds were guarded. Near Kenosha Pass, also, grass fires and incipient timber fires were seen, which were started from sparks thrown out by locomotives of the same railway.

SETTLEMENTS.

This reserve is crossed by two lines of railroad. The Colorado Midland Railway crosses the southern portion west of Florissant, following the course of the South Platte River into South Park. The Colorado and Southern Railway, otherwise known as the South Park Line, follows the North Branch of the South Platte River along the entire northern boundary of the main body of this reserve. It leaves this boundary and passes into South Park by crossing the reserve at Kenosha Pass, and the main line again crosses the reserve over Breckenridge Pass, between Como and Breckenridge. Two spurs or branch lines have been built to mines or mining camps located near or outside of the western boundary. One of these runs from Fairplay through Mosquito Gulch to the lower London mine, near the foot of Mosquito Peak. The other branch also starts from Fairplay and follows Horseshoe Gulch to the mining camp of Leavick, formerly known as Horseshoe, located near the eastern base of Horseshoe Mountain at about 10,800 feet altitude.

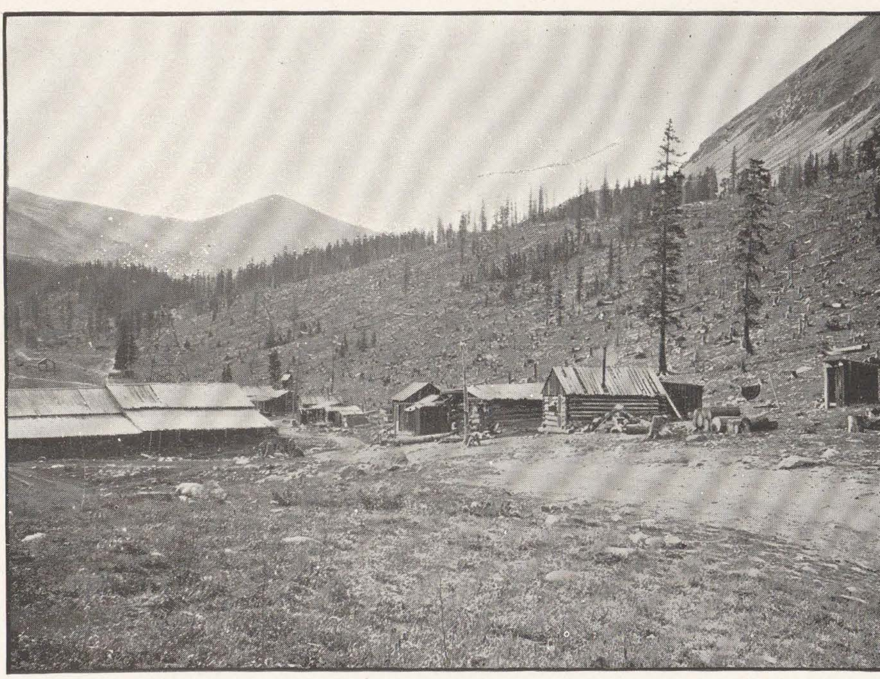
The amount of land held in private ownership is smaller in proportion to the total area than on either of the other reserves examined. It is chiefly situated in the northeastern and southern parts, and in open grazing areas lying east of South Park.

The largest settlement included within the limits of this reserve is Alma, which is located at the narrowest part of its western arm, at an altitude of above 10,000 feet. It is situated on the Mosquito Pass wagon route, between South Park and Leadville, and has a population estimated at 400 or 500, which is likely to increase or decrease



A. VIEW AT KENOSHA PASS, LOOKING SOUTHEAST.

Small aspen, scattered lodgepole pine, and Engelmann spruce.



B. LEAVICK, LOOKING NORTHWEST TO MOUNT SHERIDAN.

considerably, according to the activity of the mining industries in the adjacent country. Alma is an important supply station for the miners and prospectors in the mountains to the north and west. A smelter is located here, but this was idle during the past summer. Another smelter, also idle, is located near London Junction, which is the railroad station for Alma. Park City, about a mile and a-half west of Alma, has several occupied cabins, but appears to be just outside the reserve limits.

East Leadville, about 6 miles south of Alma, is now nearly abandoned for the active mining camp of Leavick, on the western border of the reserve. The population of Leavick was roughly estimated at perhaps 100 persons, but is likely to vary greatly according to the activity of the mines, amount of timber cutting being carried on, and other industries.

Throughout this region miners' or prospectors' cabins are not rare, but not so numerous as they are on the more mountainous range west of the reserve limits.

In the southern part of this western division of the reserve there are several small ranches, the best known being that called Platte Station, on the route over Weston Pass, at nearly 10,000 feet altitude. Near the summit of this pass there is also a small mining camp.

At the summit of Breckenridge Pass, at Boreas Station, are a number of buildings, chiefly occupied by employees of the railway.

In the main body of the reserve east of South Park the most important settlements are situated along the North Branch of the South Platte River and near Tarryall Creek. Most of the settlements along the former stream are located on its north side and are therefore outside the reserve limits. The largest on the south side is Buffalo, at the mouth of Buffalo Creek, the population of which is estimated at about 150, being very much increased in summer by residents whose cottages are vacant in winter. This land is in control of a regularly organized company known as the Buffalo Creek Park Company.

At Wellington Lake, 7 or 8 miles up Buffalo Creek, there is also established a small colony of summer residents. Cassells, on the North Branch, near Chase, is another summer resort with accommodations for 50 or more persons. South Platte and Estabrook are small stations from which is shipped considerable timber cut on the reserve.

South of Tarryall Creek are several small mining camps. The largest of these is Puma City, which a couple of years ago had a "boom" and a population of several hundred prospectors, but which was reduced to two or three score when seen in the autumn of 1898. Gold City and Jasper are other small prospecting camps.

In the southeastern corner of the reserve and along Wigwam Creek, Lost Park Creek, Tarryall Creek, and the principal creeks of the southern portion are a considerable number of small ranches, with cattle raising as the chief business, but where lumbering and prospecting also usually receive some attention.

Bordenville, on Tarryall Creek, consists simply of two or three ranches, with buildings located comparatively near each other, and at the post-office of Mountaindale, on the same stream, there is a single dwelling with accompanying farm buildings. Weekly mails are received here for other settlers or prospectors who are widely scattered in the region around.

At the post-office known as Rocky, in the southern part, similar conditions prevail, there being no aggregation of inhabited buildings to form a village, but simply a mail center for the scattered population of the country.

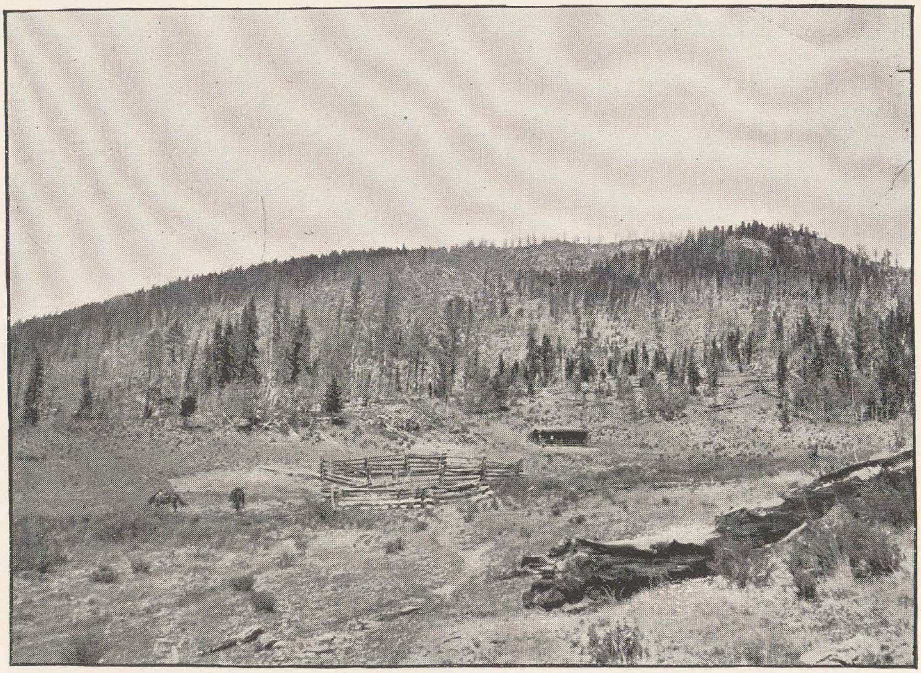
Along the Colorado Midland Railway are five or six small stations within the reserve, rarely composed of more than the dwellings of railroad employees and an occasional ranch. Some attempt has been made to make Lake George a summer resort, but apparently with slight success.

AGRICULTURE AND GRAZING.

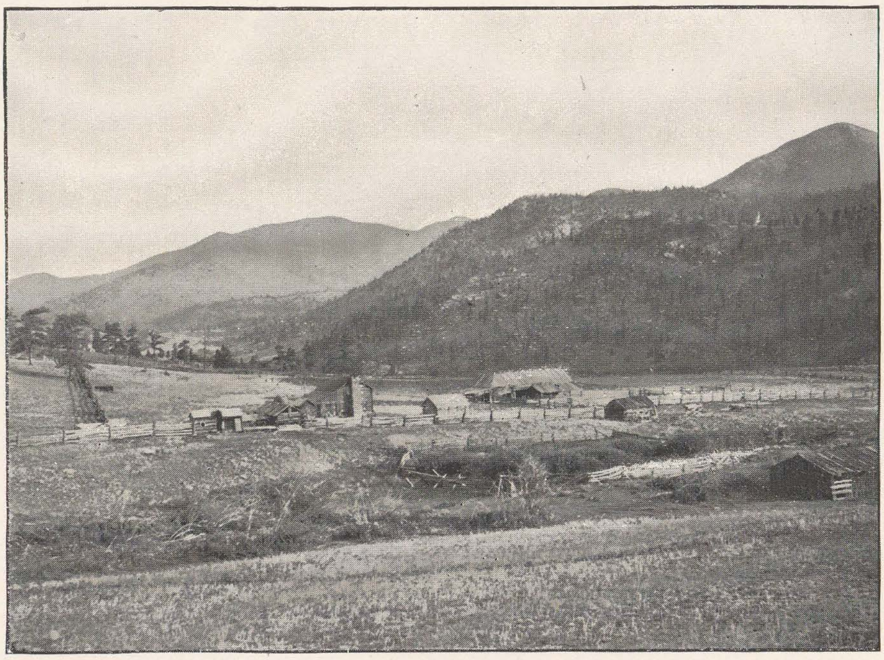
The high altitude of the greater part of this reserve makes the practice of ordinary agriculture impossible. Along some of the creeks, however, especially on the eastern slope at the lower altitudes, some hardy grains are raised and a few potatoes, but the total amount is inconsiderable, and is of no importance in outside markets, although potatoes are taken to Cripple Creek or similar local markets. Potatoes are an uncertain crop, as they are liable to be damaged by late frosts. Hay and grain are the staples cultivated, and what is grown is mostly fed to stock upon the ranches. Stock raising is therefore really the only important agricultural interest, and this would be very limited if stock owners were compelled to graze their cattle on their own lands instead of allowing them to range upon Government territory, as is the general practice.

The patches of cultivated ground are usually so small and irregular that it is difficult to obtain a true idea of the total amount actually tilled, but after a careful estimate it is probably safe to say that the total area of the ground under cultivation in the reserve is less than 3,000 acres, although more may be irrigated and cut over for native hay, but is not cultivated.

On account of high altitude, narrowness of fertile valleys, and limited water supply it is probable that there will be no very great increase of the profitable tillable area, and the country here must be considered as essentially a grazing one. The large areas of land, covered with a very

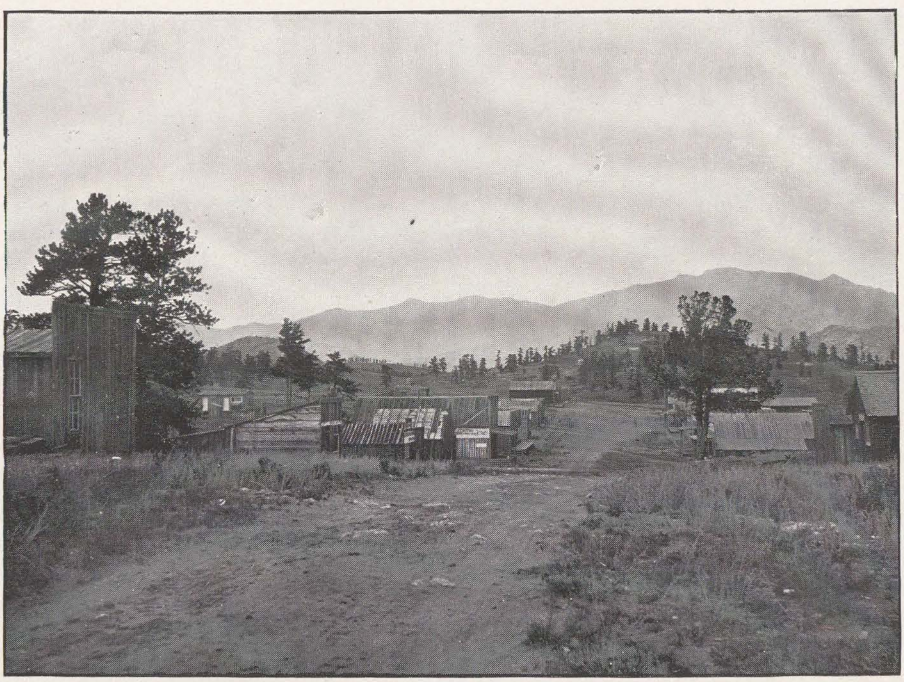


A. HERDSMEN'S CABIN IN LOST PARK; TIMBER BURNT IN 1893.



B. MOUNTAINDALE, LOOKING NORTHWEST ACROSS TARRYALL CREEK.

A. VIEW LOOKING UP LOST PARK CREEK.



B. PUMA CITY (TARRYALL POST-OFFICE), LOOKING NORTH THROUGH MAIN STREET scant growth of timber, produce a scattered growth of grasses and herbage sufficient to furnish food for a limited number of animals.

East of Craig Creek and the Tarryall Mountains it is estimated that from 4,000 to 5,000 cattle have been grazed by the ranchmen during some seasons, but during the past year the number was probably not more than one-half as great because of sales on account of a good cattle market. On all the remaining portions of the reserve it is probable that a maximum of about 5,000 cattle have been kept, the number being subject to great fluctuations in different seasons.

The bona fide residents or settlers of the reserve are not alone in pasturing cattle on public lands, as large numbers of cattle are annually driven in from outside, often the property of persons in no way connected with agricultural pursuits. It was found, for instance, that persons living in Fairplay, on the western side of South Park, made a practice of sending cattle into the Tarryall Mountain region, on the east of the park; and others living at Woodland Park, on the borders of the Pikes Peak Reserve, had herds over 30 miles away in the heart of the South Platte Reserve, to the west. Many of the ranchmen in South Park distribute some of their cattle on the reserve during the summer. Many of these cattle are annually sent into the so-called Lost Park, a region showing more of the original condition of the country and less molestation by human agencies than any other in the reserves. The number annually pastured here is said to vary in different seasons, from several hundred to two or three thousand. When visited in September, 1898, it was estimated that there were then not more than 400 or 500 in that particular region. Cattle belonging to different owners commonly run together, but as they are branded they are easily separated in the autumn "round-up," when they are sent to market or removed to lower altitudes or shelter for wintering. Cattle have been brought hundreds of miles to this region to be temporarily kept until in prime condition for final shipment, or for advantageous markets.

It will thus be seen that it is very difficult to make any close estimate of the number of cattle which the reserve annually supports.

Many sheep are kept on South Park or are brought there to be finally fattened before marketing. During the summer some thousands of them are pastured above timber line on Mount Bross, Mosquito Mountain, and other mountains lying west of the reserve, across which they are driven in order to reach the grazing ground. Little of this sheep pasturage lies within the present boundaries of the reserve. The sheep are usually in charge of herders who temporarily live in cabins near the timber line.

The pasturing of sheep as here practiced is an injury to the sources of the small streams and incidentally to the struggling young trees near timber line. The vegetation of the high mountain slopes becomes badly trampled and cut up by hoofs, as well as reduced by excessive grazing; and in the hollows or ravines, where the streams originate or take definite form, the protective covering of low shrubs, which are chiefly willows, become very much injured or totally destroyed by trampling and browsing, leaving the ground bare and exposed, and liable to be washed away by any heavy rain.

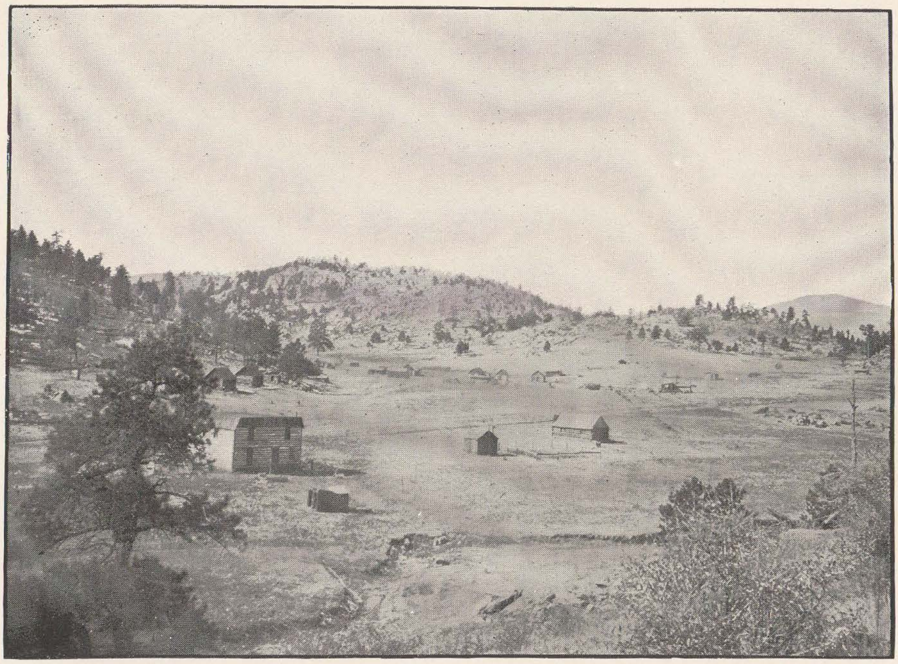
In regard to the pasturage afforded for cattle on those parts of the reserve principally used for grazing purposes, it seems to be the unanimous opinion of the earlier settlers that there has been a very decided reduction of the grazing value of the land as compared with its condition when first used for this purpose. The chief reason is obvious to these ranchmen, who admit that there has been over-pasturage, too many cattle on the same ground year after year trampling it, especially near water, so as to expose the roots of the grasses, keeping the latter as closely cropped as though devoured by grasshoppers, and preventing any possibility of production of seed for regeneration. Unusually dry seasons have also helped to reduce the grazing power of the land, droughts being so serious that it is claimed to have caused the death of mature yellow pines.

The estimated area given as now necessary to support each animal, steer, or cow on these lands varied from 15 to 40 or more acres, which may give some idea of the scanty forage afforded on a good deal of the territory under consideration.

MINING.

Throughout a large part of the South Platte Reserve more or less prospecting has been done, much is still prosecuted, and recently several small new mining camps have been established. The largest of these is Puma City (Tarryall post-office) south of Tarryall Creek, 10 or 12 miles from its outlet into the South Platte. When visited during the past summer the "boom" in this camp had passed, and a large proportion of the buildings were vacant. It was claimed, however, that good ore had been found and only capital was wanted to develop gold mines and make Puma City a thriving place. Since the past summer (1898) rich strikes and a new rush of gold-seekers to this place has been reported, but whether or not there is really cause for excitement has not been settled.

Smaller camps are Gold City and Jasper, both also south of Tarryall Creek, but nearer the South Platte River than Puma City. More or less prospecting is done by most of the ranchmen living on or about the reserves, as well as by persons who give all their time to it. As yet little has been done in the northern part of the main body of the reserve, in the region lying north of the Tarryall Mountains, although



A. GOLD CITY, ABOUT 7 MILES NORTHWEST OF FLORISSANT, LOOKING WEST.

B. ABANDONED SAWMILL SITE ON JEFFERSON CREEK.

the northeastern portion, between Craig Creek and the South Platte, has been more carefully examined.

On the extreme western arm or branch of the reserve lying west of South Park there is considerable activity in mining, both for gold and silver. The reserve limits are here so narrow in part that most of the actual mining ground lies to the west of the present boundaries.

Mount Bross, Mount Lincoln, Mount Buckskin, Mosquito Mountain, Horseshoe Mountain, and other peaks, which geographically should be included within the reserve, are all situated outside of it. On all of these active prospecting and some profitable mining is conducted.

The comparatively old town of Alma lies just within the reserve lines and is an important outfitting post for miners in the adjacent mountains, and flourishes or loses its importance with the rise or fall of mining development in the country about it.

The mining camp of Park City, a few miles west of Alma, also lies just on the reserve borders. It has been partially abandoned for more promising localities.

Some other old but small camps, such as East Leadville and Sacramento, situated within the reserve limits, have been nearly abandoned for more promising localities mostly lying outside the reservation boundaries. East Leadville has been supplanted by the camp known as Leavick or Horseshoe, situated farther up Horseshoe Gulch, at the edge of the reserve and near the base of Horseshoe Mountain, where there is active and profitable gold and silver mining. Farther south, within the reserve limits, on Weston Pass, there is some mining, although it is necessary to haul the ore many miles to mills for treatment.

Few of the operated mines possess proper mills or smelters of their own or in close vicinity, and usually the ore is shipped to some distance, as to Leadville, Colorado Springs, Buena Vista, and other places, to be treated in large establishments. A smelter at Alma and another within 2 or 3 miles of that place have not been working recently.

From most parts of the reserve the ore is either hauled by wagon to the nearest railroad or smelter, or it is brought out over trails on the backs of burros or donkeys, locally known as "jackies." By the aid of these patient and enduring animals the miner without much capital is able to bring ore over narrow trails from places which would be otherwise inaccessible without the expenditure of considerable money in the making of roads or the erection of costly machinery.

At the London mine, at about 12,000 feet altitude, on Mosquito Pass, and at the mines at the head of Horseshoe Gulch, both outside the present limits of the reserve, the ore is brought from high slopes, difficult of access, to the mill or cars in buckets suspended on endless wire rope or cables, no other power than the natural gravity of the laden buckets being required.

In some places wagon roads for hauling ore have been constructed at considerable cost to the promoters.

There is very little placer mining prosecuted within the reserve limits, the most extensive workings being those near Alma and on Tarryall Creek, above Como. During several months in some years these placers can not be worked on account of lack of water. Recently those near Alma have been idle on account of litigation, a too common hindrance to the development of mines and other industries in this part of the country.

There seems to be no doubt as to the permanent richness of the mines in the mountain range to the west of South Park, and the industry is likely to increase.

Profitable mining in the main body of the reserve east of South Park has not yet been proved a permanent and paying business, but there are indications that really good mines may yet be opened there.

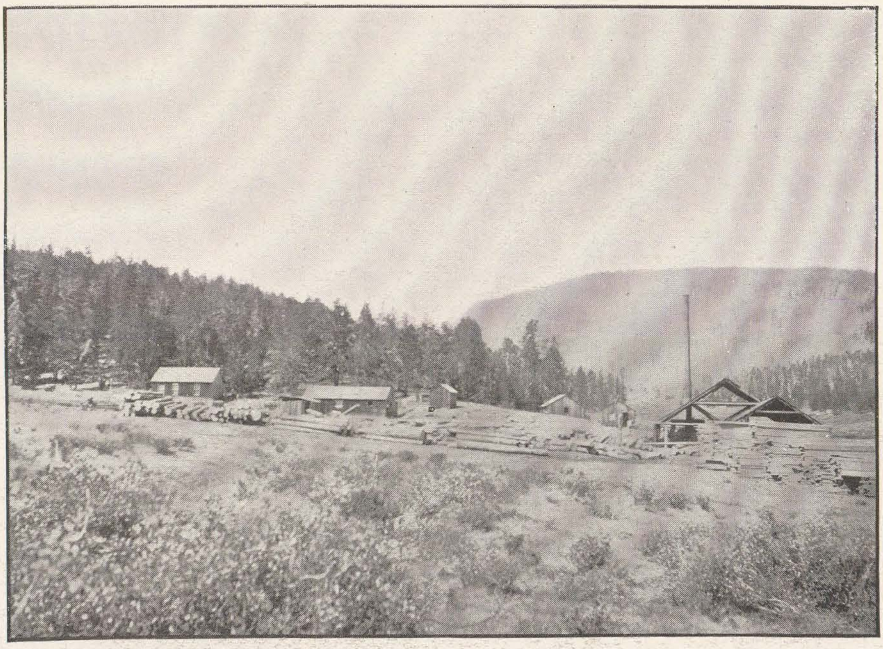
LUMBERING.

Ever since this part of the country was first settled by ranchmen, about forty years ago, the business of cutting lumber from the territory now included within the boundaries of the reserve has been unremittingly prosecuted, although during the earlier years most of the timber cut was for strictly local use. With the advent of railroads and the development of mining the shipping of lumber became important, and numerous sawmills have been almost steadily at work taking timber from private or public lands, legally and illegally. Beginning with the supplies available nearest to market or shipping station, portable sawmills have been moved gradually to the farthest and least accessible of the timbered parts of the mountains, until now they have reached Lost Park, where is located the last of any considerable area of timber land which has not had the best picked from it or been totally destroyed by fire.

The timber nearest the South Platte River and for several miles back from this stream was naturally the first to be taken, and much of this easily accessible ground has been gone over a second time in the search for sawmill logs or for the few railroad ties which might be found.

Abandoned sawmill sites, with their heaps of decaying sawdust and lumber refuse, are plentiful along the courses of the numerous small streams, but at present there are fewer sawmills in active operation than were to be found on this reserve several years ago. This is in part due to exhaustion of supplies in certain localities, and in part to the energy of forest rangers appointed by the Department of the Interior during the past summer.

During the past autumn there were only four or five mills at work



A. SAWMILL AND CAMP IN LOST PARK.

B. ENGELMANN SPRUCE UNTOUCHED BY AX OR FIRE; NEAR SAWMILL IN LOST PARK, NORTH SLOPE.

Altitude above 10,500 feet; trees 3 to 15 inches in diameter of trunk.

in the entire reserve. The largest and most important of these was found located in Lost Park, in the midst of the last considerable body of unburned and uncut forest to be found in all this region. When running at full capacity this mill could cut about 25,000 feet of lumber per day. It had been gradually moved from location to location as the good timber was cut out, a very fair lumber road being constructed and extended as necessities arose in order to facilitate the hauling of the product to the shipping station at Estabrook.

It was moved to the present site in the spring of 1893, but was then run for a few months only, when it was closed and not reopened until the spring of 1898. Like many of the larger mills in operation in this part of the country, this one was outfitted by a large lumber company which has extensive lumber yards at Denver, Colorado Springs, and other points. It was claimed by the mill operators that they had title to two sections of land, upon which they were working.

This mill is located beside a small stream in one of the open "parks," at an altitude of about 10,000 feet. The hills and ridges surrounding it are covered with timber of variable quality, according to exposure, and composed mainly of Engelmann spruce, here known as white spruce, which is almost the only tree used for lumber, although some lodgepole pine is cut and mixed with it. The Engelmann spruce reaches its best development on cool slopes having a northerly aspect; on southerly slopes it is poorer and is often supplanted by *Pinus aristata*, which rarely makes good saw logs. The best spruce timber here is not very large, trees 3 feet in diameter at the stump being uncommon, as has already been stated. Most of the logs obtained and sawed are between 12 and 15 inches in diameter at the small end, the trees probably averaging 35 to 40 feet in length of log used after stripping off the branches, as there is commonly a very short clear trunk, or practically none.

The trees are felled by sawing nearly through and wedging the sawed side, so that the tree falls in the opposite direction. The branches are stripped off just so much of the trunk as is considered desirable, usually up to about a foot in diameter at the small end. The timber is cut usually into lengths of 12, 14, or 16 feet, the heavier logs usually into the shorter lengths. Two men generally work together in felling the trees and cutting the logs, although sometimes they are assisted by a "trimmer," whose chief work is to remove the branches from the logs.

Single horses with whippletree and chain are usually employed in hauling the logs to the skids, at the side of a wagon road, where they are loaded upon wagons and taken to the mill. These skidding horses often suffer much injury to their feet and legs, especially where there is much débris from tree tops and branches, and on steep slopes they are liable to be injured by the logs which they are hauling.

The refuse tree tops and branches are left to decay where they fall, furnishing dry fuel, which would cause very destructive burning if fire should get started.

Seedlings and young trees are ruthlessly sacrificed wherever they appear the least in the way of operations, but on most of the ground now being cut over a fair number of medium-sized trees remain to shade and seed the ground and protect the new growth, although many of these trees now left or rejected are liable to fall when visited a second time by the lumberman after gleaning the best from a first cutting, or are sure to be taken when the manufacturer of wood pulp can not get material nearer a shipping station.

Like most of the movable mills in this part of the country, the sawmill in Lost Park is of cheap, rough construction, simply an open-framed building roofed over. One-fourth of the timber is lost in sawdust by the thick circular saw, which consumes a quarter of an inch in thickness with every board cut.

The sawed lumber costs about $3 per 1,000 feet to haul to Estabrook, the nearest shipping station, 14 or 15 miles distant, where it is worth $11 or $12 per 1,000 feet.

Choppers were here paid $1 per 1,000 feet (Scribner's measure) for cutting logs ready for the mill. The lumbermen roughly calculated that 14 or 15 logs of the mixed lengths cut (12, 14, and 16 feet) were required to produce 1,000 feet of lumber.

Strong efforts were being made to have the operations of this mill stopped, and at last accounts they were at least temporarily successful.

A sawmill was at work beside a small creek flowing from the Platte River Mountains into the North Branch of the South Platte, near Chase. Another small mill was located near Grant, farther up the river, but on the north or unreserved side of the stream. In October the mill was closed and the proprietor was placed under arrest.

Another mill, with a daily producing capacity of about 10,000 feet of lumber, was at work several miles south of Puma City, About 450,000 feet of lumber was cut from ground within a radius of 2 or 3 miles from the sawmill. At the end of October this mill was moved to another location near Signal Butte, outside the eastern boundary of the reserve. The lumber cut in all this comparatively low country (8,000 to 9,000 feet altitude) is yellow pine and Douglas spruce, and occasionally a blue spruce.

It is here considered worth while locating and operating a portable steam sawmill if 500,000 feet of lumber can be obtained within a radius of 2 or 3 miles, so that the average amount of lumber obtained, around some locations of the mills, is sometimes under 100 feet to the acre. A mill may move to new locations several times in the course of a

A. CHOPPERS FOR SAWMILL IN LOST PARK CUTTING ENGELMANN SPRUCE.

B. HORSES "SKIDDING" SAW LOGS IN LOST PARK.

A. TIMBER IN LOST PARK.

Three saw logs, Engelmann spruce, together containing over 1,000 feet lumber; largest log 25 inches in diameter at small end. Exceptionally large timber for this region.

B. VIEW IN LOST PARK.

Logs among refuse, cut and ready for "skidding" out to lumber road.

year, and during the last twenty-five years much of the ground has had two or three visitations from lumbermen. The distance for hauling logs depends somewhat upon the character of roads and the practice of mill managers, some preferring frequent moving of the mill to a long haul of the logs.

One or two small mills were at work near the reserve boundaries south of Florissant.

No active sawmills were found in the western arm of the reserve west of South Park, but three or four were located close to the boundaries. One of these was on the western slope of Breckenridge Pass, another east of Hoosier Pass, near the base of Mount Silverheels, and one close to the eastern boundary of the reserve on the road through Horseshoe Gulch to Leavick. The timber cut by these mills was chiefly Engelmann spruce and lodgepole pine.

At Mountaindale was seen the only water-power sawmill in any of the reserves. Its power was obtained from Tarryall Creek and its output was small, as it is operated only occasionally in order to supply some local demands.

A great many railroad ties have been cut and removed from this reserve, and the cutting of ties is still carried on, although the business is much diminished in comparison with former years. Apparently few ties are cut by regular lumbermen or by persons having tie making for their sole occupation, such cutting as is now carried on being done chiefly by ranchmen, squatters, or prospectors. The work is generally incidental to some other undertaking, and it is almost impossible to obtain any very definite idea of the somewhat limited number of ties now annually cut within the reserves. Douglas spruce is practically the only species cut for this purpose, and to be acceptable to the railroads it is considered essential that it should be cut in autumn or winter, although it was during August and September that the two or three cases of actual tie cutting were observed.

The cutting of Engelmann spruce for manufacture into paper is a comparatively recent industry in this region, but is one likely to grow very rapidly and to the great damage of the spruce forest unless restrictive measures are enforced. No cutting for pulp was actually seen within the reserve lines, although some was reported; but in two places, close to the boundary, timber cut for this purpose was in process of removal from Government land. One of the locations was in Halls Valley, 2 or 3 miles north of the most northerly part of the reserve. The wood is cut into short lengths on the hills and sent down timber chutes to the valley below, whence it is hauled to Webster, a small station on the Colorado and Southern Railway, and there loaded on box cars and shipped to Denver.

Another shipping point was Leavick, near the head of Horseshoe Gulch, so close to the western boundary of the reserve that it was a disputed matter whether or not the work came within the reserve lines. Sticks of any size down to 4 inches in diameter are taken here. The logs are hauled by horses down the slopes to a small steam sawmill, which is used for cutting them into pieces 2 feet long, after which they are loaded on box cars for shipment. A machine for stripping off the bark before shipment was on the ground, but had not been set up or operated.

In the northern part of the reserve, north and west of the Kenosha Twin Cone Mountains, during several years previous to 1893, a large gang of men were employed cutting timber for manufacture into charcoal for smelting purposes. Many thousands of acres were cut over, and practically all of the lodgepole pine and Engelmann spruce were taken to the charcoal kilns, the pine being the principal tree of this section. Twenty-five or thirty kilns were operated, part of them being located at Webster, others near Kenosha.

The timber was taken from public lands and the depredations were stopped only by the establishment of the reserve in 1893. The kilns are now abandoned, some of them broken and fallen to decay, others still in a fair state of preservation.

A great deal of apparently needless destruction attended this cutting. Hundreds of thousands of small lodgepole-pine trees were cut and left on the ground, so as to not only destroy a crop already partly grown, but to invite worse damage by fire. In some places a portion of the small trees was left standing, in others they are gradually coming in to re-cover the ground.

Destructive to forest as the cutter for wood pulp may be, he is outclassed by the manufacturer of charcoal from wood.

Some timber is cut and used locally in mines and a small amount of dead and dry material is collected and sold.

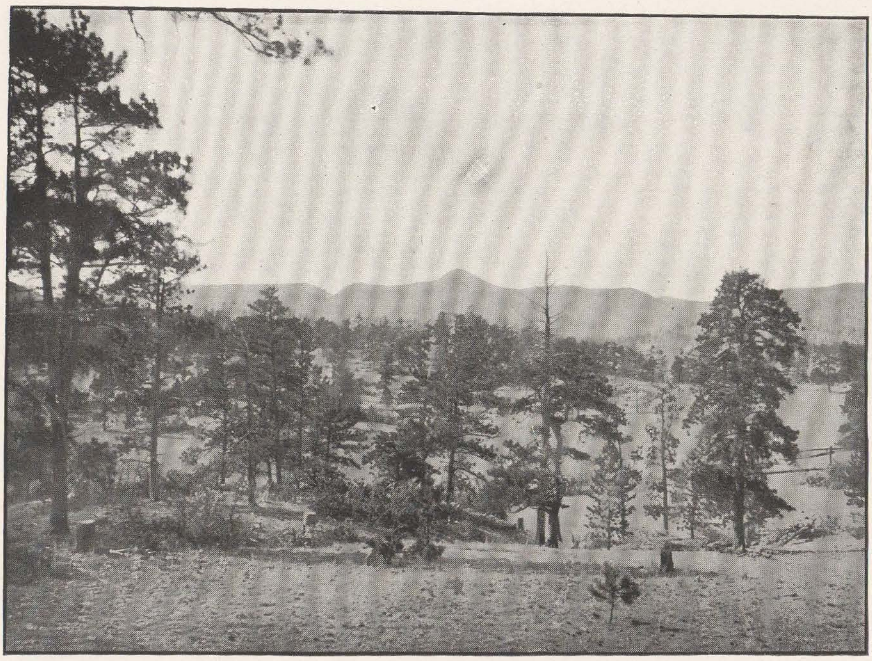
SUGGESTIONS AS TO BOUNDARIES.

As they are at present drawn the boundaries of parts of the reserve are far from satisfactory, especially considering the objects of conservation of timber and water supplies. The irregular artificial boundary lines of certain parts are little known or respected, although natural boundary lines, like the South Platte River, are too obvious to admit of any excuse for trespassing.

On account of the irregularity and narrowness of much of the western arm of the reserve, west of South Park, the timber of almost any part is easily removed by persons outside of the reservation while the reserve lines are in dispute. For the purpose of water conservation the reserve is of comparatively little value. It is unfortunate that the entire eastern watershed of the Park Range of mountains is not included within the reserve, and indeed it would have been advanta-

A. VIEW NORTH OF LOST PARK CREEK, 4 OR 5 MILES FROM ITS MOUTH.

Characteristic growth of yellow pine and Douglas spruce on considerable areas never visited by lumbermen, but subjected to surface fires at various times.



B. VIEW AT PUMA CITY, LOOKING WEST.

Yellow pine and remnants after cutting.

A. CHARCOAL KILNS AT WEBSTER, FRONT VIEW.

Openings are for filling with wood.

B. CHARCOAL KILNS AT WEBSTER, BACK VIEW.

Openings are for taking out charcoal.

geous if much of the western slope had been taken in, as here are important feeders of the Arkansas River, and also of the Blue River, which flows into the Grand. It is true that the perpetual snow banks on the sides of these high unreserved peaks are likely to furnish a certain amount of water during the summer, independent of forest conditions on the lower slopes, but the preservation of the forest would be certain to add to the flow of water and to distribute it more evenly in the early part of the summer, when the snows of the lower slopes are melting.

The main body of the reserve would be better and more simply inclosed by making the South Platte River the boundary along the entire eastern and southern sides, leaving out the territory on the south side of the stream. This ground is not mountainous, and is not of much value as a source of water supply. It is true that it has furnished and may furnish some timber, but in this respect, and also for its small streams, it is not so valuable as a large portion of the unreserved territory lying north of Florissant and Hayden Park, bounded on the east, north, and west, respectively, by the Pikes Peak, Plum Creek, and South Platte reserves. Much of this area, especially on the western side, might well have been included within reservation lines in order to preserve valuable timber upon it and to protect the small tributaries of West Creek and the South Platte River.

There is much territory of an open and almost useless character lying east of the Puma Hills and south of Tarryall Creek, but as it could not very well be separated and may in time become better timbered, it is probably best to continue it as an integral part of the reserve, unless, indeed, it should ever be found advisable to eliminate from the reserve altogether all of the region lying south of Tarryall Creek, this region being of much less value for water conservation than the higher mountain region north of the creek.

West of the Puma Hills and the Tarryall Mountains and east of South Park there are included within the reserve limits considerable areas of open, level, or but slightly timbered and rolling land, which is much used for grazing purposes. As this land is of little use for the purposes for which the reserves were established, it would seem the best policy to relocate the boundaries so that such areas would not come within the rules governing the reservation.

TREES AND SHRUBS OBSERVED IN THE PIKES PEAK, PLUM CREEK, AND SOUTH PLATTE RESERVES, AUGUST, SEPTEMBER, AND OCTOBER, 1898.

The following list of trees and shrubs is undoubtedly incomplete, but there are probably very few more species to be found within the limits under consideration. The list will serve to show the paucity of the ligneous flora of the region examined, embracing over 2,000 square miles in area and varying in altitude from under 6,000 to over 14,000 feet. The list is given alphabetically according to genera.

Abies concolor (Gord.) Parry. (Silver fir, white fir.)

Not abundant. Along streams or canyons up to 8,000 or 9,000 feet.

Abies lasiocarpa (Hook.) Nutt. (*A. subalpina* Engelm.) (Alpine fir or balsam spruce.)

Grows with Engelmann spruce up to timber line. Plentiful in few localities.

Acer glabrum Torr. (Maple.)

Common along creeks and on many mountain slopes, from 6,000 to 10,000 feet altitude. A large shrub, never arborescent, not growing above 20 feet high.

Acer negundo Linn. (See *Negundo aceroides.*)

Alnus tenuifolia Nutt. (Alder.)

A large shrub or small tree, near streams.

Amelanchier alnifolia Nutt. (Juneberry.)

Occasional; from 6,000 to 10,000 feet altitude.

Ampelopsis quinquefolia Michx.

Local, near streams; 6,000 to 7,000 feet altitude.

Arceuthobium. (See *Razoumofskya.*)

Arctostaphylos uva-ursi Spreng. (Bearberry.)

Common on mountain slopes, on coarse granite soils, and prevents washing.

Artemisia tridentata Nutt. (Sagebrush.)

In western part of the South Platte Reserve, with other *Artemisia.*

Berberis repens Lindl.

Common in some localities and on south slopes up to 9,000 feet altitude. Springs up freely from the roots after a fire has passed over the ground.

Betula occidentalis Hook. (Birch, black birch.)

Along streams, up to 10,500 feet altitude or more. A tall shrub, with numerous stems. Never truly arborescent, although sometimes 15 or 20 feet high.

Betula glandulosa Michx.

Along streams and in wet places at high altitudes. A small shrub.

Bigelovia.

There are several species of small shrubby *Bigelovia* in this region.

Ceanothus fendleri Gray.

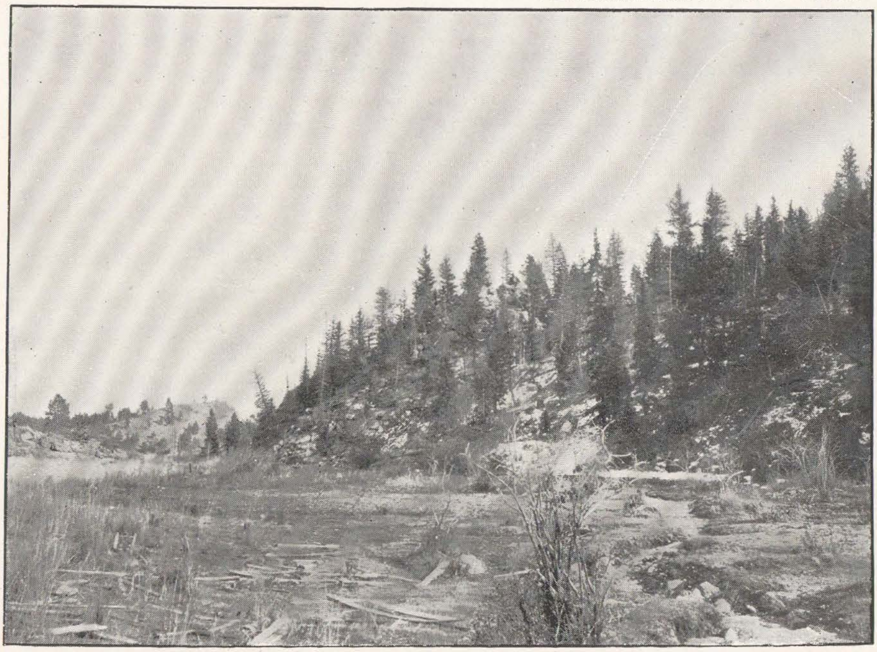
Observed in Pikes Peak and Plum Creek reserves up to 9,000 feet altitude.

Ceanothus ovatus Desf.

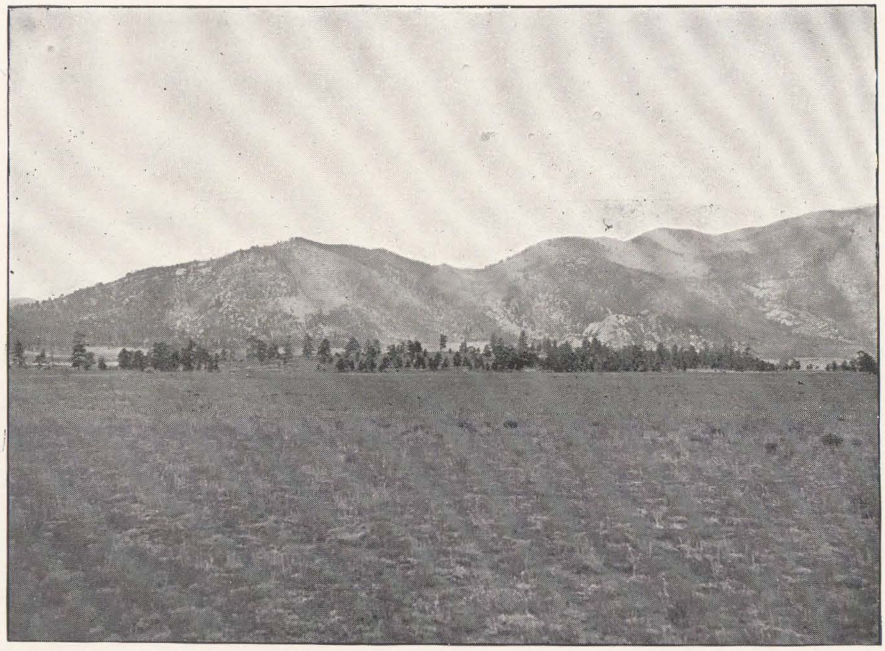
About same range as *C. fendleri.*

Ceanothus velutinus Dougl.

Eastern side of Plum Creek Reserve, 7,000 to 7,500 feet altitude.



A. VIEW ON FISH CREEK, 5 OR 6 MILES SOUTHWEST OF FLORISSANT, LOOKING EAST.



B. VIEW LOOKING WEST TO PUMA HILLS, ALONG ROUTE BETWEEN PUMA CITY AND LAKE GEORGE.

Timber on hills much burnt.

Celtis occidentalis Linn. (Hackberry.)

Rare, only seen on lower eastern slope of Plum Creek Reserve. Small, scrubby.

Cercocarpus parvifolius Nutt. (Mountain mahogany, Buffalo bush.)

Often locally abundant on coarse, granite soils, at altitudes from 6,000 to 9,000 feet. Usually an upright bush 7 or 8 feet high, but never arborescent. When burned, new shoots spring from the stumps.

Clematis ligusticifolia Nutt.

Frequent along creeks under 8,000 feet altitude.

Clematis verticillaris De C.

Occasional, up to 10,500 feet altitude.

Cornus stolonifera Michx. (Red-stemmed cornel or dogwood.)

Occasional, along streams.

Corylus rostrata Ait. (Hazelnut.)

Occasional, on lower slopes of mountains.

Cratægus rivularis Nutt. (Hawthorn.)

This species was found near Grant, on the North Branch of the South Platte River, and along the South Platte near the junction with West Creek. It is apparently rare and local in these reserves.

Cratægus sp.

A thorn bearing some resemblance to but apparently distinct from *C. macracantha* was noticed in the South Platte Reserve on Buffalo Creek, 2 or 3 miles from its mouth. It was hardly arborescent, although there were large, vigorous-stemmed plants, 8 or 10 feet high, accompanied by many suckers. Late spring frosts had destroyed blossoms so that no fruit was produced this season.

Dryas octopetala L.

Low creeping shrub, above timber line, 11,500 to 12,500 feet altitude.

Gaultheria myrsinites Hook. (Wintergreen.)

Plentiful in some localities.

Holodiscus discolor Maxim.

Common on coarse poor soils and rocks up to 10,000 feet altitude or more.

Jamesia americana Torr. and Gray.

Common on rocks and coarse granite soil up to 9,000 or 10,000 feet altitude.

Juniperus nana Willd. (Common juniper.)

Occasional; never abundant. A low spreading shrub.

Juniperus monosperma (Engelm.) Sarg. (Cedar, red cedar.)

Observed only along eastern edge of Pikes Peak and Plum Creek reserves, under 7,000 feet altitude.

Juniperus scopulorum Sarg. (Red cedar; locally also called white cedar.)

More generally distributed through the reserves and growing at a much higher altitude than *J. monosperma*, reaching at least 9,500 or 10,000 feet.

Lepargyraea canadensis (L.) Greene (*Shepherdia canadensis*, Nutt.). (Buffalo berry.)

Local up to 10,500 feet altitude or more.

Lonicera involucrata Banks.

Occasional, especially near streams, reaching to 10,500 feet altitude or more.

Negundo aceroides Moench (*Acer negundo* Linn). (Box elder, ash-leaved maple.)

Seen only along South Platte River in northeast part of Plum Creek Reserve, below 6,000 feet altitude.

Pachystima myrsinites Raf.

Observed only on west slope from Breckenridge Pass, and not actually within reserve limits.

Physocarpus torreyi Maxim.

Common on disintegrated granite soils well up mountain slopes.

Picea engelmanni Engelm. (Engelmann spruce, white spruce.)

The prevailing tree at high altitudes to timber line.

Picea parryana (André) Parry (*P. pungens* Engelm.). (Blue spruce.)

Along creeks and gulches along the lower parts of the mountains and on some of the "parks," up to 10,000 feet altitude.

Pinus edulis Engelm. (Piñon, piñon pine, nut pine.)

Occurs only within the Pikes Peak Reserve north of Manitou.

Pinus flexilis James. (Limber pine, white pine, "sugar" pine.)

Generally scattered through the reserves and reaching to timber line. Rarely abundant at any place.

Pinus aristata Engelm. (Range pine, also miscalled "piñon pine.")

Abundant on south slopes of mountains and reaching to timber line. Also scattered to the base of the mountains and on hills or "buttes."

Pinus ponderosa scopulorum Engelm. (Yellow pine, bull pine.)

The prevailing timber tree up to 10,000 feet altitude. Showing a great deal of variation and hardly considered distinguishable from the typical *P. ponderosa* Lawson, although the variety *scopulorum* is considered distinct by some botanists and is the tree found in this region.

Pinus murrayana Engelm. (Lodgepole pine, white pine.)

Abundant in many regions, either growing with Engelmann spruce and other trees or forming close pure forest of this species alone.

Populus acuminata Rydb. (Cottonwood.)

Only a few trees seen, near Manitou and Colorado Springs.

Populus angustifolia James. (Narrow-leaved cottonwood.)

The most common cottonwood or poplar along streams in this region.

Populus balsamifera Linn. (Balm of Gilead, balsam poplar, cottonwood.)

Frequent along streams; found at altitudes of 10,500 feet or higher.

Populus deltoides Marsh (*P. monilifera* Ait.). (Cottonwood, broad-leaved cottonwood.)

The tree most commonly planted for shade at places along the eastern base of the mountains below 7,000 feet altitude. Not found in the mountains.

Populus tremuloides Michx. (Quaking aspen or quaking asp, aspen.)

Abundant almost everywhere, especially after forest fires. Usually small, but in moist, sheltered canyons or gulches sometimes attaining 60 feet in height and a trunk diameter of a foot or more. Occasionally reaches to 11,000 feet altitude.

Potentilla fruticosa Linn.

This is probably the most generally distributed shrub in the reserves. Observed at different altitudes from 6,000 to 12,500 feet and possibly higher. Often very abundant on open "parks" used for grazing.

Prunus americana Marsh. (Wild plum.)

Local, along creeks on eastern side of Plum Creek Reserve, under 7,000 feet altitude. A shrub or small tree 10 to 12 feet high. The fruit is valued for culinary purposes.

Prunus pennsylvanica Linn. (Bird cherry.)

Common in many places from 6,000 to 10,000 or higher altitude. Always very small, never arborescent. Springs up freely from roots after fire. Possibly a distinct variety or species from the eastern type.

Prunus virginiana Linn. (Chokecherry.)

Frequent, especially along creeks, sometimes on rocky mountain slopes. Usually 6,000 to 8,500 feet altitude.

Pseudotsuga taxifolia (Lam.) Britton (*P. douglasii* Carr). (Douglas spruce, red spruce.)

Abundant, with yellow pine up to 10,000 feet or higher altitude.)

Pyrus sambucifolia Cham. & Schlect. (Mountain ash.)

Rather rare and local.

Quercus gambelii Nutt. (Oak, scrub oak.)

Usually growing to 7 or 8 feet in height, forming thickets. Rarely tree-like or 20 feet high.

Razoumofskya americana (Nutt.) Kuntze (*Arceuthobium americanum* Nutt.).

Parasitic on lodgepole pine; plentiful in some localities and causing considerable injury to the growing trees.

Razoumofskya douglasii (Engelm.) Kuntze (*Arceuthobium douglasii* Engelm.).

Parasitic on Douglas spruce; local.

Razoumofskya robusta (Engelm.) Kuntze (*Arceuthobium robustum* Engelm.).

Parasitic on yellow pine (*P. ponderosa*). Abundant in many localities and sometimes causing much injury.

Rhus glabra Linn. (Smooth sumac.)

Occasional, at low altitudes. Springs up again after fire.

Rhus toxicodendron Linn. (Poison sumac, poison "ivy.")

Occasional; dwarf, never climbing; found only at low altitudes.

Rhus trilobata Nutt.

A common spreading bush in many places from 6,000 to 8,000 feet altitude.

Ribes aureum Pursh. (Missouri currant, buffalo currant.)

Uncommon and local, along streams at lower levels.

Ribes cereum Dougl.

Common on rocks and poor granite soils, on mountain slopes up to above 10,000 feet altitude.

Ribes lacustre Poir. var. **parvulum** Gray.

Frequent, especially at high altitudes, reaching to 12,000 feet or more.

Ribes leptanthum Gray.

Occasional.

Ribes oxyacanthoides Linn. (Gooseberry.)

Along streams up to 9,000 feet altitude or more. Fruit edible; valued for culinary purposes.

Robinia neomexicana Gray.

Naturalized at Manitou from another part of the State. Not within the reserve boundary.

Rosa arkansana Porter.

Rosa engelmanni Watson.

Rosa woodsii Lindl.

The roses showed great variability, and other species may occur. Typical *R. engelmanni* occurs on the Cheyenne Mountain wagon road, between Colorado Springs and Cripple Creek.

Rubus deliciosus James. (Flowering raspberry.)

Common, usually with *Physocarpus*, *Holodiscus*, etc.

Rubus strigosus Michx. (Red raspberry.)

Common in localities, but not so abundant as is generally supposed. Plentiful in a few burned districts and along some roadsides. Always dwarf, rarely more than 18 inches high.

Rubus americanus (Pers.) Britton (*R. triflorus* Richardson).

Uncommon; in moist places.

Salix bebbiana Sarg. (*S. rostrata*, Richardson.)

Occasional.

Salix cordata Muhl.

Frequent along streams.

Salix desertorum Richardson, var. ?

Abundant along cold mountain streams or on wet mountain meadows or "parks" reaching 12,000 feet altitude.

Salix flavescens Nutt.

Salix irrorata Anders.

A handsome willow found along streams up to 10,500 feet altitude or more. Grows 8 to 10 feet high.

Salix lasiandra Benth.

Much resembling *Salix lucida* of the east.

Salix longifolia Muhl.

Noticed only along streams below 8,000 feet altitude.

Salix monticola Bebb.

Occasional.

Salix novæ-Angliæ Anders.

Common along streams at high altitudes.

Salix phylicifolia (*S. chlorophylla*, Anders.).

Near streams at high altitudes.

Salix reticulata Linn.

A creeping, very small willow, growing on exposed slopes above timber line.

Sambucus racemosa Linn. (Red-berried elder.)

Occasional on mountain slopes up to 10,500 feet or more. Usually dwarf, and less woody stems than eastern form.

Symphoricarpos occidentalis Hook.

Occasionally abundant, especially near streams.

Symphoricarpos pauciflorus (Robbins) Britton. (Snowberry.)

Plentiful in a few localities.

Symphoricarpos oreophilus Gray.

Occasional.

Vaccinium myrtillus Linn, var. **microphyllum.** (Whortleberry.)

Abundant in some localities, but not generally distributed. Dwarf, rarely more than 3 or 4 inches high.

Vitis vulpina Linn. (V. *riparia*, Michx.) (Wild grape.)

Very local along creeks on eastern borders of Plum Creek Reserve at about 6,000 feet altitude.

WHITE RIVER PLATEAU TIMBER LAND RESERVE.

By GEORGE B. SUDWORTH.

GENERAL LOCATION.

This reserve is situated in northwestern Colorado. Roughly, it includes the northeastern part of Garfield County, nearly the eastern half of Rio Blanco County, and a portion of the southern border townships of Routt County, immediately north of Rio Blanco. The reserve lies between Grand River on the south (distant about 15 miles) and Yampa River on the north (distant about 10 miles). The eastern border is partly inclosed by the head waters of Yampa River and by that portion of Grand River lying between Eagle River and Rock Creek. The western border is similarly inclosed by Flag and Badger creeks (Pl. XLVIII, in pocket).

BOUNDARIES.

The following are the limits of the reserve, as defined by the Executive order of October 16, 1891:

Beginning at a point between sections three (3) and four (4) on the north boundary of township five (5) south, range eighty-seven (87) west, of the sixth principal meridian in Colorado; thence north twelve (12) miles; thence east to the southeast corner of township two (2) south, range eighty-six (86) west; thence north between ranges numbered eighty-five (85) and eighty-six (86) west to the base line; thence west along the base line to the southwest corner of township one (1) north, range eighty-five (85) west; thence north between ranges numbered eighty-five (85) and eighty-six (86) west to a point between sections thirteen (13) and twenty-four (24) on the east boundary of township five (5) north, range eighty-six (86) west; thence west through the middle of township five (5) north to the center of township five (5) north, range ninety-one (91) west; thence south to a point between sections three (3) and four (4) on the north boundary of township two (2) north, range ninety-one (91) west; thence west six (6) miles to a point between sections three (3) and four (4) on the north boundary of township two (2) north, range ninety-two (92) west; thence south to a point on the base line between sections thirty-three (33) and thirty-four (34) of township one (1) north, range ninety-two (92) west; thence west along the base line to a point between sections three (3) and four (4) on the north boundary of township one (1) south, range ninety-two (92) west; thence south to a point between sections three (3) and four (4) on the north boundary of township two (2) south, range ninety-two (92) west; thence west to the northwest corner of township two (2) south, range ninety-three (93) west; thence south to the southwest corner of township three (3) south, range ninety-three (93) west; thence east to the northeast corner of township four (4) south, range ninety-two (92) west; thence south to the southeast corner of township four (4) south, range ninety-two (92) west; thence east to the place of beginning.

FACILITIES FOR TRAVEL AND METHOD EMPLOYED.

The southern boundary of the White River Plateau Timber Reserve lies about 15 miles north of the nearest railroad, so that it was entirely impossible to rely upon railway travel in my examination of the reserve. A few stage lines connect the central and northern parts of the reserve, especially the most thickly settled agricultural regions along White and Williams rivers, with railroad towns in the valley of Grand River. For my purposes these stage lines were too few in number to use in making exhaustive examination of the area. It was, therefore, deemed most expedient and economical to perform the necessary travel on horseback, with a sufficient number of pack animals to carry supplies and camp materials. The outfit procured consisted of two saddle and three pack horses, with a guide.

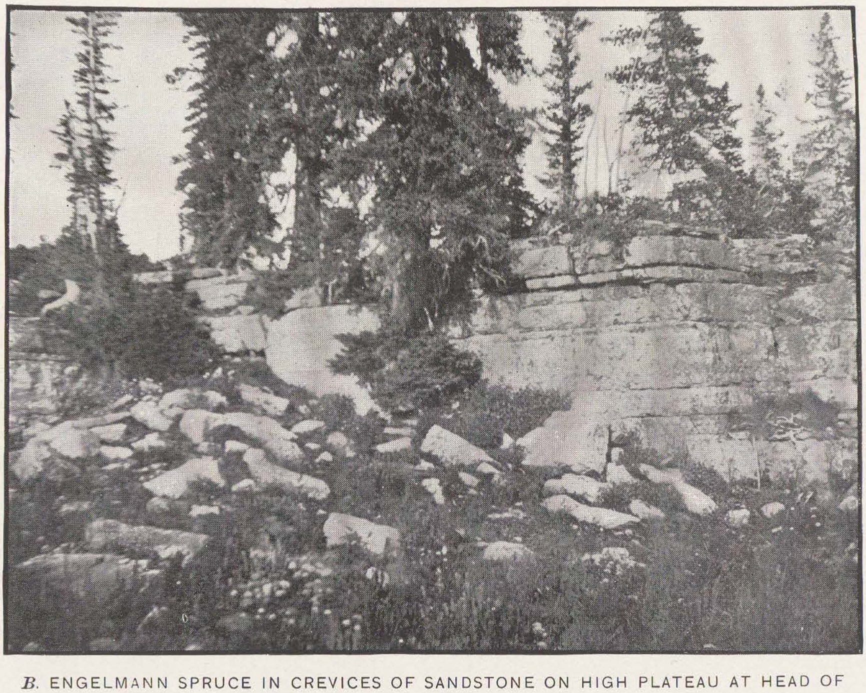
A few short and little-traveled wagon roads penetrate the reserve, either to summer resorts or to the main agricultural regions along White and Williams rivers, the two main water courses within this reserve. These roads touch small towns, as already stated, in the Grand River Valley on the south, such as Glenwood, Newcastle, Rifle, De Beque, and Grand Junction; on the west, Meeker, and on the east, Yampa, etc. Illicit lumbering operations, timber and tie cutting, together with prospective mining operations, have caused the construction of a few other short wagon roads leading into this reserve, the longest ranging from 15 to 20 miles. In a few cases ranchmen settled within the reserve have built short wagon roads up into the timbered "hills" for a distance of 5 to 10 miles, over which fuel, building, and fencing materials have been and are drawn. Settlers have also cut out and maintain many short wagon roads within the reserve, running from the settled river valleys into grazing districts, where the mutual interests of cattle and horse rangers combine to maintain summer camps and headquarters for "round-ups."

The reserve is also traversed from north to south by several trails, usually connecting the small mail posts and running to various camping and fishing resorts. The old Ute Indian trail, which goes from the vicinity of Meeker (formerly the White River Indian Agency) in a southeasterly direction to the Grand River Valley, which was formerly much used by these Indians, is still well marked where it traverses grassy parks and high plateaus, but in timbered districts is generally quite impassable owing to the constant fall of dead timber. The trails are kept open chiefly by the travel of sportsmen who annually visit certain points in the reserve.

These roadways and trails were useful so far as they went, but much of my travel was necessarily independent of roads and trails, over hills and up high mountains, through untraversed, densely-wooded, and burned districts. Such regions are, from the masses of burned and

A. VIEW NORTHEAST FROM SHAFT HOUSE AT CARBONATE.

Shows characteristic scattered stand of timber in White River Plateau region.



B. ENGELMANN SPRUCE IN CREVICES OF SANDSTONE ON HIGH PLATEAU AT HEAD OF GRIZZLY CANYON.

fallen dead timber, often impassable except by constant use of the ax and diligent search for the least obstructed passage. Travel in still other districts was most difficult, through the existence of exceedingly dense, almost impenetrable, growths of scrub oak (*Q. undulata*) and service brush (*Amelanchier alnifolia*) or aspen, through which it was often necessary to make my way in order to avoid long detours.

PLAN OF FIELD INVESTIGATIONS.

The examination of the region consisted, in brief, in first obtaining from high peaks, ridges, and plateaus a full and comprehensive view of all parts of the reserve. The topography of the region was specially favorable to such examinations, but they involved considerable hard climbing. The timbered regions being thus located and other general features and relationships understood, the wooded areas were examined in detail. This examination was made by riding over an entire district of complex character, or, where uniformity marked the regional growth, over representative portions of it, to an extent sufficient to give a safe estimate of all essential characteristics. Sample-area measurements of standing timber were made throughout the wooded parts of the reserve for all the strictly timber species and also for the various grades of development for each kind under different conditions. Estimates by sample areas were also made for all burned districts where the timber destroyed was of commercial value. Other burned-over areas were carefully examined, but no estimates were made for the aspen growth involved in old and recent fires.

As an auxiliary to the notes and descriptions of the region, a map of the reserve (Pl. XLVIII, in pocket) and a series of photographs were made, in order to illustrate the prevailing forest conditions, the details and characteristics of tree growth of various kinds, its reproduction under natural conditions and when modified by fire, the various degrees of destruction by fire and from other causes, the grazing, brush, and agricultural lands, cattle and horse ranging in the reserve, illicit timber cutting, domestic uses of dead timber by settlers, the use of timber for mining operations, and many related features which combine to give a comprehensive view of the present condition of the reserve.

GENERAL TOPOGRAPHIC FEATURES.

The White River Plateau Reserve is made up largely of high plateaus from 10,000 to 12,000 feet in elevation. These comprise nearly half the area of the reserve. They differ greatly in size, the more extensive plateaus being commonly rolling, prairie-like plains, very irregular in outline, from 4 to 6 miles wide, and often stretching away for 8 to 20 miles at practically the same level (Pl. XLIX, *A*). The smaller and isolated plateaus (locally designated "flat tops") are from 2 to 3 miles in width by 4 to 6 or more miles in length. The undulation in the surface of these plateaus seldom has a range of more than 100 feet but in exceptional instances reaches 150 to 200 feet. The surface is often broken in detail by low, rocky ledges, small knolls and ridges, and by broad, shallow basins, sometimes holding alpine marshes (Pl. XLIX, *B*).

The soil of these plateaus is a deep, light-brown sandy or gravelly loam, or in places, especially in the vicinity of knolls and ridges, the surface bears exposed laminated formations of yellowish or reddish sandstone or limestone, often thinly covered with drifted soil.

The approach to these elevated plateaus, in some places, consists of ragged, precipitous, rocky walls; in others, of long, gentle slopes 6 to 15 miles in length (Pl. L, *A*).

In addition to these plateaus, a number of mountain peaks of like elevation, or a few hundred feet higher, are conspicuous in the reserve, such as Mount Marvine, Mount Orno, Darby Peak, Dome Peak, Pyramid Peak, Pagoda Peak, Sand Mountain, Sleeping Cap Mountain, etc. Mount Marvine, Darby Peak, Plateau Peak, and Dome Peak rise out of the plateaus; while others, such as Mount Orno, Turret Peak, Shingle Peak, Pyramid Peak, Sand and Sleeping Cap mountains are unconnected with the great plateaus, and either rise by long, gentle slopes from valley levels or form the salient points in ranges of foothills or divide ridges.

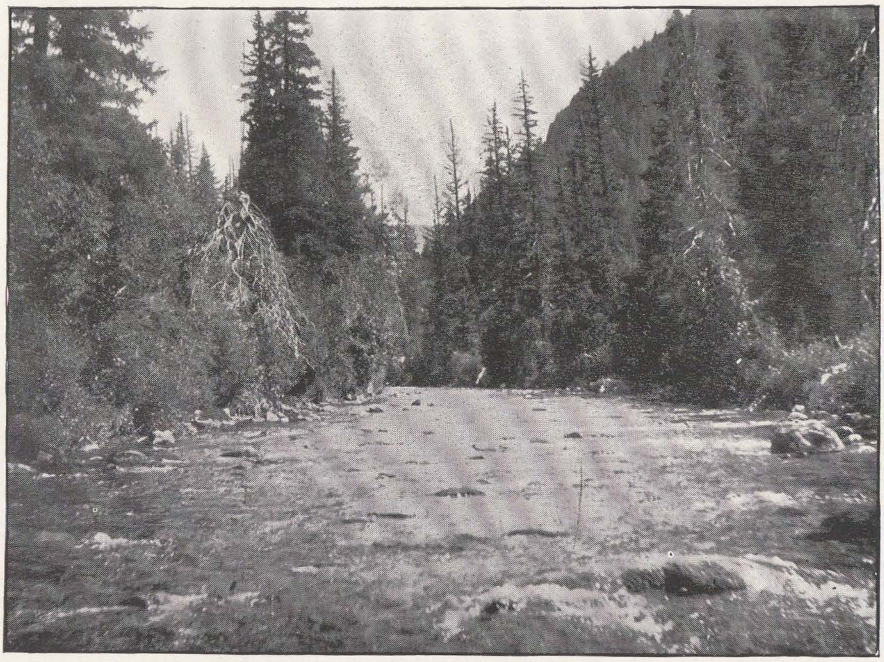
This reserve is drained on the northeast by the head waters of the Yampa River, with several important tributaries; on the north by Williams River; throughout the central districts by White River; and on the south by small tributaries of Grand River.

The rivers flow, for the most part, through valleys half a mile to a mile wide, or in regions near the headwaters through narrow, gorge-like canyons (Pl. L, *B*). The width of the streams varies from 30 to 75 feet at low water, from August to October, with a depth of 12 to 24 inches. Bowlders, small stones, and fragments of rock form the rough beds, over which the streams course at a rapid pace, forming many pools and cutting deep channels. At high-water season, May to July, these streams carry a much greater volume of water, and in the broad bottom lands often widen their course 10 to 20 feet or more beyond the summer flow.

The tributary creeks are very numerous, penetrating to the verge of the great surrounding plateaus, lesser mountain slopes, and low hills by hundreds of unnamed rivulets fed by myriads of hidden springs and masses of melting snow. The larger creeks are 4 to 15 feet wide, with 6 to 12 inches of water for the summer flow, but at high water 3 to 10 feet wider in parts and several feet deep. The beds of these streams are rocky, and as a rule the water flows at a rapid and often

A. VIEW FROM RIDGE BETWEEN FORKS OF SOUTH ELK CREEK.

Scattered red fir on lower slope.



B. SOUTH FORK OF WHITE RIVER, LOOKING UP.

Engelmann spruce and alpine fir.

tumbling pace through narrow rough-walled canyons and steep or gently-sloping vales; low mesas, benches, and lower flats form intervening tongues extending to the level, broader river-valley lands.

Innumerable alpine lakes, ponds, and "potholes" abound throughout the great plateau region and also among the higher foothills of the plateaus and about the mountain peaks. Many of these lakes form the sources of the smaller streams (Pl. LI, *B*), while others have no visible outlet, forming depositories for the snow water of the immediate slopes. Towering rocky walls and ledges often bound the larger lakes completely or in part, masses of volcanic and other fragments of rock forming the shore and lower slopes; or the lake may lie in a slight rocky depression of the plateau. Extensive marshes sometimes surround the smaller lakes and water holes in the more open regions, when the bottom has a deposit of deep black muck, while in other instances the water is held in clean sandstone or limestone basins, the shores and receding surface showing the same exposed rock, or in parts, thinly covered with a poor shaly and gravelly soil.

SETTLEMENTS AND AGRICULTURAL LANDS.

In all cases agricultural settlements are along the water courses, where a sufficient supply of water is obtainable for irrigation. The accompanying map (Pl. XLVIII, in pocket) shows the location and extent of such agricultural or "ranch land." No villages exist within the reserve. A number of post-offices have been established to accommodate the agricultural settlers. The offices established at the time of my examination were Marvine, on Marvine Creek, a tributary of White River; Buford, near the mouth of the South Fork of White River; Pyramid, near Pyramid Peak, on the east head branch of Williams River; and Pagoda, near the peak of the same name, on the West Fork of Williams River. The ranchmen holding these offices usually keep small stores containing provisions and other supplies.

Several small resorts have been established in the reserve. The principal ones are located at Deep Lake, at the head of Deep Creek, a tributary of Grand River; at Trappers Lake, at the head of the easternmost branch of White River; and at Marvine, the post-office already referred to. The latter place is said to have a "proved-up" ranch in connection with it. Rough log cabins afford rude but comfortable accommodations to sportsmen and other tourists.

Most of the available agricultural land which is occupied lies in the bottoms immediately adjacent to the streams, while much of that on the mesas and benches, from 10 to 50 feet or more above the adjacent stream, is generally unoccupied. The land is quite level, or in case of mesas and benches gently rolling or sloping. The land thus described varies in width along the streams from one-fourth of a mile to nearly a mile.

Such lands were originally covered with a growth of sagebrush. The soil is commonly a deep, rich, light-brown, sandy loam, in some places thickly strewn with bowlders and fragments of volcanic rock. These are, however, of but little hindrance to thrifty ranchmen, who remove them and make use of all the land that can be irrigated.

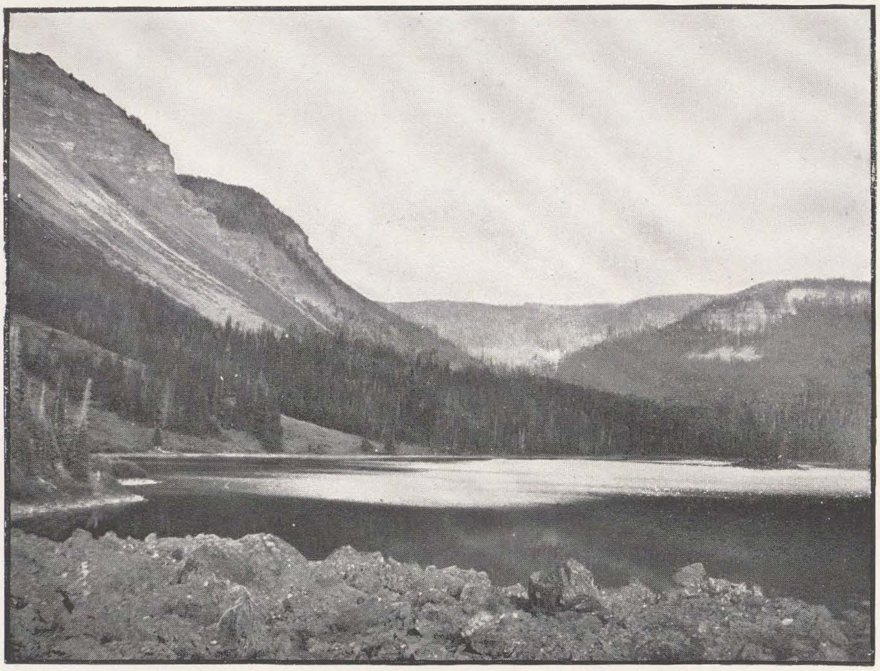
Water for irrigation and domestic purposes is ample and easily secured for lands lying adjacent to the stream levels. In some instances, however, the irrigation ditches of ranches on the creeks consume the entire flow of a stream during dry seasons. The procuring of water for irrigating the agricultural land on the higher mesas and benches is too expensive for the individual ranchman, but it is perfectly feasible through irrigation companies, who can carry water by high-line ditches from the rivers to these elevated lands, which can then be more fully occupied than at present. A few such tracts of land lie along White River, on its South Fork, in the valley of Little Beaver Creek, near the western border of the reserve, and in portions of Williams River Basin. This land is at present unoccupied, partly from the fact, already mentioned, that the procurement of water is beyond the means of the average settler, and partly because the land is at least provisionally exempted from settlement by being part of the reserve.

A considerable number of settlers have for a time held, by squatter's right, ranch land in isolated parts of the reserve upon which improvements have been made, but which, doubtless for lack of title, have been abandoned.

TIMBER-BEARING REGIONS.

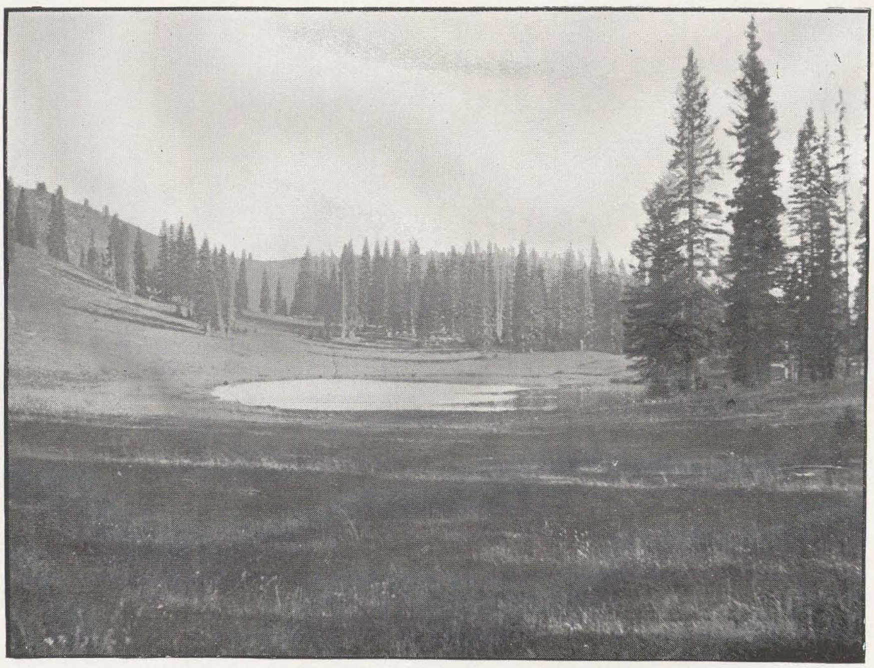
GENERAL REMARKS.

The timbered areas of this reserve share, in their character, the common feature of the entire Rocky Mountain region, in rarely consisting of extensive bodies of forest growth. The very interesting problem of how the timber was originally distributed in this region must long remain a conjecture, but at present the great plateau lands have only disconnected groups and groves of trees, ranging in size from one-eighth of an acre to 20 or more acres, or in many cases only single trees, interspersed with "parks" or grass lands, the latter varying in extent from one-fourth of an acre to 300 or more acres (Pl. XLIX, *A*). In addition to these high, wooded plateaus, the same kinds of timber, of equal value, often cover more continuously than elsewhere the slopes about the head waters of nearly all the streams between the altitudes of 9,000 and 10,800 feet (Pl. LII, *A*). While the same timber may, in some cases, be distributed on all sides of a broad basin, it is found most abundantly on the northern, northeastern, and northwestern slopes. The less important timber growth is found on the southern barer and more rocky slopes. The bottoms of nearly all the canyons bear a usually scattered stand of trees, as a rule of little commercial value.



A. UPPER MARVINE LAKE AND MARVINE CREEK CANYON, LOOKING UP.

Engelmann spruce and alpine fir.



B. SUMMIT OF WHITE RIVER PLATEAU, NEAR EAST RIM.

Engelmann spruce of largest size in scattered groups.

TIMBER AND OTHER TREE SPECIES.

The commercially important species in the reserve are conifers, which, in fact, constitute the principal and conspicuous forest growth. They consist of the following kinds, mentioned in the order of their greatest abundance:

Engelmann spruce	Picea engelmanni Engelm.
Alpine fir	Abies lasiocarpa (Hook.) Nutt.
Lodgepole pine	Pinus murrayana "Oreg. Com."
Blue spruce	Picea parryana (André) Parry.
Red fir	Pseudotsuga taxifolia (Poir.) Britt.
Yellow pine	Pinus ponderosa scopulorum Engelm.
One-seed juniper	Juniperus monosperma (Engelm.) Sarg.
Piñon pine	Pinus edulis Engelm.
Rocky Mountain juniper	Juniperus scopulorum Sarg.

The deciduous-leafed kinds are far in the minority in all respects, and are, save one, the ubiquitous aspen, little known and commonly considered as brush. The following is a full enumeration, in order of abundance and conspicuous form:

Aspen	Populus tremuloides Michx.
Rocky Mountain oak	Quercus undulata Torr.
Western service berry	Amelanchier alnifolia Nutt.
Narrow-leaf cottonwood	Populus angustifolia James.
Paper-leaf alder	Alnus tenuifolia Nutt.
Western chokecherry	Prunus demissa (Nutt) Walp
Box elder	Acer negundo Linn.
Dwarf maple	Acer glabrum Torr.
Mountain mahogany	Cercocarpus ledifolius Nutt.
Birch	Betula occidentalis Hook.

DISTRIBUTION OF CONIFEROUS SPECIES.

The Engelmann spruce is the most abundant and important timber tree within the reserve, and throughout its range is intimately associated with the alpine fir. The more exclusive lodgepole pine, however, often forms adjacent stands, and in some localities mingles with the spruce, but occurs in rather restricted areas, so that the general impression of dominance in numbers and areal distribution belongs to the Engelmann spruce. It is so closely and constantly associated with the alpine fir as to make it impossible to separate the latter from it as a forest concomitant. The spruce forms from 75 to 90 per cent of the stand where spruce and fir comprise the entire growth; in some localities, however, it is possible to find small areas in which alpine fir is dominant.

The altitudinal range of Engelmann spruce is well marked, usually beginning at about 8,000 and running up to 10,000 feet elevation. The commercial timber occurs mostly between 8,000 and 9,000 feet, while at greater altitudes it is gradually reduced in stature, until a low, stunted form is found inhabiting wind-swept rocky sites. Here the low, sprawling tree growth may consist entirely of alpine fir, entirely of spruce, or of a mixture of both species. Altitude appears to have but little if any effect on the close association of the two kinds.

The spruce and fir are spread over the high plateaus, but are nowhere found in great bodies. They occur as single trees or in isolated groves varying in size up to 50 acres. The stand is dense, not uncommonly 10 or 12 trees occurring on a plat 10 to 15 feet square, much after the manner of the bunchy growth of arborescent willows, followed by intervals of 8 to 10 feet to the next similar group. At a distance the timber appears to be of uniform density. The advance of the species in the gradual formation of larger groups by the coalition of neighboring small groups is very apparent, and doubtless is the explanation of this peculiar density of growth of spruce and fir observable everywhere on the plateaus. A single individual, seeded from a mother group or tree and established many yards away, in favorable seasons and good seed years soon gathers about it a cordon of young plants from its own falling seed. The most favorable moisture conditions are beneath the mother tree's low branches, or adjacent and under the north-side shade, where the seedlings may spring up in abundance, forming in time a dense group representing the mother tree's radius of seed dissemination. The establishment of another outpost several yards distant, less difficult now under the fostering protection of the original group, soon takes place from favorable winds lodging stray seeds among the tall grass. Many seeds fail to germinate, but the proper timely moisture conditions for starting the seed do occur, and from a seedling established to a tree and group, another part has been added at short intervals, to the original group.

The distribution of spruce and fir over the watersheds at the heads of streams which cut the plateau region, and about isolated mountain peaks, is sometimes quite similar to this peculiar group growth, but as a rule is much less interrupted, continuous stands of timber often being seen, notably on the head waters of Marvine Creek, on the slopes about Big Fish and Trappers lakes, and at the head waters of the South Fork of White River and of Williams River (Pl. LII, *B*). Here the timber appears in more homogeneous stands. The explanation seems apparent from the greater protection afforded the advancing growth from high winds in shut-in, deep valleys in head-water basins, and on the constantly shaded, moist northern mountain slopes. In such localities the Engelmann spruce and its congener occur most abundantly and there is little or no indication of the group struggle marking the plateau growth.

The soil conditions under which Engelmann spruce occurs varies from the deep, moist, humus-covered loam of narrow bottoms along and even on the moist banks of streams, and the lower gentle slopes,

A. CLOSE STAND OF ENGELMANN SPRUCE AND ALPINE FIR ON SOUTH END OF BURRO MOUNTAIN.

B. CLOSE STAND OF ENGELMANN SPRUCE AND ALPINE FIR ON LOWER SLOPES OF SLEEPING CAP MOUNTAIN.

with dense cover of herbaceous vegetation, to the dry, sandy, gravelly, or exposed sandstone of the higher plateau levels supporting but little and scanty herbaceous cover (Pl. XLIX, *A*). The largest and best timber is on the loose, moderately rich soils; that on the poorer shaly and gravelly soils and on the bare rock is smaller, less thrifty, often stunted, and apparently of very slow growth. The species shows here a remarkable adaptability to severe conditions and ability to persist and reproduce itself. The extension of the species in such localities is markedly slow, furnishing a unique type of open forest growth, composed of scattered single trees or of two or three together. The period of life appears to be limited on these sterile and rocky sites, numbers of the largest trees dying from no other visible cause than that of an enfeebled root system, the only chance of root growth being through crevices. The younger trees are perfectly healthy and show no sign of any malady, which, if the cause of death to the larger trees, should presumably have affected all or at least a few of the young trees as well as the larger ones.

Size development, to be further illustrated under timber estimates, reaches in Engelmann spruce a maximum diameter of 40 inches. This, however, is exceptional, the large trees commonly ranging from 19 to 24 inches. The extreme height reached by this species is 120 feet, which is also exceptional, large trees commonly ranging from 80 to 90 feet. The age of large timber runs from 200 to 290 years.

A striking feature in the habit of Engelmann spruce is the retention of limbs, even in the oldest trees, down to the ground, a thrifty and prolonged growth in these resulting in huge, deep-set limbs throughout the trunk. Nor is this low-limbed feature much modified in the denser stands, where the lower branches are necessarily fewer and smaller under the dense shade, but wherever light is admitted that side of the tree is clothed with heavy limb growth. It is well known that spruces, as well as many other conifers, exhibit this same low-limbed development during their early growth. The peculiar and striking feature in the case of Engelmann spruce is, however, that it retains its branches throughout its growth. The species shows a greater toleration of shade than other spruces.

The distribution of alpine fir is so closely connected with the Engelmann spruce as to need but few additional remarks. However, at lower altitudes within the vertical range of spruce and fir the latter plays a part in forest cover entirely separate from its associate. Upon considerable areas the fir forms the entire growth, yet it is also found closely mingled with aspen on the deep rich soils of bench land lying along streams and on the great plateau slopes. The mixtures vary from one in which the two species are equally represented to others in which either the alpine fir or aspen are dominant in numbers. Examples of pure fir growth were seen only on the low, tongue-like ridges along the middle waters of Elk Creek, together with examples of aspen and fir mixtures, which are, however, common in all the aspen-bearing regions immediately below that of the pure spruce and fir forests. Such mixtures are peculiarly abundant on the many rich hill slopes southwest of Burro Mountain (Pl. LIII, *A* and *B*).

Pure fir growth is confined to Elk Creek Ridge and to ridges between the forks of Miller Creek, where it is somewhat anomalous, as Engelmann spruce was found near by, under the same conditions. Here its growth is very dense, almost impenetrable, the shade being so great as to shut out all small vegetation. The tree under such conditions is small, being under 14 inches, while, as seen mingled with aspen, large trees are frequent, 18 to 24 inches in diameter, and, exceptionally, 36 inches. The growth is also much more thrifty in appearence.

The great shade-enduring qualities of this species are illustrated in the low, old, stubbed, long-branched, sprawling seedlings found in all the semiopen spaces about old trees—plants that have existed ten to twenty years in dense shade and are not over 2 or 3 feet high. Only with the dying out of the older trees, giving an abundance of light, do such long-persisting trees begin to shoot up.

The lodgepole pine is a most valuable timber tree for the future forest growth of the reserve. The available timber supply of this species is at present limited, owing to forest fires which have destroyed large areas. Its altitudinal distribution lies between about 7,600 and 10,000 feet, but its greatest development is between 8,000 and 8,500 feet. In its best growth it is found in groves, ranging in size from 5 to 400 acres on the dry sandy loam and gravel soils on the gentle slopes of low foothills, low ridges, broad, high benches, and knolls (Pl. LIV, *A*). The least-valuable growth is where it is mingled with spruce and fir on very dry, loose, rocky soils. Here the trees are low, 25 to 30 feet high, limby, and of little economic value. In its best development, in pure forest, or when it occasionally overlaps and mingles with spruce and fir of better class, this pine bears long, clean, straight trunks, from 8 to 20 inches in diameter, but commonly 8 to 14 inches, with an average height of about 75 feet.

The future importance of this species in the reserve forests can not be overestimated, both for the superior quality of timber produced and as a tree rapidly covering large burned areas. In this respect it is superior to any of the other conifers in the region, as it bears seed at the comparatively early age of 10 to 20 years, thus supplying itself with seed-bearing trees along the line of its advance, often far beyond the reach of the larger, original seed trees.

The prolific reproduction of lodgepole pine is scarcely credible, an enormous number of trees often being produced to the acre. A heavy seed year and abundant opening of the cones, the seed falling, as usual, on a bare, burned, ashy soil, results in an initial dense stand of

A. EVENLY MIXED STAND OF ALPINE FIR AND ASPEN ON FOOTHILLS NORTHWEST OF PAGODA PEAK.

Dead timber killed by old surface fires.

B. MIXED ALPINE FIR AND ASPEN ON RIDGE BETWEEN FORKS OF SOUTH ELK CREEK.

seedlings, which at the age of 10 or 12 years are as many feet high and often stand as thick as 10 trees to the square foot. They are very tenacious and the inevitable thinning takes place only after a struggle of fifteen to twenty years.

With a thinner original seeding, 2, 4, 6, or 8 feet apart, a denser stand of unequal ages soon results from the seeding of the young trees among themselves. The areal advance of such growths is more rapid than in the dense stand first described, as the more vigorous trees come to an earlier and fuller seed bearing.

These pure growths are so dense as to shut out all comers, the persistent aspen only occasionally finding lodgment.

The blue spruce is a secondary timber tree in the reserve, not only from its limited distribution, but also from the inferior quality of the wood. It is peculiarly a tree of canyon bottoms and the immediate vicinity of water courses, occurring between the altitudes of 6,000 and 8,000 feet. It is to be found on all the streams and tributary gulches throughout the reserve. At the lower elevations it gives way along streams to deciduous growths—alder, cottonwood, and, in some cases, juniper; while at the higher elevations it mingles with Engelmann spruce and alpine fir, the two overlapping on some creek bottoms for one-fourth to one-half a mile.

The blue spruce is found (Pl. LIV, *B*) along the immediate banks of streams flowing in deep, narrow canyons, or in broad, open, dry or grassy valleys. The trees occur singly or in scattered groups. Occasionally, as in the upper valley of Ute Creek, a small forest stand is found massed on either side of a stream, where, as in this instance, the trees stand thickly. In some cases, also, scattered single trees and small groups straggle up the grassy slopes on either side of a stream, or establish themselves on earthy slides and in gulches, distant several hundred yards from the stream and 200 to 300 feet above the channel.

The size of blue spruce ranges from 10 to 48 inches in diameter, but is more commonly 10 to 24 inches, with a height of 80 to 100 feet. As in case of Engelmann spruce, the habit of this tree in a moderately open stand is to bear to an old age, large, densely-set limbs to the ground; and even in a thicker stand little clear trunk is available. The soil in which it grows is moderately rich, gravelly, sandy, or rocky, and ranges from very dry to moist, such as is found on the well-irrigated banks of a perpetual stream.

The reproduction of this tree appears to be slow; large numbers of seedlings can not be found, only occasionally young trees 1, 2, or 6 feet high are observable near the old trees, and very rarely any small seedlings.

The red fir, or "red spruce," is of rather rare occurrence in this reserve, but is of the first importance, on account of the excellence of its timber and especially for its great adaptability to extremely dry and rocky situations, conditions under which all other timber species fail (Pl. L, *A*). Stunted, widely-scattered individuals are found clinging to steep earth and rock "slides" on the south sides of deep, narrow canyons, and on south slopes of gentle incline. Isolated, large, dwarfed trees are met at intervals on the high bench levels, 500 to 1,000 feet above neighboring streams; in still other localities the red fir forms important bodies, 50 to 100 acres each, of pure growth, on the northern, eastern, and western slopes of small creeks, such as the East Fork and Middle Fork of Miller Creek, the upper forks of Rifle Creek, the high benches on Canyon Creek near the head of Coal Creek, and the middle canyon of the South Fork of White River. On the edges of canyons the red fir is often sparingly mixed with Engelmann spruce, which, in all cases, succeeds the former at higher elevations. Its altitudinal range is from 6,000 to 8,600 feet, but the strictly forest growth occurs between 7,000 and 7,500 feet elevation.

The size ranges from 10 to 50 inches in diameter, commonly 10 to 20 inches, with a height of 30 to 60 feet. Large trees are exceedingly rare, usually isolated, and much dwarfed. In the densest stands—100 to 120 trees to the acre—the trees have broad crowns, with limbs down to within 2 feet of the ground, and the trunks often crooked.

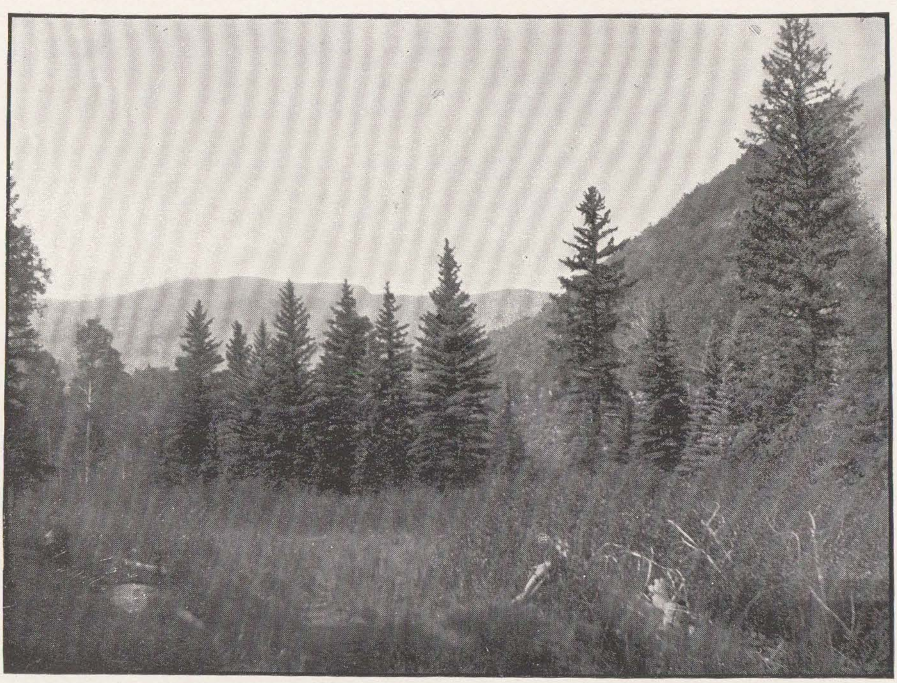
Reproduction of this species is abundant on the borders of dense stands and within all open stands; also following promptly in burned districts wherever surviving seed trees remain. On the rough, rocky canyon sides and lava benches reproduction is necessarily slow, for lack of sufficient soil. Under such conditions only a few straggling, stunted seedlings can be seen among the very scattered old growth.

Yellow pine is of the first value, but owing to its very limited stand and confined range in the reserve, must play a small part in the total output of commercial timber. Like the blue spruce, it is peculiarly a tree of canyon bottoms, but chooses those of more rocky nature, or the broad, dry, gravelly, and often bare, rocky slopes of water courses, notably along White River and its South Fork, Canyon Creek, and along a few other similar streams that cut the southern, middle, and western portions of the reserve. As is common elsewhere in the Rockies, this tree nowhere forms a dense stand, but is very scattered, being found between the altitudes of 5,500 and 7,500 feet, or for the middle region of the reserve, chiefly at about 7,000 feet. The considerable amount of this pine which once stood along White River and its South Fork has been cut out by local mills, as well as being much damaged by frequent fires; so that at present the species is represented only by lone trees. The original stand in the creek canyons farther south received like treatment. At some points the rough, rocky, and poor slopes are shared with red fir.

The size development ranges from 12 to 24, and occasionally 36 inches in diameter and from 60 to 80 feet in height. The strong natural

A. OLD DEEP-BURNING GROUND FIRE IN LODGEPOLE-PINE FOREST NEAR THE HEAD OF COLE CREEK.

Shows part of original forest and reproduction of pine near border.



B. CHARACTERISTIC STAND OF BLUE SPRUCE ON EAST DIVIDE CREEK.

habit of this tree to produce long, clean trunks is well exemplified even in the widely-scattered stand of the reserve. Lone trees have a clean trunk 20 to 30 feet.

Reproduction is rare but observable, very few seedlings and young trees being found in the area of old growth. The seed production, however, is usually rather abundant, yet rarely prolific, on account of the usually dry and unfavorable condition of the soil. The dry and bare rocks, in whose crevices occasional trees find lodgment, or the dry, hard gravel with bunch-grass form poor seed beds to receive the annual crop.

The one-seed juniper forms no part of the functional forests of the reserve, in no way contributing to the conservation of water. This is due to its remoteness from head waters and because it possesses none of the conserving properties of any other type of forest. Its growth is much like apple orchards in cultivated ground. Its timber value is only local.

Aside from the occasional occurrence of this tree on a few of the rocky and exposed cliffs in the canyons along the southern boundary of the reserve, it is met with chiefly in the Williams River Basin, where it forms the only tree growth on the sandstone and gravelly, mound-like foothills on the north side (Pl. LV, *A* and *B*). It was seen in a few similar situations on the south side, chiefly the isolated desert hills and valleys along the middle course of the West Fork of Williams River.

As shown in illustrations, it nowhere forms dense forests, the trees being always far apart, with broad, low crowns. Its usual height is 10 to 15 feet, with twisted, eccentric trunks, 6 to 8 feet in length, and 12 to 36 inches in diameter. Destroyed in part by frequent fires, it persistently and slowly reproduces itself, defying the extreme arid conditions where it chooses to grow.

The piñon pine is to be mentioned only as an occasional associate of the foregoing species, and in all respects shares with this species its peculiar unforest-like features. In the region adjacent to Grand River Valley and south of the reserve considerable quantities of piñon pine occur under the same conditions described above, in some instances in pure scattered stand, and in others more or less mixed with one-seed juniper.

Likewise the Rocky Mountain juniper is only an occasional associate of the above juniper and pine; being rare and somewhat similar to its more abundant congener, it passes for the same tree. As seen almost exclusively on the lower slope of the East Fork of Miller Creek, and in the canyon of the middle part of the South Fork of White River, it is mingled very sparingly with red fir and one-seed juniper, just above the stream level at about 7,000 feet elevation. Throughout the reserve it appears to be strictly confined to the lower edge of the stream slopes, where the soil is richer, rarely extending more than 50 to 75 feet up the slope. In fact, in the Gunnison River Valley, where it is much better developed and of more frequent occurrence, it is confined almost entirely to tributary creek bottoms adjacent to the lower river bottom. It has a trunk 12 to 25 feet in height and 4 to 12 inches, rarely 24, in diameter.

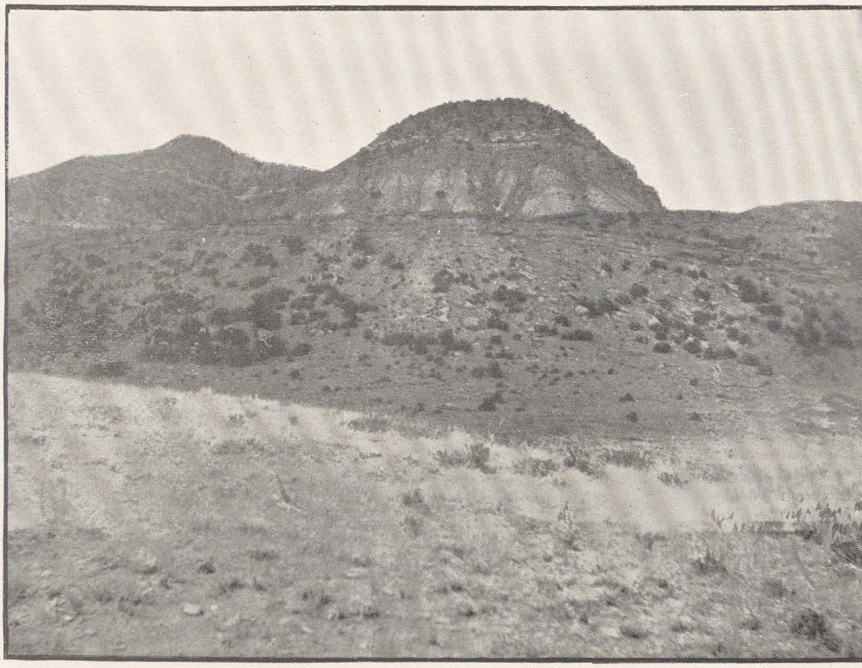
It is quite as prolific in seed production as the one-seed juniper, but reproduces itself very slowly, although growing in better and moister soil than prevails where the one-seed species grows.

Next to the Engelmann spruce and alpine fir in their combined importance and prominence, the aspen is the most widely-distributed tree in the reserve. It has, however, little to commend it to notice except its sylvicultural value, its economic importance being small.

The aspen ranges in altitude from about 8,000 to 10,000 feet. Its areas of best development lie between 8,000 and 9,000 feet. It is a tree of steep, rugged, rocky slopes, of gentle and vast sloping benches and low hills that make up the great declines from the high plateaus to the higher levels of nearly all the water courses. It may even be found on the edge, and more or less scattered over the top of several of the smaller high plateaus. While it appears to grow irrespective of slope, it is found, for the most part, covering slopes with southern and southwestern exposures.

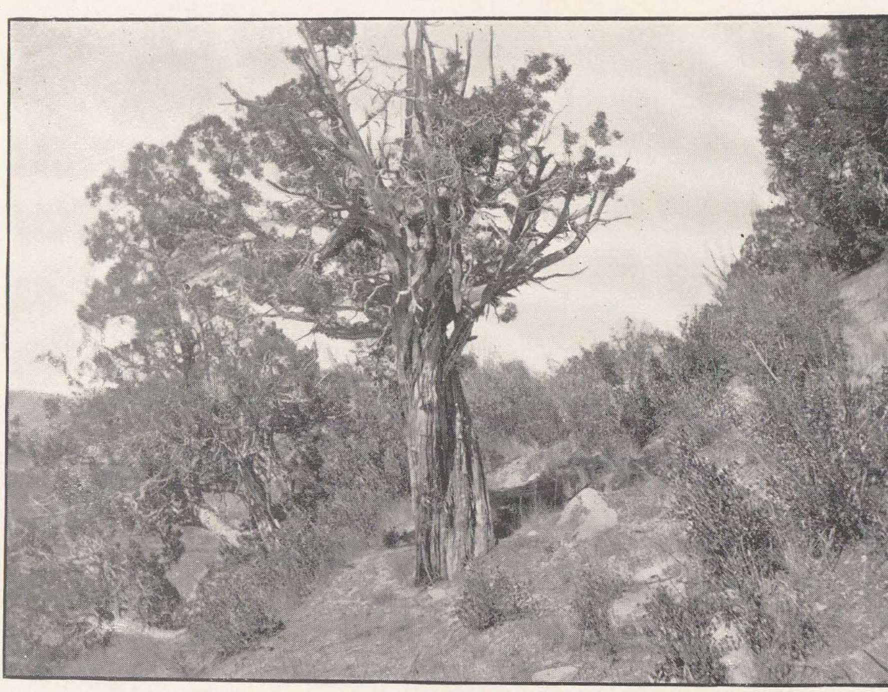
It merely exists and spreads in gnarled, stunted forms on the higher, almost bare, rocky portions of south slopes, making its first stand in the depressions—shallow gulches and fissures—from which it steadily advances and covers slopes otherwise bare of tree growth. Where it reaches over the edges of the great plateau rims in thin lines and groups it is likewise stunted; but here high fierce winds appear to check the development. Only on the lower and middle gentle slopes and benches, with deep, rich soil, does the aspen form a noticeable forest growth. In such localities it is vigorous, rapid, and in dense stand, its light foliage, however, always admitting a heavy undergrowth of cheat grass, rye grass, large succulent umbellifers, and small shrubs, such as *Symphoricarpos*. In this larger forest growth it enters the middle altitudinal range of Engelmann spruce and alpine fir, and with an equal mixture of these conifers often forms a dense forest cover, interrupted, as is pure spruce growth, with small grassy "parks," and running up to the pure coniferous forest. This mixed stand may be suddenly joined by one of pure aspen, and again by a mixed stand of aspen with 10 to 50 per cent of alpine fir (Pl. LIII, *A*).

The aspen ranges in size from 6 to 24 inches (in some instances 30 to 36 inches) in diameter and from 30 to 60 feet in height. The trunks are smooth and clean, 25 to 40 feet to the crown. The aspen of the wind-swept plateaus and hill crests is always of very low stature,



A. PORTION OF RANGE OF SANDSTONE HILLS ON NORTH SIDE OF WILLIAMS RIVER.

Shows scattered stand of one-seed juniper.



B. ONE-SEED JUNIPER.

gnarled, and with peculiar, flat-topped crowns, the trunks 3 to 8 inches in diameter and 10 to 20 feet in height. Toward and at its upper limits of growth it occurs chiefly in small patches, but tenaciously holds its ground, rapid reproduction replacing the trees constantly broken by high winds.

The Rocky Mountain oak, known to all settlers as "oak brush" or "scrub oak," appears in the reserve mostly as a low, scraggy shrub, spread over nearly all the low hills and broad slopes with southern, eastern, and western exposures between the altitudes of 7,000 and 8,000 feet. It is, however, in general no respecter of exposure, being found on all sides and on the crowns of many foothills at 7,000 to 7,500 feet elevation (Pl. LVI, *A*). It forms a dense, continuous brush cover 2 to 10 feet high, often so dense as to be quite impenetrable; or it may be more or less mingled with service brush ("sarvice" of settlers), which is in many respects equal to the oak as a barrier to travel. The poorer soils and exposed situation commonly chosen by this species rarely produce arborescent forms; but on a few low slopes and benches, with deep, rich, well-watered soil (as on head of Beaver Creek, South Fork of White River, etc.), the same brushy species becomes a small tree, with crooked, curved trunks 12 to 15 or more feet in height and 2 to 12 inches in diameter, forming small groves.

This species is never found in connection with any of the coniferous species, usually being remote from them on the low, exposed foothills and larger slopes, which are, by reason of aridity, devoid of forest growth. It is commonly the growth which replaces the sage- and grease-wood brush of the lower agricultural lands on adjoining higher levels. As a conserver of moisture, holding masses of snow, this species may be of importance. With the heavy fall of leaves, its intricate, dense thickets have some humus-forming qualities, not entirely destroyed by the hard grazing to which oak-brush lands are subjected. The wood has no commercial value.

The western service berry is somewhat less abundant, but as a low, rigid bush is a constant associate of the Rocky Mountain oak, nowhere reaching the size of a tree. In moist, rich, low gulches the slender stems (1 to 1½ inches in diameter) are 6 to 8 feet in height, but for the most part the species occurs in a broad, flattened, shrubby form, closely mingled with oak brush or, less commonly, with small aspen. The settlers use the abundant fruit, which is much like a large whortleberry, as a sauce.

The narrow-leaf cottonwood is found only on the immediate banks of streams with broad valleys and narrow, moist bottoms. It is the only tree of the White and Williams river bottoms, where it is most abundant, and from which it extends up several tributary valleys and canyons to an altitude of 8,600 feet. In a few cases there are continuous growths of cottonwood extending from the river up creek bottoms, as on Marvine, Ute, Fawn, and Lost creeks, while in other instances, as on South Fork of White River, West Fork of Williams River, Middle Fork of Miller, Little Beaver and Coal creeks, disconnected patches of this timber occur at intervals and far above the river bottoms. The belts of this timber vary from a single line of trees to a body 50 yards in width and several miles long, while isolated patches are from one-eighth of an acre to 5 acres. The growth is usually dense enough to exclude all grass, only bushy willows and alder sharing the moist sandy or mucky bottoms. It is a tree with crooked, tortuous stems 40 to 50 feet in height and 10 to 24 inches in diameter; the trunks are clear of limbs for 20 to 30 feet.

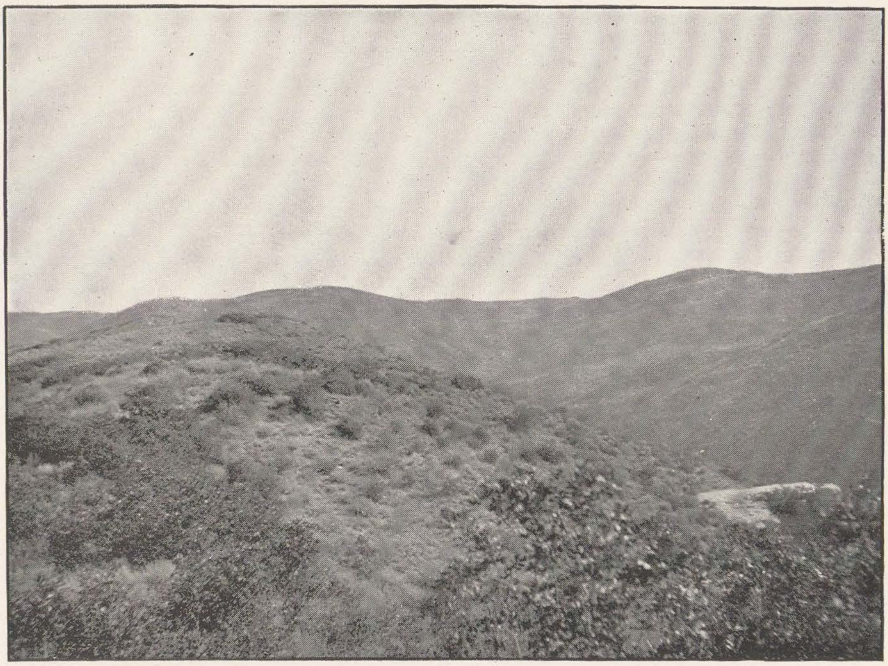
Abundant reproduction is going on along the streams, dense patches of seedlings covering all the moist sand bars and extending less thickly back to the drier soil of the higher banks among willows, alder, and birch.

As a forest concomitant the cottonwood is of no importance in the reserve. Its meager distribution affords but little protection and conservation of water on streams owing to its remoteness from all head waters. It gives no protection from erosion of river and creek banks in agricultural districts, as the gullying stream cuts behind and leaves the trees in the washed-out channel; in only a very few instances does it check, at intervals, the rushing torrents of rock-bound, deep, and narrow canyons. It is of no commercial value.

The paper-leaf alder, at best like an overgrown shrub, with tall stems appearing to come from the same root, is likewise an inhabitant of all the water courses between 7,200 and 9,000 feet elevation, the largest growth occurring at 7,500 to 8,500 feet elevation; at its upper limits it is reduced to a low shrub. On the middle levels it forms dense lines of thicket growth on the low, moist banks, as well as a few yards back from the streams. The largest stems are 20 to 25 feet in height and 2 to 6 inches in diameter. At the upper limits of distribution the dense thickets of this species formed about tributary springs and streams often serve as the only protection to head waters distant from forest growth; the larger growths, usually below forest areas, serve little more purpose than preventing erosion of the stream banks. This species is commercially of no importance.

The western chokecherry is a close associate of the Rocky Mountain oak and service berry, and is chiefly low and brush-like, only occasionally in open stands of low aspen attaining 10 or 12 feet in height and 1½ to 3 inches in diameter. In some localities it forms almost pure thickets, bearing quantities of fruit, which is much prized and used by the settlers for preserves and jelly, being the only fruit available to many.

The box elder is to be mentioned only as a rare small tree or shrub, found in the reserve on the middle canyon of the South Fork of White



A. BRUSH-COVERED HILLS NORTH SIDE OF WILLIAMS RIVER VALLEY.

Shows treeless character of north border of White River Reserve.

B. OLD DEEP-BURNING GROUND FIRE IN ENGELMANN SPRUCE AND ALPINE FIR NEAR HEAD WATERS OF WILLIAMS RIVER.

Shows destruction of timber in small spots in plateau region.

River, near the head of Coal Creek, and at the great bend in the upper valley of Williams River. At the last-named place are a few trees 15 to 20 feet in height and 6 to 10 inches in diameter; elsewhere found only as a shrub.

The western birch is of no importance, occurring only along streams and adjacent moist bottoms among willows and scattered cottonwoods. It is always remote from all forest growth, occurring as a rule on streams flowing through agricultural and adjacent brush lands. The slender stems, 1 to 2 inches in diameter, are 6 to15 feet in height, forming thick clumps at the water's edge or at some distance away. It is common on the West Fork and tributaries of Williams River.

The dwarf maple is rare in this reserve. It appears only as a slender-stemmed shrub, 4 to 8 feet high, in moist situations on the canyons of. Coal Creek, Little Beaver Creek, and on the head waters of Williams River, associated with alder, or in an open growth of aspen in deep, rich soil, at 7,000 to 8,500 feet elevation.

Elsewhere, outside of this reservation, it appears to be much larger, as a few trees seen in the deep canyon of Perham Creek, on the west border of Battlement Mesa Reserve, were 15 feet in height and 3 to 4 inches in diameter. Forestally it is of no importance on account of its great rarity, and it shows no evidence of any but casual increase.

The mountain mahogany is an insignificant, straggling shrub growing among junipers and piñon pine on dry, rocky, southern and western slopes, or in a thin cover of oak and service brush in sterile soil at altitudes of 8,000 to 9,000 feet. It was observed on the dry hills along the north boundary of the reserve, and in few similar sites on the middle waters of the West Fork of Williams River, remote from all forest growth.

In addition to the shrubby forms of tree species enumerated, several willows are frequent in marshy situations along the upper courses of all streams. A low, stunted species forms large, thick, matted patches on the highest plateau levels.

Two shrubby species of haw (*Cratægus douglasii* and *C. saligna*) form dense thickets, 8 to 10 feet high, on the middle course of Marvine Creek, along White River in Pothole Valley, on its South Fork, and in the agricultural districts along the banks of Williams River. The common sagebrush (*Artemisia tridentata*), 2 to 8 feet high, covers all the low benches near streams, thence extending up the slopes and mingling with oak brush. The shrubby "grease wood" (*Sarcobatus*) and the low bushy *Purshia tridentata* are also associates of the sage on some of the river benches. The "snowberry" (*Symphoricarpos racemosus*) is constantly met throughout the broad bench lands and gentle slopes occupied mostly by aspen. Accompanying this shrub are tall grasses, weeds, wild rose, currant, and gooseberry bushes, which often form the greater part of a low, dense soil cover.

COMMERCIAL VALUE AND USES OF TIMBER TREES.

The Engelmann spruce, by reason of its greater abundance, must furnish the largest supply of commercial timber from this reserve. The quality of the wood fits it for all ordinary building purposes, but affords only a small percentage of first-class lumber. The trunks being thickly studded throughout with large limbs, produce knotty lumber, which is mostly of second-class or third-class value in a general market. Very little "clear" lumber can be found. It seasons in good form and is locally used for general building, bridges, planking, etc.

Sound, dead, standing spruce, found in large quantities 10 to 25 miles distant, furnishes almost the sole timber used by settlers for their log houses, outbuildings, fence poles, and corrals. The long distance to be hauled renders the lighter, dead timber preferable to green. The restrictions placed on cutting green timber are not always respected.

The alpine fir has a light, corky wood, is usually knotty throughout, and fit only for rough boards. It is best under cover, as it shrinks and warps badly. It is much less durable when exposed to weather than Engelmann spruce. The larger trees, 10 to 20 inches in diameter, are sawed with spruce, and used for roof boards and weatherboarding.

Sound, dead fir is used by settlers for building logs, together with the spruce.

The most valuable lumber for clearness and excellence of quality is derived from lodgepole pine, locally called "white pine." It compares in quality with the eastern short-leaf pine (*Pinus echinata*), and is similar in texture and appearance. It is used for general building purposes, especially for interior woodwork, where clear lumber is required. On account of its straightness and freedom from knots the fire-killed standing timber is also much prized by settlers for building logs and other uses, being cut and hauled along with spruce and fir.

The present supply of this timber is limited, owing to fire, but sufficient remains for immediate local consumption.

The red fir in this reserve is rarely cut for lumber, although highly prized when procurable. Being nearer to settlements than other coniferous timber and superior to it, the small existing bodies on Coal, Miller, Rifle, and Canyon creeks have already been plundered, chiefly for ties, piling, and domestic building logs for special purposes. The original stand of large lumber trees, which is now exhausted, on the head of Little Beaver Creek, furnished saw timber for local building purposes. Considerable large, hewn bridge timber was cut out on Miller Creek for use on White River.

Yellow pine is practically not in use in the reserve settlements. The original stand along the White River (Pothole Valley) and on the lower slope and benches of its South Fork has been lumbered out for local building timber, for which it is greatly prized.

The blue spruce does not appear to be used as a lumber tree except very occasionally, when logs are cut in close connection with Engelmann spruce. The wood is harder, rather "slivery," tough, more difficult to work, and less durable than the Engelmann. It is stiff and strong, however, and suitable for large timber to be used under cover. The limited, scattered supply, usually remote from other lumber trees, doubtless accounts for its escape from the sawmill. Ranchmen occasionally use the dead timber, with Engelmann spruce, fir, and lodgepole pine, for log buildings.

The one-seed juniper supplies ranchmen with durable fence posts, and, with the exception of those cut from the less durable Rocky Mountain oak, constitutes the sole resource. It has a brown heartwood with a strong odor of cedar. The wood is brittle, and the life of a post is from ten to fifteen years. The posts are used for barbed wire fences, or less commonly for post and pole fences.

Ranchmen also use the dead juniper, of which there is always 5 to 10 per cent in extensive growths, for fuel. It makes a quick, hot fire, and is much superior to pine, spruce, or fir for this purpose.

The Rocky Mountain juniper is well known to settlers as red cedar. It is used for fence posts, which are much more durable than those of one-seed juniper.

The piñon pine does not occur in sufficient quantities for any but occasional use as fuel. Outside the reserve, to the east and south, it is cut for railway ties.

The large quantities of aspen timber available in various parts of this reserve seem not to have found further use by settlers than for fuel, house logs, fence and corral poles. The dead timber, usually fire killed, is preferable on account of its lightness, if it has to be hauled long distances. The green timber is exceedingly heavy. The small saplings are used as pickets for garden fences, and sometimes for "slat and wire" fences. It is the only deciduous wood generally available for fuel, and is much preferred to spruce or fir. The barkless dead trunks stand for years, bleached and dried in the sun, and when used for fence poles last for ten or more years. Green aspen fence posts are sometimes used by the poorer settlers, who, being without money and beyond reach of cedar or spruce, use what is at hand, in order to comply with the fence law.

The paper-pulp value of green aspen should commend this large supply to the attention of pulp manufacturers. In nearly all cases the heaviest bodies lie where they would be easily accessible by inexpensive roads to mills located on White River or Williams River. Careful exploitation would in all cases be beneficial to the younger trees left, and would remove a constant accumulation of falling, ripe timber which supplies débris for the ravages of forest fires. High winds are annually felling the larger trees to such an extent that parts of these forests are quite impassable.

The Rocky Mountain oak does not often attain useful dimensions. Wherever it does, as on the South Fork of White River, and in the Coal, Beaver, and Little Beaver Creek region, the ranchmen use the timber for fence posts and fuel. Posts last from five to eight years. Next to the junipers of the region it is the most durable post timber obtainable.

The larger-sized logs of the narrow-leaf cottonwood are occasionally used by ranchmen for building log houses, and the smaller trees for fence poles. Its presence on neighboring streams affords limited but convenient supplies, which must otherwise be hauled from the forests of the reserve 15 to 20 miles away. The timber is not at all durable when in contact with the soil, but if protected, house logs and peeled fence poles last from ten to twenty years. Otherwise it is of no commercial value. It is seldom used as fuel.

CONSUMPTION OF TIMBER, SOURCES OF SUPPLY, MARKETS, AND PRICES.

The average settler within the reserve, as well as settlers 10 to 25 miles away, use very little sawed lumber. Building and fencing is, for the most part, done with round logs and poles. Earth serves for roofs and hewn slabs for floors, or in some cases, terra firma. Indeed, very few logs are used by the poorer classes, who live in "dugouts." All the earlier settlers, mainly before 1885, and the later comers, with few exceptions, have relied on round timber for all purposes. In recent years a few of the most prosperous are able to use sawed lumber and shingles for houses. In their present condition most of them could not afford to buy sawed building timber at any price, when logs can be had for the hauling or "packing."

Ranch land has no commercial timber on it, and only a very small amount of domestic wood, consisting of cottonwood, juniper, and in rare cases a few blue spruce trees. Sagebrush is the principal woody plant growing on agricultural lands. At present, as in the past, therefore, most domestic and all commercial timber comes from the reserve forests or from unreserved public lands.

The principal markets are at Newcastle, Rifle, Meeker, and Yampa. The first two are railroad towns and the last two remote from railroads. The railroad towns consume considerable lumber shipped in from the Pacific coast and from Denver, as well as that illicitly cut from the reserve. The other towns necessarily receive their supplies largely, if not entirely, from mills cutting reserve timber or that on outlying public land.

The prices for Engelmann spruce lumber range from $14 to $16 per M. for rough and $20 to $22 for surfaced. Alpine fir is usually not selected, but sold with spruce. Lodgepole pine in the rough costs $16 to $18, and surfaced, $20 to $22 per M.

The demand for lumber by settlers is not great. It would be greatly increased if prices were lower. The poorer settlers can not buy it. Those in better circumstances use very little on account of high prices.

DESTRUCTION OF TIMBER.

Under this head is included all damage or destruction by natural agencies, such as snowslips and landslides; storms or related agencies; by depredations, such as illicit sawmill operations, piling and tie cutting; and by recent and old fires.

DESTRUCTION BY NATURAL AGENCIES.

From October to April high winds sweep over the timbered plateaus and uproot or seriously damage about 1 per cent of standing green spruce and fir timber. Decayed trees are broken off near the ground or topped. Large sound spruce standing in small, isolated groups often succumbs to such continued blasts. Spruce trees rooted in crevices of exposed lime rock are also apt to give way under storm.

The larger-sized alpine fir suffers more than big spruce. It is usually broken and uprooted, even in dense stands of timber, and especially when its age limit (175 to 200 years) is reached. Big trees are, however, generally weak from being "doty," hollow, or "wind shaken." while the sound, younger trees rarely suffer.

Besides the timber destroyed by the direct violence of the wind, there is a considerable quantity of dead standing spruce and fir mingled with the green timber. It extends in an interrupted, irregular, narrow belt from the region of Deep Lake and Carbonate westward to the headwaters of East Elk Creek. The dead timber amounts to from 10 to 25 per cent of the total stand and includes nearly, or quite, all the largest and oldest trees. They bear evidence of having died about twenty to twenty-five years ago.

No information could be obtained from settlers as to the date at which this timber died. Their common theory is that the timber was killed by frost. The date assumed for the death of this timber is based on a comparison of its present state of preservation with that of timber killed by fire, the date of which was approximated from the actual age of the succeeding young growth of the same kind.

The living trees are in all cases very thrifty, exhibiting no signs of injury from the selective agency which destroyed the larger trees. The trunks and root system show no injury from insects.

Prof. E. A. Swarz contributed an article to Insect Life, Vol. VII, 1894, page 254, in which he stated that the ravages of the bark beetle (*Hylesinus sericeus*) are sometimes extended to the Engelmann spruce, resulting in killing the trees, as observed by him on Big Cottonwood

Creek. It is questioned, however, whether the wholesale destruction of the above-described timber is due to this insect.

It is believed, moreover, that if the trees were killed by insects defoliating them, working under the bark, or otherwise fatally injuring the trees, the damage would not have been confined so peculiarly to the largest trees.

From the absence of insect injury it is conjectured that the timber may have died from one of two causes. It is notably true that during severely cold seasons the sapwood of all green trees is frozen throughout. If, while in this state, it is subjected to the violent racking of unceasing, heavy winds, the wood fibers may have become extensively broken, and the trees later succumbed to such injuries. Old spruce and fir trees are not at all recuperative, and it is believed that when rigidly stiffened with frost the taller and larger of them are likely to have suffered under heavy winds.

Death may also have occurred from a sudden failure of an accustomed amount of soil moisture. The less adaptive, maturer trees always suffer under such changed moisture conditions, while the younger growth more easily adapts itself to the changed conditions. Instances are not wanting in Eastern forests where all the older trees have been killed by the sudden draining of swamps or by other reduction of the water of habitually moist regions. Old coniferous trees usually suffer most, as in the case of the Eastern tamarack (*Larix laricina*), while the younger trees adapt themselves to the suddenly changed moisture conditions.

Very little timber is destroyed by snowslides, rockslides, or landslides. A single instance was observed on the north side of the steep, rocky slope of Upper Marvine Lake, where a snowslide, carrying lava rock, cut a narrow lane through small-sized Engelmann spruce and fir timber, uprooting, breaking off, bending, or splitting all trees in its path. This occurred in the spring of 1898, and included about one-eighth of an acre of trees 4 to 10 inches in diameter.

A small landslide was observed on the east slope of the east head branch of Williams River, where the earth, with half an acre of small Engelmann spruce, fir, and aspen, was carried to the bottom of the slope, 200 feet below. This slide, which occurred in the spring of 1897, was due to snow water absorbed by a thin stratum of soil lying on a yielding, fine shale. Similar, but smaller, landslides were occasionally seen elsewhere on the steep, soil-covered slopes of streams in the Williams and White river basins, but the amount of timber destroyed is insignificant.

Engelmann spruce and fir are occasionally destroyed by the constant breaking away of great masses of lava rock from the escarpments of the high plateaus bordering the head basins of the Yampa, White, and Williams rivers. In addition, the descending masses of rock severely "bark" and gouge opposing trunks. Young trees usually recover from such injuries, but permanent damage is often inflicted upon larger trunks. The abraded portions of the trunk never heal over completely. The exposure rots the heartwood, and the tree loses some, if not all, of its useful timber, or its weak trunk may be broken by wind.

DESTRUCTION BY DEPREDATION.

Large quantities of merchantable spruce and fir have been cut for lumber at various points in this reserve, and mainly during the last ten years.

Active mills were found on the head of Coal Creek and on the east fork of Elk Creek. Five other mills had been in existence in the reserve, but were abandoned or suppressed several years ago. Two were found near the head of Grizzly Canyon, two near the head basin of Yampa River, 2 or 3 miles up the stream from the eastern border of the reserve, and one near the head of Hunt Creek. All were steam mills, except the uppermost one on Yampa River, which was a small water mill.

The timber cut by these mills ranges from 10 to 40 inches in diameter, representing the general range in size for spruce and fir in the reserve. The capacity of the Yampa River water mill was about 2,000 feet B. M. per day, while that of other mills is 5,000 to 10,000 feet per day. The running season is from May to December.

The Yampa River and Ladd Creek mills placed their output in the adjacent well-settled valley of Yampa River. The Grizzly Canyon mills found a market in the Grand River Valley settlements, 15 to 20 miles away, while the active mills on Coal and Elk creeks were placing their lumber at Meeker and Newcastle, about the same distance away.

It is difficult, and in most cases quite impossible, to secure from neighboring settlers reliable information concerning the work or existence of the mills. They are at once suspicious of all strangers who seek the most casual information concerning past or present illicit milling. Doubtless they fear to implicate themselves with criminal actions. Most settlers seem to feel that the mill operators, occasionally of their own number, are entitled to all the protection that evasive answers or noncommittal silence will afford. "Haven't saw no mills in this country" is the usual information received.

In the case, moreover, of woodland cut over by mills now abandoned the cut-over areas have been swept by fire. Both cut and uncut areas are so completely confused in a general destruction as to make careful segregations of cut-over land difficult—in some instances impossible.

As near as could be learned, the Yampa River mills began operations about 1886 and ceased in 1889 or 1890. The timber land cut over amounts to about 300 acres. The combined cuttings of these mills for about four years' activity are approximately 3 million feet B. M., consisting of Engelmann spruce, alpine fir, and lodgepole pine. The last-named contributed about 25 per cent. The timber was on the south slope of the Yampa River Valley, and, for spruce, ranged from 12 to 30 inches in diameter and 100 feet in height; for lodgepole pine, 12 to 26 inches in diameter and 75 to 80 feet in height. The fir was under 20 inches in diameter and 80 to 90 feet in height.

No information could be obtained concerning the operations of the sawmill on the head of Hunt Creek. Its work was probably discontinued about 1890 and may have continued three or four years. A fire appears to have killed patches of timber in this vicinity previous to the mill operations, and also since cutting ceased. The area of stumpage taken is, however, moderately clear, notwithstanding the succeeding fire. The area cut over here is approximately 200 acres, extending irregularly southwestward along the eastern head branch of the creek and northwestward up an adjoining ravine and its slopes. The timber cut consisted of Engelmann spruce and alpine fir, 12 to 40 inches in diameter and 100 feet in height, together with 25 per cent of lodgepole pine, 10 to 14 inches in diameter and 60 to 80 feet in height. The entire stumpage taken here is estimated at 2 milliom feet B. M. Apparently some dead timber was sawed, but the bulk of timber taken was green.

The immense waste attending this and other similar operations is well illustrated in the tangled mass of unused and half-used felled timber lying in the track of this mill's work. The cutting near the mill is moderately clean work compared with cutting elsewhere.

The steam sawmill found on the headwaters of Coal Creek was originally operated in the canyon at the head of Little Beaver Creek. The supply of timber at this point being exhausted, the mill was moved to its present situation, at the junction of the two head branches of Coal Creek, about 20 miles from Meeker. It was reported by some settlers that the mill was burned while in Little Beaver Canyon, the resulting destruction of surrounding timber making a move to its present site necessary. Still others aver that the mill had cut out the available timber in the vicinity and that after the mill was moved fire was started to destroy all signs of lumbering operations.

This mill is said to have begun operations in Little Beaver Creek Canyon in 1885 or 1886 and to have ceased about 1889. A destructive fire swept through the narrow canyon and over the adjacent slopes, once timbered with red fir, Engelmann spruce, and a small amount of alpine fir. The burning was so clean as to make it difficult to follow the cutting done. It is estimated, however, that about 100 acres were cut, on which the entire stumpage is estimated at 800,000 to 1,000,000 feet B. M. Red fir contributed about 10 to 15 per cent, Engelmann spruce about 50 per cent, the remainder consisting of scattered alpine fir and lodgepole pine.

The sawmill now operated on Coal Creek has a daily capacity of 5,000 to 10,000 feet. It is said to have been operating here from seven to ten years, with an average annual run of about six months. The principal cutting has been confined to the north slopes of the two head branches of Coal Creek, the haul to the mill being from one-half to 2 miles. The present season's cutting is entirely on the north fork of the creek. The timber cut is mainly Engelmann spruce, with 10 to 25 per cent of lodgepole pine. A number of burned patches are scattered throughout the lumbered district, from which all large, sound logs are taken, but a great number of logs come from green trees.

Roughly but safely estimated, the mill yard and skidways along the wagon road in the timber contained 400 to 500 green Engelmann spruce logs, with 10 to 20 per cent of lodgepole pine; also 100 to 150 fire-killed spruce and pine logs. The spruce logs ranged from 10 to 40 inches in diameter and 12, 14, and 16 feet in length; the pine, 10 to 16 inches in diameter and 16 feet in length. At a low estimate these logs should have given a total cut of 100,000 feet B. M.

The acreage covered by the work of this mill is scattered over the two adjoining north slopes of Coal Creek and one intermediate small ridge, in all estimated at 400 acres. It has been irregularly cut over, and the amount of timber taken at various points is curiously large or small. The greater part of the area appears to have been first culled in spots. Later certain portions were nearly denuded. Still later another general cutting has taken place, leaving here and there large single trees and groups of standards. Another peculiarity of these operations is the "slashing" of one-fourth to one-half acre of timber and then leaving it untouched for a season. The following season it is cut and "snaked" out, possibly with the less criminal conviction that it is dead timber. The total cut for the 400 acres gone over by this mill is estimated at 5 million feet B. M.

Another steam sawmill was found on the head of East Elk Creek, about 15 miles by wagon road from Newcastle. The original situation of the mill was about 2 miles farther down from this point on the same stream. The location was at the junction of a tributary valley with the main branch of the creek, and very near the southern boundary of the reserve. Probably the design was to be outside the reserve, on "neutral," or unreserved government land. Work began here about 1890, and continued to October, 1897, the date at which the mill was moved to its present site.

The areas cut over lie on the north slopes of the adjoining valleys, extending about 1 mile up the dry valley and about 2 miles up the watered valley. The acreage is estimated at 450 acres, and the total cut of lumber at 3,600,000 feet B. M. The species cut were Engelmann spruce and alpine fir, ranging from 12 to 24 inches in diameter for the spruce and 12 to 20 inches in diameter for the fir.

In the watered valley, where there is now a good even stand of young timber, the cutting consisted in a clean culling of all trees down to about 10 inches in diameter. The culling in the adjacent dry valley took nearly all the timber, most of the original growth being large, leaving a few irregularly scattered trees among a tangle of tops and neglected saw logs. The logs were "snaked" out of this valley to the mill, distant about one mile, while logs from the watered valley were brought down by a wooden tramway, about 2 miles long. The largest supply of logs was taken from the latter valley.

Before coming to Elk Creek this mill is said to have been operated at two points on Canyon Creek, outside and very near the southern boundary of the reserve. The cutting ranged southward over the bottom, sides, and lower benches of the canyon for 3 miles, with a breadth of one-fourth mile. The timber taken was yellow pine, 18 to 44 inches in diameter, and red fir, from the sides of the canyon and benches, 200 to 500 feet above the bottom, 12 to 20 inches in diameter. The area denuded and cut over was about 400 to 500 acres, and the total amount of timber sawed approximated 2,500,000 feet B. M.

The mill now in operation on the watered valley of Elk Creek began work in October, 1897, and was running September 16, 1898. As nearly as could be estimated, the mill is situated about 2 miles north of the southern border of the reserve. The period of activity and daily capacity could not be ascertained, but the former is probably six months, May to November, inclusive, and the latter about 10,000, certainly not exceeding 15,000 feet B. M. The cutting is from the adjacent north slope of the creek, extending toward its extreme head for from one-fourth to 1 mile above the mill. The timber immediately about the mill has not been cut except along the immediate edge. The species cut are Engelmann spruce (60 to 75 per cent) and alpine fir, ranging from 10 to 26 inches in diameter. The cutting is irregular. A light cutting in places is followed in others by stripping the land of all its timber. In all cases the cutting is very wasteful, leaving unused masses of sizable tops.

The entire area denuded and cut-over is estimated at 300 acres, and the total amount of timber sawed at 1,500,000 feet B. M.

The mill yard and skidways on the log road from the mill to the timber contained 300 logs, of which 200 were green spruce and fir, the remainder being dead spruce. The spruce logs were 12, 14, and 16 feet in length, and 10 to 24 inches in diameter. The fir was 16 feet in length and 10 to 22 inches in diameter. A safe estimate of the green logs in sight should give a cut of 18,000 to 20,000 feet B. M.

Very little timber was found to have been cut in the reserve for railway ties, piling, and bridges. On August 30, 1898, a small cutting of red fir was found on Coal Creek, 2 miles below the head of the stream. Green logs 16 feet in length and 12 to 14 inches in diameter, were being cut from a bench on the north slope, 100 feet above the bottom of the canyon and delivered to the wagon road in the canyon by sliding the logs down on a peeled-log chute. Fifty to sixty logs had been cut and hauled out to the vicinity of Meeker, but by whom could not be learned.

Red-fir piling timber was also being cut on the eastern high benches of Canyon Creek, possibly outside, but very near, the southern boundary of the reserve. The timber ranged from 12 to 22 inches in diameter and 24 to 28 feet in length. In all 40 to 50 acres have been cut over on the benches of this canyon, including timber down to 8 or 10 inches in diameter. The acre yield is about 5,000 feet. An occasional yellow pine was also cut from the bottom of the canyon. On September 18, 1898, 30 to 40 logs were seen on a skidway for hauling in the bottom of the canyon. The logs are delivered to the bottom of the canyon, 300 to 500 feet below the wooded benches, by means of an earthen slide or chute. About 2 per cent of the logs are destroyed in the violence of the descent. The timber was being hauled to the vicinity of Newcastle, to be used, it was said, for bridge piling.

From 300 to 400 red-fir ties had also been cut from the same bench region, but were left where they were hewn, to be chuted and hauled out later.

Closely connected with these smaller depredations should be mentioned the sale, cutting, and hauling, by parties other than settlers, of sound dead spruce, fir, and lodgepole-pine logs. The timber used is 24 feet in length and 10 to 14 inches in diameter. Parties suspected of selling the timber to consumers, for building purposes, were seen cutting and hauling large quantities from the head waters of Coal Creek to the vicinity of Meeker, White River City, and other places.

STATUS AND POLICY OF TIMBER DEPREDATORS.

Strangely enough, nearly all illicit lumbering and other timber depredations are looked upon by settlers as blameless ventures. Such operations furnish a limited amount of employment to the poorer classes, and but for occasional sore enmities toward the richer mill operators, the latter are held in the light of benefactors. Indeed, by very many they are considered to be taking only what rightfully belongs alike to them and all other settlers. The depredator's good name is not thought to be sullied by the veritable theft of timber from the national domain. The spirit of some landless settlers of the poorer class is well illustrated in the following remark made to the writer by a party suspected of selling dead building logs:

> This timber belongs to us settlers and we're going to get it! The Government officials can't prevent us, either, with an army! If they attempt to stop us, we'll burn the whole region up.

As already stated under another head, the settlers usually give their moral support to all milling operations in the reserve as well as to those outside which derive logs from the reserve timber. Notwithstanding this moral acquiescence, it is observable that mill operators resort to various shrewd protective tactics. Almost no sawed lumber is left at the mill or anywhere on the reserve. Often the lumber is drawn as fast as cut to some point just beyond the boundary of the reserve, whence it is disposed of with less danger of implication. Again, if pounced upon by "timber agents" it is held to be less criminal to have dead logs on the mill yard than green. The haul of green and dead logs from the forest to the mill yard is therefore arranged so that all the green timber is conveniently run through the mill first.

Operators are watchful and suspicious of all strangers. My unexpected arrival in the region of the Coal Creek mill resulted in stopping all cutting, sawing, and skidding, and within twelve hours 17 teams were at work hauling away lumber accumulated at the mill.

OUTLYING SAWMILLS.

A few sawmills were found outside the reserve. A small water mill was operating on Yampa River about 2 miles below the eastern border of the reserve. It is located on a dry sage mesa, at least 6 miles from any log supply. Presumably logs were derived from the reserve forests near, as this is the only resource. No hauling was being done at the time, so that this could not be determined. The few logs being sawed were from dead lodgepole pine and Engelmann spruce, 10 to 12 inches in diameter. The lumber was for local consumption in Yampa River Valley.

A steam sawmill was said to be operating in the spruce, fir, and lodgepole-pine timber on the hills of the Morrison Range, 10 to 15 miles east of Yampa. Owing to lack of time this region was not examined. The range is plainly visible and appears to be extensively and well timbered. The output is said to be consumed in the adjacent valley of the Yampa River.

Information was given by settlers that a steam sawmill plant, once in operation on the South Fork of White River, is soon to be located on the head waters of Milk Creek, 8 or 10 miles north of the Coal Creek mill, probably very near the north boundary of the reserve. The alleged purpose of this mill is to cut the body of Engelmann spruce and lodgepole pine lying within the reserve on the north slope of the high hill north of the head of Coal Creek (Pl. LIV, *A*).

DESTRUCTION BY FIRE.

Large quantities of commercial timber have been destroyed in this reserve by forest fires. All of the species have suffered, but comparatively larger quantities of lodgepole pine have been destroyed than of other kinds, which is due to the fact that the most widespread conflagrations have occurred more in the zone of lodgepole pine than elsewhere. While considerable quantities of spruce and fir have been destroyed within this zone, as a rule the upper, more widely timbered plateaus and watersheds remained untouched, except in spots where the fire crept up from contiguous growths (Pls. LVI, *B* and LVII, *A*). The timber which once clothed the lower slopes and broad benches along the White and Williams rivers and many smaller water courses has for the most part been swept off by forest fires. In some cases the original timber has been entirely exterminated; in others, patches and scattered single trees have survived.

The most destructive fires appear to be more or less connected, having doubtless occurred at the same time. The burn on White River, for example, extended over all the contiguous lower slopes of tributary streams, from the head waters of this river to the western boundary of the reserve. Likewise the burn on the head of Yampa River extended southward and northward over all the timbered slopes, and in places up to the great plateau levels above and over a low divide into the Williams River Basin. The heaviest burn in point of timber destroyed occurred on the White River and Yampa River watersheds. The burn in the Williams River Basin was extensive, but was confined to areas carrying large quantities of aspen mixed with some spruce and fir.

The most widespread fires occurred long ago and covered nearly all the region at present bearing fire marks. Over these older burns have followed second, and sometimes third fires, restricted to from one-half of an acre to 50 acres. The original fires were in part surface and in part deep fires; but the surface fires effectually killed the conifers by scorching the low branches and thin bark. Deep-burning fires appear to have been most prevalent in pure coniferous growths. Following surface fires the barkless, bleached shafts remain standing from ten to twenty years (Pls. LVI, *B* and LVII, *B*), except where later fires have consumed the well-seasoned, highly inflammable boles. Where deep burning has taken place the trees are mostly prostrate. Standing fire-killed spruce and lodgepole pine far outlast the alpine fir, the roots of which soon rot off, when the trunks are rapidly felled by heavy winds.

The old, deep fires went far into the ground, consuming the thoroughly dry humus and tree roots. The dense stand of trees fell as fast as the roots were burned off (Pl. LIV, *A*). The well-known appearance of deeply-burned forest land is often concealed by the advent of young trees, grass, and weeds. But deep trenches are still visible where these fires cut narrow lanes into blocks of surviving green timber and then ceased burning. The fire-felled trunks lie in mingled masses breast deep, among which the succeeding young growth has established itself.

But little definite information could be secured from settlers concerning the origin and date of the most destructive and widespread fires. From a careful study of the age of the trees which have come in on the older burned areas it is believed that these fires occurred from ten to twelve years ago. A story current among the settlers is that most of the fires were set by the Ute Indians. A general correspondence in the appearance of the more extensive burns throughout the reserve lends some plausibility to this suspicion. The alleged purpose of the Indians is said to have been to effect a general burning in order to drive all the large game out of the State. If true, the fires must have been set about 1887, the date when the Utes were moved from Colorado. While the majority of young growth on burned areas is from 10 to 12 years old, a few burned areas of considerable extent bear young tree growth 19 to 20 years old, so that part of the old fires must have occurred prior to the Indian evacuation.

The fires following over the old burned areas are said to have occurred from four to six years ago. Most of them were confined to small areas, where a complete consumption of the dead timber has taken place. The soil is bare, with deep pits where the fire has burned out the dry tree roots. In a few cases these second and third fires have extended the area of the original burn by invading bodies of green timber. The damage done is, however, not extensive.

As a rule these later fires have caused considerable anxiety to settlers located in the immediate vicinity. The occupied valley ranch lands are always connected with the inflammable masses of dead timber above by dense thickets of aspen, alder, and other brush growing along the bottom of the slope and, therefore, in constant danger of being swept by fire. It is related that in 1894 a fierce fire broke out on the north slope and benches of White River, below the South Fork, and ran wildly through the immense quantity of fallen and standing dead yellow pine along the bottom of the slope. Ascending the slope, the fire consumed quantities of lodgepole pine, spruce, aspen, and fir above the river bottom. The fire extended the entire length of "Pothole Valley," where the principal settlement lies, and but for the united and determined efforts of the settlers would have crossed to the north bank of the river, with great destruction of crops and other property. Elsewhere remoteness from areas carrying dead timber has generally exempted other settlements from fire, but not entirely from the fear of danger.

No one knows the cause of these fires. Settlers usually give out that they were due to "tenderfoot campers."

A few fires of four or five years' standing were found to have killed timber in patches throughout the upper wooded levels, involving from one-half an acre to 5 or 10 acres (Pl. LVII, *A*). In some spots the burning was deep, consuming all the humus and buried punky logs;

A. OLD FIRE IN ENGELMANN SPRUCE AND ALPINE FIR ON BURRO MOUNTAIN.

Shows destruction of timber by surface fire.

B. OLD SURFACE FIRE IN LODGEPOLE PINE NEAR HEAD OF COLE CREEK.

but more often surface fires caught in the low-branched spruce and fir and killed them by scorching. Only conjectures could be made as to the cause of these fires, as the locations were too far distant to have been even noticed by settlers. Evidently the deep fires occurred late in the season, when a light fall of snow put an end to an otherwise more extensive burn. The surface fires must have occurred in early spring or summer, when only surface litter was dry enough to burn.

A careful examination many times revealed the unmistakable signs of a camp—unconsumed tent pegs, cut camp wood, and other débris—within the burned area.

Another type of burning was also found. Small, recent fire spots, covering from 4 to 8 square feet, were often met in the depths of pathless forests, or in dense timber a few yards from an old, little-used trail. The dry grass and decayed wood were all consumed, and usually the bark of one or more big firs or spruces within the area fatally scorched. Almost no sign of human or animal presence is visible in such regions, but a painstaking search would sometimes reveal the track of a shod horse. Evidently a lighted match had fallen here after doing duty at a pipe.

During the season 1898 no large fires occurred in the reserve prior to September 18. In September a small fire, covering about one-fourth of an acre, was discovered by me on the north bank of the South Fork of White River, about 20 miles above its mouth. The river bank is 5 or 6 feet above the water at this point and the timber very dense, with a deep, dry humus and many buried, dry, half-decayed logs. A deep, almost smokeless, fire had felled a number of big green spruces by slowly burning off the roots, the fire being fed by the mass of inflammable matter in contact. Such fires are flameless. They are buried 12 to 16 inches below the tangled, mat-like surface cover of green plant roots. Here they eat into the punky buried wood and powdery humus in a line of living coals a foot deep and as broad. The heat is intense, soon converting big green roots into charcoal, which serves to feed the destructive advance of such fires. Several hours' digging exposed the fire, which was finally extinguished with many hatfuls of river water. It proved to be from a neglected, long-smoldering camp fire, for besides the usual signs of a camp fire, the perpetrators had, on leaving, obligingly left a record nailed to a tree, which is illustrative also of their law-observing spirit in respect to game and fish:

> JULY 25, 1898.—This is to sertifie that we leve this mornin' with a lode of fish and dear meet.
>
> JOEL BARNS & CHAS. BAIRD.

It is lawful to kill deer in Colorado only from September 1 to October 15. Fishermen are allowed to carry off not more than 20 pounds of trout, the only fish in the region.

On September 19, 1898, a fire was started from a neglected camp fire in the green spruce, fir, and aspen south of Sleeping Cap Mountain. An unknown "tenderfoot tourist," as characterized by natives, was overtaken by night in this vicinity, and being afraid, built an unduly large camp fire and sat up all night. At daylight he set out for Meeker, leaving a deep, smoldering camp fire. After several days' fanning by a strong southwest wind the fire spread eastward over the great rolling bench, on which an old fire had left great quantities of dry fallen aspen; there were also scattered dead shafts of Engelmann spruce, fir, and, here and there, tangled heaps of fire-killed lodgepole-pine trunks. A tall, heavy growth, too, of dry grass among the débris increased the inflammability. The fire ran to Lost Park and through its long, dry grass reached the broad grass- and brush-covered slope on the south and west sides of Sand Peak, all the track of an old fire and covered with an abundance of fallen dead aspen logs.

At about the same date two other fires were reported. One broke out in the Williams River Basin, near a camping resort on Williams Lake. This fire is said to have started from a neglected camp fire. It spread chiefly through brush and dense aspen, with a thin mixture of spruce and fir below the heavier bodies of spruce and fir, about the head waters of this stream. The other fire burned about 5 acres of green Engelmann spruce and fir near the head of Grizzly Canyon. It also is believed to have originated from a neglected camp fire.

Reports of the last three fires came to me through settlers after I had completed my examination of this reserve and left the region. While the above outline may be taken for the present as fairly indicative of the damage done, the intention is to secure later more detailed information on the exact limits and character of these fires through circulars sent to various intelligent ranchmen and herders known to the writer familiar with the region.

The total area burned over by old fires is estimated at 171,620 acres, and the total destruction of commercial timber is placed at 85,900,000 feet B. M. Of this, 26 million feet consisted of lodgepole pine, 59 million feet of Engelmann spruce and alpine fir, and 900,000 feet of red fir. The amount of yellow pine destroyed by fires of any period is probably very small. This is due in part to the fact that nearly all this timber was lumbered out prior to the burning which took place in its range. That which remained suffered little on account of a very thin stand and comparative isolation from other more extensive forest growth. Considerable immunity from fire is also afforded by its very thick bark and the fact that its inflammable crown is carried high above the ground.

No estimates were made of the amount of aspen destroyed by fire; but all aspen forests destroyed or marked by fire have been mapped.

The area burned over by fires during the present season (1898) will probably not exceed 80,000 acres, and the amount of commercial timber destroyed will not exceed 2 million feet B. M, consisting entirely of Engelmann spruce and fir. As already noted, the greater part of these fires burned over ground devastated by old fires, involving but little valuable timber.

GENERAL CONSIDERATION OF FOREST FIRES.

Conditions favorable to fires.—The season of 1898 may be taken as an average dry one. The condition of all timber lands at this season, therefore, may also be considered an average of the condition known to be dangerous and specially apt for the introduction of forest fires. While it is possible, as shown by the example on the South Fork of White River, for a deep-burning, early fire to maintain itself for weeks, and probably for months, with increasing intensity, the majority of dangerous forest fires are set and maintained from the middle of August to the end of October. The most critical period is from the first of September to the middle of October. With little or no rain during the previous months, all the deep humus becomes as dry and almost as inflammable as powder. To this must be added immense quantities of well-seasoned fallen and standing timber, branches, and innumerable decayed, punky logs, buried and half buried. Add to these also thousands of acres of open woodlands, brush lands, and connecting "parks," covered with the densest and heaviest growth of tall grasses and rank weeds. All of this herbaceous vegetation is dead or killed with frost by the first of September and dry as wheat straw. Moreover, as the last weeks of September and the first of October approach, continuous driving winds prevail. During this time and until the snows or checking rains arrive, this great region is a constant menace and a latent possibility of almost total destruction by fire. A lighted match, a single spark no larger than a pin head falling at random, is in a few minutes fanned into a leaping demoniacal blaze, literally beyond control. The handling of camp fires in such a region during this critical period is at best very risky, requiring the utmost care to keep them under control. The common practice is to leave them unextinguished.

Possible perpetrators.—Unfortunately, for the prevention of forest fires, the region under consideration is well stocked with fish and large game—deer, elk, bears, etc. Moreover, at the very beginning of the critical fire period the State game laws are open. Hundreds of hunters with camping outfits enter the reserve at this time, in fact, many have established their camps from a week to ten days before the game season is open. The entire reserve, from all its points of accessibility, is literally patrolled by hunters until snow falls.

The hunters who come to the reserve are ranchmen and townspeople from 10 to 30 miles away, together with a goodly number of so-called "tourists" from distant cities in the middle West and East. Not unfrequently wealthy European sportsmen are among the number. The time spent in the reserve is from two weeks to three months, the settlers near at hand, however, often remain only a week. In addition to these transient hunters and campers, "cattlemen" range large numbers of cattle in parts of the reserve. They are riding and camping more or less during the entire season, and especially from September to November, when the various "round-ups" occur, and later, the "drifting" of the herds off the reserve "range." The above-mentioned parties with sawmill operators and very few prospectors make up the list of persons likely to be in the reserve.

Relation of circumstantial interests to fires.—All forest fires in the reserve are bound to occur through the voluntary or involuntary agency of those living or traveling within it. As a rule the more intelligent settlers near and in the reserve understand the relationship between forest cover and water supply. And since their only supply of water for irrigation comes from streams whose head waters are protected by the reserve forests their common interest leads them to be watchful of fire in the reserve during the dangerous period. Personal contact with such settlers enables the writer to vouch for this practice. The selfishness of human nature, however, allows some of those from greater distances, not compelled to be interested in this source of water supply, to be less careful of fire while in the reserve. This is not aimed at the high-minded men found in this region and elsewhere who always recognize the common necessity and decency of protection to public property regardless of personal interests.

The cattlemen have a direct interest in the prevention of forest fires in the reserve, both for the safety of their cattle and the preservation of their feeding range. As a matter of fact, the owners of large herds in the reserve, or their representatives, are often active in the prevention of forest fires within their reach. If fires are ever due to the agency of ranchmen and cattlemen interested in the maintenance of the reserve, it must be through some unwonted inadvertence. Some of the less responsible herders ("cow punchers," "cow boys") are often careless with matches and fire. They have no interest beyond their season's or month's wages, and the burning, through even their own carelessness, of a few hundred acres of reserve timber is of little moment to them. The writer saw a few such irresponsible herders lighting their pipes and afterwards throw blazing matches into dry grass and among forest litter. Several incipient conflagrations from such sources were prevented, but through no effort of these herders. The common sentiment among this class is expressed in the following: "Well, I guess Uncle Sam can stand the racket, if the whole shootin' match burns up."

The "tourists" from distant points usually travel in the reserve with native guides, who are mostly conscientious, law-abiding settlers, with all the interests of the public domain at heart. Their travel in the reserve is characterized by the greatest care with camp fires. With other interested settlers they are known to have voluntarily spent much time and labor in extinguishing forest fires which involved no personal interest; save, possibly, that the destruction of the Government's extensive forests might lessen the tourists' need of their services as guides. Some of them also own ranches in the immediate vicinity of the reserve, and these are therefore doubly interested in the prevention of forest fires.

The large number of reckless, lawless hunters and fishermen, who invade the reserve in the manner seen on the South Fork of White River, are, doubtless, the persons most to be feared, and on them rests the greatest blame for neglecting camp fires and other means of causing fires. They have no spirit of the true sportsman. Their chief aim is to secure all the plunder possible, which is attractive to them only for its pound value. They are a class irresponsible and unrestrained. It is therefore to be concluded, and this position is supported also by the consensus of opinion throughout the region, that the majority of recent fires have occurred through the carelessness of such reckless campers.

Willful and pernicious perpetrators.—Occasional forest fires in the reserve are said to be due to willful and pernicious perpetrators. Stories are rife among settlers in certain vicinities that a deep hatred for some sawmill operators has led unknown parties to set fire to several mills from which there resulted extensive burning of adjoining forests. On the other hand, it is also alleged by settlers that mill operators have deliberately set fire to desirable blocks of commercial timber. The fires were set sufficiently early in the season to insure only a light surface burning, but severe enough to kill the timber by scorching the thin bark and low-branched crowns. It is said these parties then cut the fire-killed timber with a feeling that they were committing a less culpable theft than if cutting green timber. Moreover, if caught by timber agents, the stumpage claimed is less for "dead" than for green timber. As far as could be determined, these statements rest on no tangible proof. It is to be added, however, that the existence of recently burned patches of the best timber in the vicinity of at least one mill gives color to a suspicion of design. The burning was entirely unconnected with any of the older general burns of the region, and appeared to be strangely selective in point of good lumber trees. These fires must have occurred in spring or early summer, when the ground litter was damp, as the damage done was simply enough to kill the trees. The timber killed was in equally as good condition for lumber as when green.

Suppression of forest fires.—A large number of disastrous forest fires have their origin in neglected camp fires, which are allowed to become deep seated prior to the dangerous period. Burning prior to these drier months is necessarily slow, surrounded as it is by dense green herbage; but the abundant heaps of logs and other forest litter may often be sufficiently dry to sustain a deep fire until the dry period begins, when, with the advent of high winds, the fire is driven for miles. These smoldering fires are generally visible to travelers in the reserve for at least 15 or 20 miles. During the last days of August the writer clearly distinguished several small forest fires burning in the Battlement Mesa region, 25 miles away. Their position remained unchanged for a number of days until heavy winds spread and united them into one vast conflagration.

Taken at the proper time, all of these incipient fires could have been extinguished. The season's fire, which started near Sleeping Cap Mountain, is said, on good authority, to have remained in a quiescent state for nearly a week, during which time it was visible for a long distance. Under a heavy draft of wind it was later beyond control. But there are periods in the advance of even widespread fires when the forcing winds cease for a shorter or longer time and the fires move slowly. At such times well directed, persistent efforts will extinguish them or prevent further spreading. Light snows, likely to occur early in October, are powerful checking agencies, usually extinguishing surface fires and putting a short check upon deep-burning fires. Immediately after these snowfalls is a proper time to effectually extinguish the visible fires smoldering among log heaps and buried tree trunks. If such a timely opportunity be neglected, a few bright days melt the snow, and fierce winds soon fan the buried embers into savage activity.

STANDING COMMERCIAL TIMBER.

One of the most difficult problems in the study of the forest resources of this reserve is a determination of the amount of standing timber. As already pointed out, there are no regularly large, continuous bodies of timber. Except in the case of a few continuously-timbered watersheds the distribution of timber is in single trees, small groves of a dozen trees, and in bodies of from one-fourth of an acre to sometimes 50 or more acres, all interspersed with grassy "parks."

Numerous calculations were made in representative wooded areas as to the amount of timber contained in tracts of from 1 mile to 2 miles square. From these calculations it is believed that fairly correct approximations were reached for the proportions of timbered land on the high plateaus and also for the more continuously forested watersheds. It is estimated that of the total area of the reserve, 1,198,080 acres, about 41 per cent bears merchantable timber, distributed in the sparse manner peculiar to the region. About 25 per cent of this is actually wooded, while the remainder consists of grassy, interspersed parks. Fourteen per cent of the total area was originally covered with merchantable timber, which is now burned off. Thirty per cent of the total area consists of brush land, including small, unimportant aspen. The remaining 15 per cent is included in pure grass land, improved agricultural land, and land covered with sagebrush. Some of this is already available for ranch land, while other portions may become so with the accession of water.

The average acre yield of merchantable timber is also very difficult to determine on account of the great variation in size and composition throughout the wooded regions. There are, moreover, no well-marked forest types occurring regularly over any considerable area except for the denser stand of timber on watersheds. As a whole the diameter and height measurements for the entire timbered area are peculiarly similar. This uniformity in size development is attended, however, with different degrees of density. The high plateaus are less densely wooded than the watersheds. It is possible, therefore, to establish at least two types of acre yield—one for the plateau region, the other for all timbered watersheds.

It was believed that some of the settlers and sawmill operators might have some practical information on the yield of timber per acre for the various localities lumbered over by them, but no attention appears to have been given to such determinations, or in instances where figures were given out they were so absurdly small as to be very questionable. For example, one mill operator stated that two to three lumber trees per acre, as a general average, was all that could be counted on.

TABLES OF MEASUREMENTS OF SAMPLE QUARTER ACRES.

A survey of the following tables of diameter measurements for sample areas taken in various parts of the plateau region and on timbered watersheds will illustrate the common-size development for commercial timber. In selecting quarter-acre plats for measurement neither the largest and densest stands nor the smallest and most thinly-disposed timber was chosen. Areas were selected which would give an average expression for the size and density of the block of timber in which the sample was located. It must be explained also that the extremely large number of log trees found per sample area is due to the peculiar habit Engelmann spruce and alpine fir have of growing in thick bunches. From 10 to 15 large trees are often found on a plat as many feet square, followed by an open space of a few yards or feet to the next group. Thus all the log trees may be crowded into one part of the plat measured or may be disposed in two or three distinct, dense groups. Each table of measurement is preceded by a short special description of the site from which the measurements were taken.

SAMPLE QUARTER ACRE NO. 1.

Sample quarter acre situated in valley of Upper Yampa River (head of "Cole Creek"), in region of Mount Orno. It represents a bunched growth of Engelmann spruce as found on watersheds, all trees of log size, with small alpine fir seedlings scattered among the large trees. No other tree growth below 10 inches in diameter. Timber all sound and none dead. Trunks free from branches for 10 to 15 feet. Total number of trees, 47; average height, 78 feet; age of average tree, 215 years. Timber on a western slope; soil dry, rocky in part, with moist muck on rock, the plat being intersected by a small spring stream. Humus 2 to 4 inches deep.

Table of measurements of Engelmann spruce on sample quarter acre No. 1, at head of Cole Creek, near Mount Orno.

	Diameter in inches, breast high.																	
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Number of trees on quarter acre....	6	2	3	1	4	2	2	3	3	2	6	2	1	3	4	1	1	1

SAMPLE QUARTER ACRE NO. 2.

Sample quarter acre situated on head waters of Hunt Creek, on the west slope of Mount Orno Plateau, in the region of Yampa River. Represents Engelmann spruce and alpine fir in a continuous, dense growth, or with only very small, occasionally interspersed grassy parks. The fir forms about 30 per cent of the stand, which is characterized by a more or less even disposition of the trees, as distinguished from the bunched growth peculiar to the high plateau region. The log trees amount to 75 per cent of the entire stand, the younger growth being from 2 to 9 inches in diameter and mostly spruce. The boles are clear of branches from 12 to 16 feet. Total number of spruce, 25; fir, 12. Average height of spruce, 85 feet; age, 200 to 214 years; height of fir, 90 feet; age, 100 to 180 years. Timber on a northwest slope with exposed, dry, rocky, gravelly soil; humus, 1 to 2 inches deep. Contiguous parts of this forest grow in moist, mucky superstratum on broken rock.

Tables of measurements of Engelmann spruce and alpine fir on sample quarter acre No. 2, on head waters of Hunt Creek.

ENGELMANN SPRUCE.

	Diameter in inches, breast high.												
	12	13	14	15	16	17	18	19	20	21	22	23	24
Number of trees on quarter acre.....	2	1	4	3	2	2	2	3	1	1	2	1	1

ALPINE FIR.

	Diameter in inches, breast high.					
	12	13	14	15	16	17
Number of trees on quarter acre	3	2	2	2	1	2

SAMPLE QUARTER ACRE NO. 3.

Sample quarter acre on east side of Mount Orno Plateau slope, 1 mile below the foregoing site. It represents Engelmann spruce and alpine fir as it occurs on watersheds in one-half to 1 acre groves, interspersed with grassy "parks" of from one-half to 2 acres. About 30 per cent of the entire stand is fir. Log trees 90 per cent of total stand, the younger growth being from 2 to 6 inches in diameter and composed about equally of spruce and fir. The timber is all sound and the boles bear limbs to the ground. Total number of spruce trees, 32; fir, 15. Average height of spruce, 80 feet; age, 196 years. Average height of fir, 60 feet; age, 112 years. Southwest slope with dry, rocky, and shaly soil; humus in very dense shade, 2 to 4 inches deep. Contiguous growth, for several miles about similar.

Tables of measurements of Engelmann spruce and alpine fir on sample quarter acre No. 3, on east side of Mount Orno Plateau.

ENGELMANN SPRUCE.

	Diameter in inches, breast high.																
	10	11	12	13	14	16	17	18	19	20	21	23	24	26	28	32	36
Number of trees on quarter acre	1	1	3	1	1	2	3	3	3	1	2	1	4	1	3	1	1

ALPINE FIR.

	Diameter in inches, breast high.		
	10	11	12
Number of trees on quarter acre	6	5	4

SAMPLE QUARTER ACRE NO. 4.

Sample quarter acre on the west slope of Mount Orno Plateau, 2 miles northeast of the foregoing site. Represents a phenomenally close stand of Engelmann spruce and lodgepole pine which are common at intervals on dry benches along the lower levels of the timbered zone on the above slope. In places the dry benches of 2 to 5 acres each carry a nearly pure stand of lodgepole pine, while in other places a quarter acre of pine may be entirely surrounded by an equally dense stand of Engelmann spruce. Again, the spruce and pine may be more or less evenly mixed, the density remaining about the same. Between these dry benches occur shallow vales, "draws," where Engelmann spruce and alpine fir prevail, and complete the general composition of timber in this lower belt.

The pine on this plat forms about 30 per cent of the total stand, being mostly in pure growth, surrounded by mingled spruce and pine. Log trees, 95 per cent of total stand; the younger trees consist of spruce and pine, and are 4 to 6 inches in diameter. Trunks all free from limbs for 16 to 20 feet. Total number of spruce, 55; pine, 23. Average height of spruce, 79 feet; age, 180 years. Average height of pine, 65 feet; age, 140 years. Timber all sound. Soil very dry, rocky, and gravelly; humus 2 to 3 inches deep. Shade very dense, excluding all undershrubs and herbaceous plants.

Tables of measurements of Engelmann spruce and lodgepole pine on sample quarter acre No. 4, on west slope of Mount Orno Plateau.

ENGELMANN SPRUCE.

	Diameter in inches, breast high.								
	10	11	12	13	14	15	16	18	21
Number of trees on quarter-acre	5	11	10	11	8	4	4	1	1

Tables of measurements of Englemann spruce and lodgepole pine on sample quarter acre No. 4, on west slope of Mount Orno Plateau—Continued.

LODGEPOLE PINE.

	Diameter in inches, breast high.					
	10	11	12	13	14	18
Number of trees on quarter acre	*a* 3	*b* 3	*c* 10	*a* 4	2	*a* 1

a 1 dead. *b* 2 dead. *c* 3 dead.

SAMPLE QUARTER ACRE NO. 5.

Sample quarter acre, situated in Williams River Basin, 6 miles below head of the stream. Represents Engelmann spruce and alpine fir in part bunched and evenly disposed. Characteristic stand for all the watersheds of this stream, interspersed with numerous small grassy parks. Fir, 20 per cent of the total stand. The adjacent small, dry, gravelly benches occasionally bear a very few lodgepole pines, 12 to 20 inches in diameter, scattered among the spruce and fir. Log trees, 90 per cent of entire stand; smaller trees, 2 to 8 inches in diameter, and consisting chiefly of spruce. Trunks mostly with limbs to the ground, only a few clear of branches for 8 to 10 feet; timber all sound. Total number of spruce trees, 43; fir, 10. Average height of spruce, 90 feet; age, 210 years. Average height of fir, 69 feet; age, 120 years. Western slope, in part with moist, rich, rocky soil, and small bench with deep deposit of moist muck on rock. Humus 6 to 10 inches deep.

Tables of measurements of Engelmann spruce and alpine fir on sample quarter acre No. 5, in Williams River Basin.

ENGELMANN SPRUCE.

	Diameter in inches, breast high.																				
	10	11	12	13	14	16	17	18	19	20	21	22	23	24	25	27	28	29	30	32	36
Number of trees on quarter acre	2	1	2	1	*a* 3	5	2	*a* 3	*a* 4	1	3	3	2	3	2	1	1	1	1	1	1

a 1 dead.

ALPINE FIR.

	Diameter in inches, breast high.	
	10	11
Number of trees on quarter acre	4	6

SAMPLE QUARTER ACRE NO. 6.

Sample quarter acre situated on the eastern slope of Sand Mountain. Represents nearly pure stand of Engelmann spruce log trees, with 10 per cent of alpine fir, 2 to 8 inches in diameter. The timber is on a moist, rocky flat at base of the mountain, and is characteristic of timber at this level, which occurs in bunched open bodies of 2 to 20 acres. From 5 to 12 trees stand on an area 25 feet square. The grassy openings between the groups of trees are filled with 200 young spruce, 1 to 15 feet high and one-half to 4 inches in diameter. Log trees all sound and trunks with limbs down to the ground. Total number of trees, 37; average height, 97 feet; age, 220 years. No dead fallen timber. Humus under shade of groups, 4 to 6 inches deep.

Table of measurements of Engelmann spruce on sample quarter acre No. 6, eastern slope of Sand Mountain.

	Diameter in inches, breast high.																
	13	14	16	17	19	20	21	22	23	24	25	26	27	28	29	30	31
Number of trees on quarter acre	2	2	2	1	4	2	3	3	4	1	1	5	1	2	1	2	1

SAMPLE QUARTER ACRE No. 7.

Sample quarter acre situated on the east slope of Sleeping Cap Mountain;[1] a dry, rocky and in part moist, flat, 800 feet below the summit. It represents Engelmann spruce and alpine fir on a forested level similar to that described for the foregoing sample area, and is designed to illustrate the westward extension of the same general growth. Log trees, 80 per cent of the total stand; about 30 per cent of the log trees is fir. The younger growth consists of 150 young spruce and fir, mostly 1 to 3 feet high; a few 10 to 20 feet high. Nearly all trunks with branches down to the ground. Timber all sound. Total number of spruce-log trees, 32; fir, 15. Average height of spruce, 81 feet; age, 198 years. Average height of fir, 89 feet; age, 158 years. Soil rocky; in parts with rich, moist humus 6 to 8 inches deep. Several small spring streams in vicinity.

Tables of measurements of Engelmann spruce and alpine fir on sample quarter acre No. 7, on eastern slope of Sleeping Cap Mountain.

ENGELMANN SPRUCE.

	Diameter in inches, breast high.																
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	28	30	32
Number of trees on quarter acre	a1	2	1	1	3	1	2	3	2	a3	1	2	5	1	a1	2	1

a 1 dead.

ALPINE FIR.

	Diameter in inches, breast high.				
	11	12	13	24	25
Number of trees on quarter acre	3	5	4	2	1

SAMPLE QUARTER ACRE No. 8.

Sample quarter acre on head waters of Coal Creek, south side of stream. It represents a pure growth of fire-killed lodgepole pine on a north dry gravelly slope (Pl. LVII, *B*). The stand is characteristic of lodgepole pine for this vicinity, which occurs, however, in pure stands of only 20 to 50 acres. These usually pass into mixtures composed of pine and 10 to 50 per cent of Engelmann spruce. The same general growth once extended widely over the low gravelly slopes and benches on the north and south sides of Coal Creek, but is now greatly reduced by fire. Total number of log trees, 40, forming 90 per cent of entire stand; small trees under 6 inches. Trunks clear of branches for 16 to 20 feet. Timber all sound. Average height, 63 feet; age, 145 years. No evidence of a preexisting forest.

[1] Sometimes known as "Lost Peak," from its proximity to "Lost Creek" and "Lost Park."

Table of measurements of lodgepole pine on sample quarter acre No. 8, at head waters of Coal Creek.

	Diameter in inches, breast high.						
	10	11	12	13	14	15	16
Number of trees on quarter acre...	5	8	6	6	12	1	2

SAMPLE QUARTER ACRE NO. 9.

Sample quarter acre on head waters of Milk Creek; site on the high ridge between head waters of Coal and Milk creeks. Represents a nearly pure growth of lodgepole pine on a dry, gravelly northern slope. The growth is dense, but in spots is mingled with alpine fir, aspen, and spruce. This feature is characteristic throughout the slope. Total number of pine-log trees, 49; fir, 12; aspen, 2; spruce, 2; all forming 95 per cent of the total stand. Younger trees, 3 to 6 inches in diameter, and consisting mainly of pine. Timber all sound, and trunks free from branches for 12 to 25 feet. Average height of pine, 65 feet; age, 148 years. Average height of fir, 70 feet; age, 110 years. Spruce 50 and 68 feet high, 10 and 16 inches in diameter. Aspen, 50 feet high and 10 to 13 inches in diameter, standing apart from other growth in an open space. Humus 2 to 3 inches deep, or in places the stony, gravelly soil exposed. Dense shade of conifers excluding all undershrubs and herbaceous vegetation. Thin grass among the aspen.

Tables of measurements of lodgepole pine and alpine fir on sample quarter acre No. 9, at head waters of Milk Creek.

LODGEPOLE PINE.

	Diameter in inches, breast high.							
	10	11	12	13	14	15	16	17
Number of trees on quarter acre	6	8	10	6	6	6	5	2

ALPINE FIR.

	Diameter in inches, breast high.				
	10	11	13	14	16
Number of trees on quarter acre	3	*a* 3	*b* 3	*b* 2	1

a 2 dead. *b* 1 dead.

SAMPLE QUARTER ACRE NO. 10.

Sample quarter acre on head waters of Coal Creek. Represents a practically pure growth of Engelmann spruce on a rich, moist, rocky north slope. The sample area contained a single alpine fir and lodgepole pine, the latter a straggler from a higher part of same slope, where the soil is drier and poorer. A very dense growth of spruce, such as occurs at irregular intervals, connected by very open or only moderately dense mixtures of alpine fir and spruce. This stand represents one of the better stocked areas recently cut over for a sawmill in the vicinity. The following measurements were taken from the newly-cut stumps. With the exception of a very few small alpine-fir seedlings, scattered through the cutting, the log trees constituted the entire growth. But this is exceptional. Usually from 10 to 20 per cent of the stand consists of spruce and fir saplings, scattered among the larger trees. Total number of spruce log trees, 60; lodgepole pine and alpine fir, 1 each. Ninety per cent of timber sound. All trunks bear branches to the ground. Average height of spruce, 100 feet; age, 187 years. Pine, 58 feet in height and 13 inches in diameter; fir, 75 feet in height and 17 inches in diameter. Soil watered by several spring rivulets. Humus moist, 4 to 6 inches deep, on broken rock and gravel.

Table of measurements of Engelmann spruce on sample quarter acre No. 10, at head waters of Coal Creek.

	Diameter in inches, breast high.																					
	12	13	14	16	17	18	19	20	21	22	23	24	25	26	28	29	30	31	32	34	36	38
Number of trees on quarter acre	2	2	4	3	7	4	2	3	2	4	2	3	2	1	4	1	4	2	2	1	4	1

Sample Quarter Acre No. 11.

Sample quarter acre situated on the head waters of Miller Creek. Represents a stand chiefly of Engelmann spruce, with thinly-mingled alpine fir and large aspen adjacent; all growing in moist, rich soil of a narrow creek bottom (30 yards wide) and extending upon the immediate east and west slopes. The large spruce trees are more or less grouped. The small, well-shaded intervals between the groups bear a few scattered spruce and fir seedlings, 1 to 2 feet high. The log trees form 80 per cent of entire stand; the younger trees, mainly spruce, are 3 to 7 inches in diameter. Total number of log spruce, 41; fir, 5. Thirteen aspen are included in the sample area and form an open growth apart from the other timber. Log trees all sound, and mostly with limbs to the ground; a very few trunks bear branches 10 to 15 feet above ground. Average height of spruce, 90 feet; age, 180 years. Fir, 50 to 65 feet high, and 10, 11, 13, and 14 inches in diameter; aspen, 40 to 50 feet in height and 10 to 18 inches in diameter. No vegetation under the dense shade of the conifers; grass among aspen. Humus 6 to 10 inches deep.

Table of measurements of Engelmann spruce on sample quarter acre No. 11, at head waters of Miller Creek.

	Diameter in inches, breast high.																				
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	28	30	31	35	36	39
Number of trees on quarter acre	4	2	1	4	4	2	1	2	2	2	2	1	1	1	3	3	1	1	1	1	2

Sample Quarter Acre No. 12.

Sample quarter acre situated on the first great bench above and to the west of Ute Creek Canyon and near the head waters of the stream, represents a pure growth of lodgepole pine in dry, gravelly soil. The growth is characteristic of the species for this region. The sample is from one of several small bodies surviving an old fire, and shows the enormous number of trees produced by this species per acre. All the northern and northeastern slopes below the spruce and fir belt were once heavily timbered with pine of this character. Along the upper border of the belt the pine is more or less mixed with spruce and fir. Scattered among the remaining pine are small patches of aspen and fir. Total number of log trees, 67, forming 75 per cent of the entire growth. The younger trees are 2 to 6 inches in diameter. A few fir seedlings, 6 to 15 inches high, have crowded in along the pine border since the fire. Average height of lumber trees, 67 feet; age, 151 years. Timber all sound. Trunks clear of branches for only 10 to 15 feet, the remainder of the trunk bearing small dead branches up to the crown, which is about one-third of the height. There is exceptionally less clear timber in the pine of this vicinity than at other stations. Soil very dry, gravelly, and much exposed in spots. Dense shade in the interior of the plat (representing the original shade conditions) entirely without undershrubs or other vegetation. Humus in unwashed spots, 1 to 2 inches deep.

Table of measurements of lodgepole pine on sample quarter acre No. 12, bench west of Ute Creek Canyon near the head waters of the creek.

	Diameter in inches, breast high.						
	10	11	12	13	14	15	16
Number of trees on quarter acre	*a* 11	*b* 24	*a* 16	*c* 10	1	3	2

a 2 dead. *b* 3 dead. *c* 1 dead.

SAMPLE QUARTER ACRE NO. 13.

Sample quarter acre situated on the south end of Burro Mountain. Represents a growth of mainly Engelmann spruce, with a small amount of alpine fir and lodgepole pine. The sample is illustrative of a peculiarly dense growth of spruce found in rich, moist hollows below the higher wind-swept mountain plateau. These growths are not frequent. Elsewhere they occur on the rich, moist, well-protected benches along the upper eastern and northern slopes of this mountain. In some places they extend up onto the mountain through the low-cut hollows and depressions in the rim of the plateau. Such bodies of timber cover from 5 to sometimes 10 acres, with interspersed open grassy spots only a few yards in extent. On the higher, drier, and less-protected plateau of the mountain this dense growth is replaced by distant groups in broad, grassy parks. These heavy stands are not sufficiently extensive to be taken into account as commercial forest types, but illustrate the great capacity of the species under favorable conditions (Pl. LII, A). The pine is accidental, the station being far above the altitude of commercial growth.

Total number of spruce log trees, 79; fir, 6. The log trees constitute the entire stand, with the exception of seedling spruce and fir. An abundance of these 1 to 4 feet high are found in all the small openings. Average height of spruce, 100 feet; age, 198 years. Fir, 80 feet high; diameters, 14, 15, 16, 18 inches; age, 160 years. Pine, 65 feet in height and 13 inches in diameter. A few trunks are clear of branches for 15 to 20 feet, but in most cases bear dead, rigid limbs to the ground. Ninety-five per cent of timber sound. Soil deep, moist, on loose, broken rock; humus 10 to 12 inches deep. A light growth of shade-enduring herbaceous plants prevail.

Table of measurements of Engelmann spruce on sample quarter acre No. 13, on south end of Burro Mountain.

	Diameter in inches, breast high.																						
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30	31	34	35
Number of trees on quarter acre	3	4	*a* 6	*a* 6	8	6	2	4	*a* 5	4	*a* 5	5	6	1	2	*a* 2	*a* 2	*a* 1	2	2	1	1	1

a One dead.

SAMPLE QUARTER ACRE NO. 14.

Sample quarter acre situated on the head of the west head branch of the South Fork of White River. Represents a nearly pure growth of Engelmann spruce, with small quantity of alpine fir, as it occurs at the west end of the great White River

Plateau. The sample is part of a 5-acre body growing on a rich, dry, sandy, and gravelly knoll, such as is common throughout the plateau region. The trees are very closely grouped, not infrequently 9 to 12 trees on an area 10 feet square. Small grassy spots among the groups bear a dense stand of young spruce and fir, the latter rather more numerous than the spruce. The plat contains no undersized trees above the seedling growth, the log trees constituting the sole stand. The absence of undersized trees is frequent elsewhere in this region, but characteristic only in part, the saplings and larger undersized trees often amounting to from 20 to 30 per cent of the entire stand. The small proportion, 6 per cent, of fir in this plat is a minimum for the region. A more general expression is from 10 to 30 per cent.

Total number of spruce log trees, 56; fir, 4. Average height of spruce, 68 feet; age, 197 years. Fir, 60 feet high; diameters, 12, 13, 15,[1] 16.[1] Trunks with thick branches to the ground; a feature common to all spruce and fir in the plateau region. Timber all sound. A few fallen, decayed trunks. Soil on a substratum of sandstone, 2 to 3 feet below the surface. Humus among the dense groups of large trees, 6 to 8 inches deep; soil exposed among the seedlings and with tufts of bunch-grass.

Table of measurements of Engelmann spruce on sample quarter acre No. 14, at head of west head branch of South Fork of White River.

	Diameter in inches, breast high.																		
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Number of trees on quarter acre	4	2	5	5	5	2	4	7	2	4	5	1	1	2	3	1	1	1	1

SAMPLE QUARTER ACRE No. 15.

Sample quarter acre situated on the north slope of the upper east branch of Elk Creek (East Elk). Represents a growth of Engelmann spruce and alpine fir, in which the two species are pretty evenly mixed. The stand is characteristic of the watersheds on the head waters of most of the streams which drain the southern part of this reserve. In a few instances the fir of this region becomes dominant in numbers. It was found in a pure growth in only one locality in the reserve. This is on a narrow ridge between the westernmost forks of Elk Creek. The isolation is peculiar, as a mixture of spruce and fir occurs on parallel ridges with the same general soil characters. The density of timber represented by the sample plat is very variable. About one-half of the plat illustrates the heaviest and the other part the lightest stand found in the vicinity. It is a continuous growth, in which the trees are more or less evenly distributed.

The spruce log trees number 35 and the fir 27, together forming about 90 per cent of the entire stand. The remaining younger growth ranges from 1 to 6 inches in diameter. On adjacent areas, however, recently cut over by a sawmill in the vicinity, careless felling and snaking out the logs has demolished nearly all the undersized trees and seedlings. The uncut portions elsewhere are, if carefully lumbered, sufficiently stocked with seedlings and undersized seed trees to quickly and entirely recover any lumbered-out areas. Considerable dead fallen timber exists in this region. A more or less heavy growth of cheat grass, oat grass, and succulent weeds abounds, owing to the light admitted among the narrow-crowned firs. Average height of spruce, 98 feet; age, 169 years; fir, 90 feet high and 157 years old. About 85 per cent of log timber is sound. The large firs are often defective ("wind-shaken" or hollow) at the butt for

[1] Dead.

8 to 10 feet. The trunks are often free from branches for 10 to sometimes 20 feet, but more often with scattered, persisting dead branches down to the ground. Soil dry, sandy, and gravelly, with humus 6 to 10 inches deep.

Tables of measurements of Engelmann spruce and alpine fir on sample quarter acre No. 15, on the north slope of the upper east branch of Elk Creek.

ENGELMANN SPRUCE.

	Diameter in inches, breast high.										
	10	12	14	15	16	17	18	20	22	24	26
Number of trees on quarter acre.............	2	2	a2	2	3	1	a5	6	b7	4	1

ALPINE FIR.

	Diameter in inches, breast high.										
	10	11	12	14	15	16	17	18	19	20	22
Number of trees on quarter acre.............	2	2	a3	8	1	2	a2	3	a1	2	1

a 1 dead. b 3 dead.

No tables of measurement are given for red fir, for the reason that the commercial quantities of this timber in the reserve are so small and accidental as to play no appreciable part in the total lumber output. A general estimate will be given later for standing red-fir timber. As stated elsewhere, most of the log sizes—in fact, the major part of this timber—has been removed or destroyed by fire. Only a few small bodies remain. The little useful timber in these is of great importance as a protection to the steep, rocky watersheds where it exists, and it should be preserved or cut only under the most careful direction.

The same is true of the still smaller quantity of yellow pine in the reserve. Its very scattered growth and limited extent make it unworthy of consideration for the present. Considerable quantities have been cut along the southern lower slopes of the White River and its South Fork, as also on the lower canyons of several creeks draining the southern part of the reserve. The remnants left, however, would not warrant any special lumber operations.

No table of measurements is given for the blue spruce, which is a timber tree, but which, except in very few locations, occurs in too small quantities. At best, it is to be considered only in connection with large quantities of Engelmann spruce. Two such stations were found in the valley of Ute and Miller creeks, where both species mingled, the Engelmann spruce at its lowest and the blue spruce at its upper limit of altitude. Here the blue spruce may have a timber value when lumbered with other more abundant species.

ACRE YIELDS.

Mention has already been made of the unusually large number of log trees per sample areas measured. A computation of the acre yields represented by the various tables of measurement shows a very large production of lumber. Considering the fact, however, that the bodies from which these measurements were taken do not represent regions of continuous timber growth, but those only partially timbered, the estimated acre yield for the plateaus and watersheds becomes much less striking.

It seems proper to note in this connection that much of the plateau timber will be undesirable to the practical lumberman, for the present at least, on account of the small quantities available in the widely separated groups. Moreover, the second-rate quality of all the plateau spruce and fir, coupled with the necessity of long haulage, will make lumber operations unprofitable in these thinly-timbered sections. This timber may be desirable after other better-stocked and more accessible resources have been exhausted.

The method employed for determining the acre yield was, in brief, to take the diameter measurements, at breast height, of all standing trees on sample areas down to and including 10 inches. These measurements were divided into diameter classes, and for all trees of each class the basal areas of their diameters were computed in square feet. The basal area of the average tree for each diameter class was found by dividing the basal area of the class by the number of trees it contained. From this figure the corresponding average diameter for the class is found. The diameter of the average tree for the sample area was computed from the average trees for the diameter classes. The practice was to fell this tree and scale the log lengths up to 8 inches in diameter for the smaller end of the top log. Average age and height were also taken from this tree.

The average acre yield of Engelmann spruce in the plateau region is placed at 2,500 board feet. For all watersheds and other similarly protected regions the acre yield is 4,000 feet. Average acre yield for alpine fir, 1,000 feet.

AMOUNT OF STANDING TIMBER.

Following is an estimate of the total amount of standing timber in the reserve:

	Feet B. M.
Spruce	930,000,000
Fir	310,000,000
Lodgepole pine	50,000,000
Red fir suitable for ties and piling	25,000,000
Aspen suitable for pulp timber	100,000,000

RECAPITULATION OF TIMBER DESTROYED BY FOREST FIRES AND ILLICIT LUMBERING.

Following is an estimate of the total amount of timber of various kinds destroyed by fire and by illicit lumbering:

	Feet B. M.
Lodgepole pine burned	26,000,000
Lodgepole pine cut	2,750,000
Spruce and fir burned	61,000,000
Spruce and fir cut	15,470,000
Yellow pine cut	2,500,000

Tables showing a comparison of diameter, height, and age for all sample areas, with average acre yields, and number of trees of various diameters on each sample area.

ENGELMANN SPRUCE.

Quarter-acre No.	Diameters in inches, breast high.																														Each quarter acre.			
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total number trees.	Average diameter.	Average height.	Average age.
1	6	2	3	1	4	2	2	3	3	2	6	2	1	3	4	1	1	1	....	....	....	....	....	....	....	....	....	....	....	....	47	18	78	215
2	....	....	2	1	4	3	2	2	2	3	1	1	2	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	25	17	85	214
3	1	1	3	1	1	....	2	3	3	3	1	2	....	1	4	....	1	....	3	....	....	....	1	....	....	....	1	....	....	....	32	21	80	196
4	5	11	10	11	8	4	4	....	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	55	13	79	180
5	2	1	2	1	3	....	5	2	3	4	1	3	3	2	3	2	....	1	1	1	1	....	1	....	....	....	1	....	....	....	43	21	90	210
6	....	....	....	2	2	....	2	1	....	4	2	3	3	4	1	1	5	1	2	1	2	1	....	....	....	....	....	....	....	....	37	23	97	220
7	....	....	....	1	2	1	1	3	1	2	3	2	3	1	2	5	1	....	1	....	2	....	1	....	....	....	....	....	....	....	32	22	81	198
10	....	....	2	2	4	....	3	7	4	2	3	2	4	2	3	2	1	4	....	1	4	2	2	....	1	....	4	....	1	....	60	24	100	187
11	4	2	1	4	4	2	1	2	2	2	2	1	1	1	3	....	....	....	3	....	1	1	....	....	....	1	1	....	....	2	41	20	90	180
13	3	4	6	6	8	6	2	4	5	4	5	5	6	1	2	2	2	1	2	....	2	1	....	....	1	1	....	....	....	....	79	19	100	198
14	4	2	5	5	5	2	4	7	2	4	5	1	1	2	3	1	1	1	1	....	....	....	....	....	....	....	....	....	....	....	56	18	68	197
15	2	....	2	....	2	2	3	1	5	....	6	....	7	....	4	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	35	19	98	169

ALPINE FIR.

Quarter-acre No.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total number trees.	Average diameter.	Average height.	Average age.
2	....	....	3	2	2	2	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12	14	90	180
3	6	5	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	11	60	112
5	4	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10	11	69	120
7	....	3	5	4	....	....	....	....	....	....	....	....	....	....	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	15	89	158
9	3	3	....	3	2	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12	19	70	110
15	2	2	3	....	8	1	2	2	3	1	2	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	27	15	90	157

Tables showing a comparison of diameter, height, and age for all sample areas, with average acre yields, and number of trees of various diameters on each sample area—Continued.

LODGEPOLE PINE.

Quarter-acre No.	Diameters in inches, breast high.																														Each quarter acre.			
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total number trees.	Average diameter.	Average height.	Average age.
4	3	3	10	4	2	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	23	12	65	140
8	5	8	6	6	12	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	40	13	63	145
9	6	8	10	6	6	6	5	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	49	13	65	148
12	11	24	16	10	1	3	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	67	12	72	151

EFFECTS OF DEFORESTATION BY VARIOUS AGENCIES ON SUBSEQUENT GROWTH.

EFFECT OF ILLICIT LUMBERING.

It is only the slaughtering methods of cutting and careless logging employed by illicit mill operators which affect subsequent regeneration. The object of these men is to cut and dispose of as much timber as possible in the shortest space of time. Such methods of lumbering are very, if not wholly, destructive of all existing young growth, and, through the removal of all seed trees, prevent new seeding. If a stand of spruce and fir in the region of the watersheds contain young seedlings and 25 to 30 per cent of undersized trees, and undergoes a culling of all larger stock, the subsequent growth will not be materially changed in character and composition. Much young stock will be uselessly destroyed by the ordinary method of taking out the log timber, but enough may survive to finally reforest the cut-over area. Restocking the area will, however, require much longer time than if the cutting and logging were properly done. Moreover, by careless lumbering the chances of total destruction by fire are greatly increased through added fresh fuel in the shape of half-used tops left on the ground. Where, as shown by several sample plats, the lumber trees constitute the total stand, with few or no seedlings, the lumbering methods of the timber thief, either at once or by piecemeal, have swept off every tree. The tangled masses of neglected logs and unused tops and limbs which are left create conditions most favorable to fire. In some cases this slaughtering has left adjacent or distant bodies or small groups or outlying single spruce and fir trees, from which for old cuttings time has shown a slow, scattered regeneration among rank weeds and grass. Where aspen was near, or even a few miles away, the solitary struggling conifers appear to have been quickly surrounded by dense thickets of this species. The increasing shade of the aspen subdues the dense weed and grass growth to a thin, straggling stand, affording very favorable conditions for the advance of spruce and fir. If at this juncture fires run over the ground, killing, as is usually the case, all conifers, the subsequent growth will be aspen, and this will remain until some chance agency brings back seed of the original growth.

At points where lodgepole pine has been lumbered out, the very few undersized trees not cut are broken, twisted, and bent in the felling of log trees. There is usually none of the original growth standing after the logger has left. These dense, pure growths of lodgepole pine admit of no annual or other periodic seeding, such as is usual in open stands of spruce, so that there are no seedlings to at once take the place of the old trees removed. Barring the most likely ravages of fire among the tangle of tops and other débris, the future forest growth depends on the near or remote presence of seed trees. Lodgepole pine quickly reestablishes itself in cleared districts from remnant seed trees and from untouched borders. The densest of stands spring up, even to the exclusion of the ubiquitous aspen. In localities where pine has been entirely cut out, leaving scattered spruce and fir in the vicinity, the cleared pine land is largely recovered by aspen, with a small number of fir and spruce. Occasional patches of lodgepole pine have been entirely cut out in the midst of a surrounding growth of spruce and fir. Seedlings from the latter have made rapid advances along the borders, where the greater richness of the soil and protection of the forest border favors their growth. Other outpost seedlings also appear among the tangle of lodgepole-pine logs, 100 to 200 yards from the mother border; but the major part of the denuded pine land is quickly covered by aspen, through which spruce and fir continue to spread with increased vigor. On the poor, gravelly soils originally held by lodgepole pine, the introduction of spruce and fir is greatly facilitated by an existing, scattered stand of aspen.

EFFECTS OF FIRES.

The forest growth following forest fires is conditioned by the character of the fire. The reappearance of the original timber species is made possible or impossible only by the degree of thoroughness with which the old growth has been removed. It may be positively stated that in itself deep or shallow burning has no lasting influence on the soil to exclude species which once held the ground. Lodgepole pine burned off may follow again and again, as may also Engelmann spruce and fir. The fact that in one or another instance the regeneration requires a greater or less time, is dependent both upon physical barriers imposed, as it were, by fire cuttings, and also upon the partial or complete destruction of all near or outstanding original growth.

If a stand of spruce and fir be completely killed by fire, and is so isolated as to be beyond or above the reach of the seeding capacity of its own kind, through either wind or water, the burned area will remain unrecovered by these species for all time. If within its altitudinal range, the far-reaching aspen will claim the land for its own, as it is the only other tree of the region which accepts all conditions and cast-off tenures. If the spruce and fir growth killed by surface fire be surrounded by a near forest of its own kind, or adjacent to a surviving group, the return of these species is assured. But the return is subject to long delay and hindrance from dead standing trunks, which, by occupying the ground, form an effective barrier to the few wind-driven seed that fall within their lines (Pl. LVII, *A*). Moreover, with the sudden influx of light, such fire-killed areas of timber are immediately taken possession of; first, by a dense growth of willow

A. OLD FIRE ON MARVINE CREEK IN ENGELMANN SPRUCE AND ALPINE FIR.

B. OLD BURN IN LODGEPOLE-PINE FOREST ON LOWER SLOPES OF SLEEPING CAP MOUNTAIN.

Shows reproduction of same species from cones on fire-killed trees.

weed (*Epilobium*), and then by tall, dense grasses and weeds. These form a matted cover to the soil, and for a time effectually prevent tree seed from finding lodgment in humus or soil. The borders of such fire spots are often marked by a line or patches of seedling spruce and fir from a near mother tree or group, while the thickly studded interior burn remains treeless, awaiting the clearing process of decay and wind.

Where, on the other hand, a deep, all-consuming fire had left nothing but a few charred logs and stubs, or by deep burning alone had felled the spruce and fir, leaving outstanding groups or single seed trees, these species have again returned to the burned area. It is evident, however, but to be demonstrated only by a continued study of newly burned areas, that several, probably two to three years of quiescence follow deep soil-consuming fires. Before regeneration is possible there must take place the necessary absorption and dissipation of excessive noxious elements left by fire.

Besides the actual unfitness of burned ground to immediately encourage seedling growth, additional delay to land becoming reseeded may be due to the more or less long interval between seed years. This is especially true of Engelmann spruce and alpine fir. The years of seed production vary also for different localities in the same region, as does the amount of seed borne.

Burned areas of the above type situated below the high plateaus are likely to and do become stocked with aspen in groups or mingled with the incoming conifers (Pl. LVIII, *A*), while if located in the plateau region or about the elevated head waters of streams far distant from aspen growth, the recovering of the burned area by the original conifers proceeds without interruption from the aspen.

In the case of burns within or near the aspen belt, the returning growth is in some places pure spruce and fir or bodies of the latter interspersed with those of aspen; or again, in an adjacent locality the growth may be an even mixture of spruce, fir, and aspen. A careful examination of these burned areas, which often appear to have originally carried only spruce and fir, shows frequent charred remains of aspen among those of the conifers. The inference is that the same general seeding influences produced an original growth similar to the present incoming one.

The lodgepole pine, which is one of the three species covering the largest areas, possesses a very remarkable power of reproduction after an attack by fire, a feature which explains its phenomenal advance over burned areas (Pl. LVIII, *B*). It is popularly believed to cover all burned areas, without reference to the previous growth. A close study of all the burned localities reforested by this species showed, however, without an exception, that lodgepole pine existed formerly in large quantity, or in some quantity, wherever young growth is now present. Unlike the spruce and fir of this region, and irrespective of adjacent living seed trees, the lodgepole pine may succeed itself through seed from standing fire-killed trees. It usually happens that some of the thick-scaled, serotinous cones are unaffected by fire or not sufficiently burned to prevent them from carrying the seed through the fire. Later the cones open and liberate the seed. This almost invariably takes place in the case of surface fires, and many times when the fire is more severe, reseeding takes place from dead pines with greater certainty and rapidity than is usual by spruce or fir from living trees. In all cases the latter species is reseeded only from living trees near the burned area, while with the lodgepole pine this may take place not only from near living trees, but also from some of the fire-killed trees.

Lodgepole pine is an annual seeder, and therefore always possesses a crop of seed at the season when fires are most likely to occur. When killed by surface fire, parts, if not the whole of the crown may be heated but unburned. The serotinous cones are usually green when most fires occur, and otherwise capable of enduring a great deal of heat before opening. Ample protection is afforded the ripe seed under their thick scales. Thus a supply of seed is preserved from the fire and may be held over for from two to nine or more years. The cone scales open at intervals, or in some cases all at once, and liberate the seed. An examination of lodgepole pine killed by fire two years ago showed many unopened cones containing perfect seed. Dense stands of seedling pines about dead seed trees attest the effectiveness of this remarkable economy.

It also happens many times that, in a deep burn which kills all and fells most of the pine, a few scattered trees escape the ground burning and carry their seed supply safely through the fire, to release it later, as in the case of trees killed by surface fires.

The reappearance of lodgepole pine is, therefore, doubly assured to all burned areas where living and dead seed trees exist; while, under all conditions of fire, the crop of seed carried by the thin-scaled cones of spruce and fir must invariably fall under the influence of heat, and be consumed during the fire. Seed shed soon after the fire would most likely fail to germinate on newly-burned land. The reproduction of lodgepole pine is still further facilitated above that of the spruce and fir, through the early seeding (at 15 to 20 years) of young trees.

In the few instances where red fir had been destroyed by fire there were here and there surviving green trees, from which reseeding was evident over very old burned ground. The young trees, 1 to 4 feet high, formed bodies of pure growth in places, and, together with mingled patches of small aspen, were re-covering the burn with a growth similar to the original. From the standing and fallen fire-killed trunks the composition of the burned timber was easily made out to be the same as that coming in. The very heavy, corky bark of large, isolated red fir often successfully resists fire, thus saving to the denuded district a number of seed trees. The thinner bark of denser, smaller growths is quickly and fatally scorched by even surface fires.

Where yellow pine has not been completely burned off, its return is inevitable, but slow. The heavy grass and weeds which invariably follow burning on soil-covered slopes forms a perfect barrier to reseeding. The scarcity of soil on nearly bare, rocky slopes which once carried a growth of this pine is also a discouragement to rapid reseeding. The original growth was at best a much-scattered stand, and when depleted by fire the surviving seed trees are usually very distant. Reproduction is scarcely noticeable, except in occasional young trees 6 to 10 feet high. Mingled with these is a more or less dense growth of aspen.

The conditions recited as favorable to a reproduction of the original more valuable forest growths in all burned areas in this reserve are quite prevalent—in fact, far more general than those in which the chances of recovery are few or none. Some of these areas, as shown by illustrations, are practically re-covered by a stand of the original kinds. Others are in part so covered, with evidence of completion in the near future; while, in a few instances, the widely distant patches of seed trees and their scattered offspring must require many more years to reclaim the burned ground. The more-rapidly established aspen may prevail in parts where the spruce and fir have been too slow, but not to the final exclusion of these conifers. The latter show a remarkable ability to spread through groves of the shorter-lived aspen. Doubtless many years will be required to effect a complete reforestation of the great fire-marked and denuded areas too prevalent in this reserve. But there is no reason to believe that, with efficient protective measures, this reforestation will not be accomplished.

At this most critical period, however, when the young forest growth of these burned areas has gained a hard-earned hold of ten to twenty years' standing, it is hourly threatened by fires on all sides—fires that, if once started, are likely to sweep off this young growth, and with it, possibly, every chance of its reappearance. The dead lodgepole-pine seed trees that once supplied seed over the large areas now heavily stocked with young pines are gone. With the destruction of their young progeny no mother trees will remain to produce another stand. These young trees, although bearing small quantities of seed, are still too small to survive even a surface fire. The hour has come when protection is needed that will insure undoubted safety to these millions of valuable conifers.

GRAZING AND GRAZING LANDS.

AREA GRAZED AND EFFECTS OF GRAZING.

The prosperous ranchmen settled within or near the reserve, on the White, Williams, and Yampa rivers and smaller streams, use some part of the reserve for ranging their cattle and horses. Residents of distant and neighboring small towns, and ranch settlers from remote agricultural valleys, also have large herds of cattle and horses on the reserve. Summer camps and cabins are established at various convenient points in the region where animals are held. All the work incident to the care of cattle and horses on the range is done from these headquarters. Cattle are taken to the range in May and June and allowed to run till the fall "round-ups." They are then driven off the reserve either to a lower "winter range" or are held on the ranch and fed. Horses are usually not fed or sheltered during winter, but "drifted" from the high, cold levels and allowed to "rustle" on the sage mesas and lower brush-covered foothills.

Practically no ranch in or out of the reserve affords pasture land for even a very small number of animals, excepting, possibly, for a few weeks in the fall after the second crop of alfalfa has been cut. Even then the stacks are frequently not fenced so as to make this short pasturage available. The cattlemen of towns have no inclosed pasture.

Most of the arable land of ranches in this region is devoted to the raising of forage for wintering the cattle. At most very little wheat and oats are raised, and chiefly for home use. A few of the larger ranches are devoted equally to forage for cattle and grain crops.

Much of the reserve must therefore be used for a range, if ranchmen continue to raise live stock on the present large scale. On a ranch of 160 acres the complement of cattle may be 100 to 1,000 head, according to the "start." Without doubt most of the settlers find a profitable, often the only, revenue in their beef herds. The contrast, however, between the unlimited range facilities at the command of ranchmen in this region and the conditions under which Eastern cattle raisers labor is very striking. The Colorado stock raiser has thousands of acres of wood and grass land without rent—without the asking—while the Eastern producer must hold his stock on lands rented or owned.

Cattle were found on nearly all the water courses penetrating the interior of this reserve; thence they range over all the low foothills, among brush, open timber, and burned-over land. Wherever a constant supply of running water is available, the animals remain throughout the summer season, May to November. At many points, however, cattle can not be held longer than July, on account of failing water supply. They are then driven to a part of the range where it can be found.

As seen in the dry, late summer months large areas of grassy park land were almost entirely untouched by cattle, even where it is near a supply of water. At this season the bunch grass begins to die and is tough. The animals prefer, therefore, to range among open groves of aspen, fir, and spruce, and along the brush-covered creek bottoms. They also feed over the lower contiguous slopes of these valleys and up to their very spring sources. The scanty but tender grasses found here are more acceptable. As the season advances the water supply of many small streams grows less and less. The thirsty animals trample down every vestige of herbage about the stream and the little oozing springs in their endeavor to find water. Streams that carried 100 to 200 inches of water in early summer, in August bore only enough water to fill the animals' foot-holes in the soft mud along its course.

As a rule, in late summer cattle range along the water courses and in all the moist, timbered coves and gulches, where feed and water and protection from the heat can be found. Horses range much higher than cattle, always preferring the open park land or the brush-clad, timberless, high hills.

It is impossible to state how many horses and cattle are annually ranged in this forest reserve; doubtless many thousands. Large numbers were constantly seen on the east, north, and west sides of the reserve.

The use of this great range, as now generally appropriated by cattle owners is, unquestionably, a great boon and, with consistent limits, a necessary encouragement to settlers. But in the promotion of all the interests involved, it would seem that a distinction must be made between reserve land suitable only for range purposes and that which is properly forest land.

The immediate objects of forest preservation and reproduction can not be attained to the fullest extent and in the shortest time if the damage from grazing must be contended with. The unmanaged forests of this region are comparable with the farm crops. Grazing would not improve the latter, nor could it be practiced without injury. To be sure, cattle neither eat the large trees nor do they browse on any of the important young timber species found in the reserve; but the trampling of thousands of range animals may kill millions of little conifer seedlings as effectually as if mown down with a scythe.

As is well known to nurserymen, coniferous seedlings are among the most difficult of plants to propagate during the first few years. If, therefore, they are expected to maintain themselves in nature, they must at least be protected from being trodden to death before they are strong enough to assert themselves. But the trampling and feeding of cattle among young conifer seedlings large enough to withstand such violence is in no sense beneficial. Such treatment always retards growth. The naturally loose, absorbing soil is replaced by a hard-packed one which prevents further seeding. Throughout all the open, unburned forest region of this reserve there is a most unaccountable absence of conifer seedlings under 10 years of age. The spruce and fir bear an abundance of seed at periods of two or three years, but no young seedlings are to be found among and near these trees where cattle have trodden. With every chance of injury or retardation removed, the irregular and insufficient moisture and other adverse conditions of these regions make the regeneration of these conifers slow and uncertain.

Contrasted with these conditions are the tangled masses of logs and litter left by fire, literally impassable to animals, where young seedlings may be found in small numbers. They are well guarded from all intruders.

Cattle also range over thousands of acres of surface-burned land on the lower watersheds, now thinly clad with various mixtures of conifers and aspen. With protection from the trampling of herds, it is possible to reestablish in such districts a forest cover of commercial and functional value. The presence of forest cover is most vital to the water flow; but with the present privileges of unrestricted grazing all betterment and extension of tree growth is clearly seen to be retarded. Regeneration is held at a standstill wherever there are signs of grazing. The thin stand of herbaceous plants, which, undisturbed, nurse the tender conifers till they can stand alone, are trodden flat. The moisture of the humus and soil is dissipated by exposure, and seasons upon seasons go by without the regeneration of a single forest tree. In some places even the hardy aspen is seen to halt in its advance, and still more so must the weaker spruces, firs, and pines.

It is not the intent to convey the impression that range animals lay bare the earth in one uninterrupted stretch wherever they go. Many spots are left; but many more are destructively trampled. Certainly the damage is enough to show a great and undoubted retarding influence upon forest regeneration.

ACTUAL AND PROVISIONAL GRAZING LANDS.

Among the vast areas wholly or in part denuded by fire and now variously recovered with aspen and thinly-scattered conifers, all interspersed with stretches of grass and brush land, it may appear difficult to segregate those portions which are properly only grazing lands and those fit only for forest growth. This will be specially difficult if done to the satisfaction of settlers whose herds find subsistence throughout these districts.

There are in the reserve low-lying, brush-covered hills of vast extent, where, very probably, from the nature of conditions, forest trees have never existed and will never exist. Their relationship to and effect upon water flow is generally very remote. They are brush lands of long standing which from their nature can never become agricultural lands and are therefore useful only for grazing.

The succeeding higher levels, which are more or less covered with aspen and scattered conifers, have an unquestionable influence as an auxiliary protection to watersheds. The tree growth is now mostly small, but the position for conservation and protection to water flow is important. The best of feed abounds in these thinly-wooded districts and except where tangled fallen trunks form impassable barriers the grass is always reached at some season by range cattle. By exemption from grazing this forest growth will be improved and extended. It is believed that such areas should be exempted from grazing.

The pure grass lands found along nearly all the larger water courses are such as may be fitly devoted to grazing. Their usually rough and broken surface renders them unfit for agricultural lands. Moreover, the general absence of timber trees in these grassy vales indicates the reluctance, for lack of proper conditions, of spruce and fir to take possession. The very heavy sod effectually prevents further seeding. A scattered growth of willows is the common woody growth, while spruce and fir descend from the surrounding slopes to the edge of the grassy bottom.

These natural grass and brush lands are portions of the reserve which may form permanent ranges for grazing. Their occupation without injury to the adjacent forest land can be effected only by fencing. The requisite rail timber is easily obtained from the abundance of dead trees on burned areas near by. The burden of construction should undoubtedly be undertaken by settlers enjoying grazing rights. In fact, the writer was asked by several settlers in the region of Yampa River if the Government authorities would allow them to fence certain grass lands for hay and pasture. The purpose of these settlers was to secure rights and control to the exclusion of all other parties.

What may be termed provisional grazing lands are comprised in the various high plateaus or "flat tops."

They are extensive grassy plains, sparingly wooded at certain points. The grass is usually abundant and heavy. A large portion of these plains are sufficiently watered to permit cattle to graze the entire season. Other portions are supplied with water for only the first half of the grazing season, so that cattle must be moved as the drier months approach. Still other well-watered grass- and brush-covered portions of these plateaus are so free from timber as to be available for grazing, but are for the most part at too high an elevation. They lie at and above timber line. In the hottest months the air is chilly and moist, such as cattle appear to dislike. Of their own accord they graze much lower down. Bands of elk hold undisputed possession of these flats.

Only a provisional use of these plateau grass lands for grazing is desirable. This may be accomplished by so fencing the grass land as to exclude all animals from the timber and at the same time allow sufficient space near the timber to permit every advance of young growth. Fences standing at 50 to 100 yards from seed trees will protect the possible advance of seedlings for 10 to 20 years. With the need of more room, portions of the fences could be easily shifted.

Clear areas of 200 to 500 or more acres of such land are available, and dead sound fencing timber is almost always to be found at hand. It would seem, therefore, that the necessary fencing to be done by settlers in exchange for grazing rights would be fully repaid. It is evident, moreover, that settlers owning agricultural lands in the vicinity of the reserve should enjoy grazing rights over applicants from distant points with no agricultural interest in the region.

On the whole, a retrenchment upon the present unlimited range privileges of cattle men in this reserve would in some localities occasion little privation, as the range available to them chances to be mostly brush land. Only small inroads are made upon forest cover. The topographical features of some localities also greatly limit the wandering of range animals to well-defined brush regions. In some other cases the area grazed passes more easily from a brush to a forest cover, from which animals could be excluded only by fencing to and from certain naturally impassable points.

VALUE OF BRUSH LANDS TO FOREST COVER.

While the only economic value of brush lands lying contiguous to forest lands in the reserve is for pasture, nevertheless these low, dense covers bear an important relationship to the forests. They form, as it were, a miniature cover to all foothills below the true arborescent growth, and they connect and extend the conservative influence of the latter with the dry sage lands of the lower agricultural districts.

The thickets of oak and service brush, which constitute the bulk of this cover, shade the ground completely, and give a leaf mold comparable with that of a light forest cover. Nutritious grasses grow in the small bare spots among the thickets, as well as among the brush itself. This rigid, hardy brush resists all destructive agencies. The grazing of thousands of cattle has no appreciable effect upon its hardy persistence, and its unyielding stems defy all washing from descending snow waters. No gullying occurs where it is once established, except where roads and trails have been cut through.

Early fires have swept through thousands of acres of this growth lying on the middle courses of nearly all the small mountain streams trending to the principal rivers. The severity of these fires is attested now only in the larger, blackened, dead stems surrounded by impenetrable thickets of new root sprouts. Apparently, for settlers give no information, only surface fires have flourished, there being usually insufficient substantial litter to encourage a deeper fire.

Occasionally, as pointed out elsewhere, this oak produces small arborescent stems which prevail in the rich soil of protected coves and hollows on the general slope, but aside from a few fence posts and fuel derived from these thickets, the wood is of no economic value. Moreover, there is no possibility that these brush lands, even in the most favorable situations, will ever admit and foster any of the other tree species of the region. A sharp line of separation is nearly always observable between the harsh aggressive thickets of oak brush and the insinuating aspen, which is the tree connecting brush lands with the conifers. The rough, rocky nature of this brush land makes it entirely unfit for agricultural purposes. Of necessity, therefore, these brush lands must remain what they are, impregnable, but auxiliary in their ameliorative effects to the forests above them.

It may be urged that since brush lands are unproductive of wood material, they are not properly forest lands, and should, therefore, be excluded from the reserve. A very potent reason, however, for including all brush lands with adjoining forests, is to bring them under the same effective fire service as the forest land. By so doing, the constant danger of fire being communicated to the forests through the brush would be averted, while range privileges of settlers would be in no way interfered with.

UNPATENTED AGRICULTURAL LANDS.

The exact status of agricultural lands occupied and improved by present settlers could not be ascertained without considerable detailed work which was believed to be unwarranted. Small parcels of land, however, appear to remain unsettled, altogether, probably 300 to 400 acres situated on the White River above Pothole Valley, on the South Fork of the White River, and on Miller and Ute creeks. In addition to these, several improved ranches in Pothole Valley, on White River, are said to be occupied by "squatters," parties whose intentions were to "prove up" after filing, but who failing to do so prior to 1891, are in doubt as to whether it can now be done at all. They live in constant fear of being ejected. The ranches on Miller Creek, Elk Creek, and on the head of the West Fork of Williams River were confessedly held without title. Still other recent settlers on the head of Williams River were suspected of being in the same condition.

Considerable improvement has been made on several of those ranches, while in other cases the constant fear of ejection or belief that there will be no future opportunity of securing titles, prove disheartening to their efforts. They are especially anxious for definite information as to the Government's policy toward their claims since the proclamation. To such inquiries the statement was made that the intention of the Government is to make all agricultural land available to settlers.

POSSIBLE REDUCTION OF AREA OF RESERVE.

In the valley of "Little Beaver Creek," within the west border of the reserve, are from 500 to possibly 800 or more acres of unclaimed agricultural land which may well be excluded from the reserve. It consists of sage mesas running up to the extensive brush-covered slopes on the east and south. A somewhat prevailing sentiment of settlers in the vicinity desires the release of this land for occupancy. And since the land is entirely of an agricultural nature, there is no good reason why it should not be made accessible to settlers. At present, however, no water for irrigation is available from streams in the immediate vicinity; but it is said that water could be secured through a high-line ditch from White River. The same ditch would also make available certain parcels of high mesa land on White River, near Beaver Creek.

MINING OPERATIONS.

No active mining operations were found. An old mining camp, called Carbonate, was found on the high plateau about 22 miles due north of Glenwood Springs. The shaft house and a number of log cabins are still in existence, but all were abandoned in 1885. The main shaft was sunk for silver, which was found in insufficient quantities to warrant further operations. The shaft is about 8 feet square, 100 to 125 feet deep, and timbered with 10-inch to 14-inch Engelmann spruce logs derived from the immediate vicinity. The timber cutting incident to these mining operations, which continued less than two years, was mostly of a selective nature, making but little visible impression on the small groups of spruce and fir in the vicinity. No complete clearing was done.

A few prospectors were seen at work in this vicinity testing old gold claims. Their operations involved the cutting of only a small quantity of dead spruce and fir for fuel.

POPULAR SENTIMENT TOWARD THE RESERVE.

Most of the ranch settlers within and near the lines of the reserve are intelligent people, and seem to appreciate the great importance of maintaining a continuous forest cover about the head waters of the streams which supply their ranches with domestic and irrigation water. In fact, the scarcity of water in some of the thickly-settled creek bottoms has impressed the settlers very deeply with the idea of forest preservation. They are also equally alive to the necessity of preventing forest fires. The common opinion is that a supervision of these reserves by the National Government is the most effective means of perpetuating the forests. As already stated, however, most settlers have no rational idea as to what economic use will be made of timber in the reserves. The immediate concern of law-abiding settlers is whether or not they are entitled to dead timber for fuel, fencing, and ranch buildings. Nearly all believe this right to have been denied them when the reserve was proclaimed. In fact, this belief has been spread largely through the reported action of several "timber agents" in the Battlement Mesa Reserve. Settlers are said to have been warned not to cut dead timber of any kind. Generally loth, however, to believe the Government authorities really sanctioned such a procedure, little or no antipathy is expressed against the maintenance of this forest reserve. "Timber agents" are severely censured as acting maliciously or under false impressions of their duty.

Some severe criticisms were heard from settlers as to the wisdom of including land fit for agricultural purposes; the Government's intention of finally excluding all such land from the reserve is entirely unknown to them. It would seem advisable, therefore, that some steps should be taken to popularize the Government policy in respect to the reserve, or at least to inform settlers of the regulations concerning their privileges in the reserve.

BATTLEMENT MESA FOREST RESERVE.

By George B. Sudworth.

GENERAL LOCATION.

The Battlement Mesa Forest Reserve lies south of Grand River, inclosed on the east by Roaring Fork and Crystal River (Rock Creek), on the west by the Lower Gunnison River, and on the south by the North Fork of the latter. The irregular northern boundary of the reserve is distant from Grand River 6 to 20 miles. The eastern boundary lies just to the west of and nearly coincident with the course of Crystal River (Rock Creek), in the region of Sopris Peak and Chair Mountain. The middle course of Gunnison River and its North Fork (west of Coal Creek) lies south of the reserve and is from 2 to 15 miles distant from the southern boundary. The exclusion of the main valley of Hubbard Creek, and also the region about the head waters of Forked Tongue Creek, increases the irregularity of the southern line. The irregular western boundary of the reserve lies to the east of and within the angle formed by the confluence of Gunnison and Grand rivers, the two streams being 6 to 20 miles distant. A deep cutout in this boundary excludes from the reserve the entire valley of Plateau Creek. All the boundary lines of this reserve lie, for the most part, high up in the slopes of the watersheds drained by the streams forming the principal boundaries.

BOUNDARIES.

The boundaries, as established by Executive order of December 24, 1892, are as follows:

Beginning at the northeast corner of township seven (7) south, range ninety-three (93) west of the sixth (6th) principal meridian; thence westerly along the township line between townships six (6) and seven (7) south, to the northwest corner of township seven (7) south, range ninety-three (93) west; thence southerly along the range line between ranges ninety-three (93) and ninety-four (94) west, to the northwest corner of section nineteen (19), township seven (7) south, range ninety-three (93) west; thence westerly along the unsurveyed section line between sections thirteen (13) and twenty-four (24), fourteen (14) and twenty-three (23), fifteen (15) and twenty-two (22), sixteen (16) and twenty-one (21), seventeen (17) and twenty (20) and eighteen (18) and nineteen (19), township seven (7) south, range ninety-four

(94) west, to the northwest corner of section nineteen (19) of said township and range; thence southerly along the range line between ranges ninety-four (94) and ninety-five (95) west, to the northwest corner of township eight (8) south, range ninety-four (94) west; thence westerly along the township line between townships seven (7) and eight (8) south, to the northwest corner of section three (3), township eight (8) south, range ninety-five (95) west; thence southerly along the section line between sections three (3) and four (4), nine (9) and ten (10), and fifteen (15) and sixteen (16), to the northwest corner of section twenty-two (22) of said township and range; thence westerly along the section line between sections sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19) of said township and range, and sections thirteen (13) and twenty-four (24), fourteen (14) and twenty-three (23), and fifteen (15) and twenty-two (22), township eight (8) south, range ninety-six (96) west, to the northwest corner of section twenty-two (22) of said township and range; thence southerly along the section line between sections twenty-one (21) and twenty-two (22), twenty-seven (27) and twenty-eight (28), and thirty-three (33) and thirty-four (34) of said township and range, to the northwest corner of section three (3), township nine (9) south, range ninety-six (96) west; thence westerly along the township line between townships eight (8) and nine (9) south, to the northwest corner of section three (3), township nine (9) south, range ninety-seven (97) west; thence southerly along the section line between sections three (3) and four (4), nine (9) and ten (10), fifteen (15) and sixteen (16), twenty-one (21) and twenty-two (22), twenty-seven (27) and twenty-eight (28), and thirty-three (33) and thirty-four (34), to the southwest corner of section thirty-four (34) of said township and range; thence easterly along the township line between townships nine (9) and ten (10) south, to the southeast corner of township nine (9) south, range ninety-six (96) west; thence northerly along the range line between ranges ninety-five (95) and ninety-six (96) west, to the southeast corner of section thirteen (13), township nine (9) south, range ninety-six (96) west; thence easterly along the section line between sections eighteen (18) and nineteen (19), seventeen (17) and twenty (20), sixteen (16) and twenty-one (21), fifteen (15) and twenty-two, fourteen (14) and twenty-three (23), and thirteen (13) and twenty-four (24), township nine (9) south, range ninety-five (95) west, to the southeast corner of section thirteen (13) of said township and range; thence northerly along the range line between ranges ninety-four (94) and ninety-five (95) west, to the southeast corner of township eight (8) south, range ninety-five (95) west; thence easterly along the township line between townships eight (8) and nine (9) south, to the southwest corner of township eight (8) south, range ninety-two (92) west; thence southerly along the range line between ranges ninety-two (92) and ninety-three (93) west, to the southwest corner of township ten (10) south, range ninety-two (92) west; thence westerly along the second (2nd) correction line south, between townships ten (10) and eleven (11) south, to the northwest corner of township eleven (11) south, range ninety-six (96) west; thence southerly along the range line between ranges ninety-six (96) and ninety-seven (97) west, to the northwest corner of township twelve (12) south, range ninety-six (96) west; thence westerly along the township line between townships eleven (11) and twelve (12) south, to the northwest corner of fractional section two (2), fractional township twelve (12) south, fractional range ninety-eight (98) west; thence southerly along the range line between fractional range ninety-eight (98) west of the sixth (6th) principal meridian, and range two (2) east of the Ute principal meridian, to the southwest corner of fractional section thirty-five (35), fractional township thirteen (13) south, fractional range ninety-eight (98) west of the sixth (6th) principal meridian; thence easterly along the township line between township thirteen (13) and fractional township fourteen (14) south, to the southwest corner of township thirteen (13) south, range ninety-six (96) west; thence southerly along the range line between ranges ninety-six (96) and ninety-seven (97) west to the

southwest corner of township fourteen (14) south, range ninety-six (96) west; thence easterly along the township line between townships fourteen (14) and fifteen (15) south, to the southeast corner of section thirty-three (33), township fourteen (14) south, range ninety-five (95) west; thence northerly along the section line between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4), townships fourteen (14) and thirteen (13) south, range ninety-five (95) west, and sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28) and twenty-one (21) and twenty-two (22), township twelve (12) south, range ninety-five (95) west, to the southeast corner of section sixteen (16) of said township and range; thence easterly along the section line between sections fifteen (15) and twenty-two (22), fourteen (14) and twenty-three (23) and thirteen (13) and twenty-four (24), township twelve (12) south, range ninety-five (95) west, and sections eighteen (18) and nineteen (19), seventeen (17) and twenty (20), sixteen (16) and twenty-one (21), fifteen (15) and twenty-two (22), fourteen (14) and twenty-three (23) and thirteen (13) and twenty-four (24), township twelve (12) south, range ninety-four (94) west, to the southwest corner of section eighteen (18), township twelve (12) south, range ninety-three (93) west; thence southerly along the range line between ranges ninety-three (93) and ninety-four (94) west, to the southwest corner of township twelve (12) south, range ninety-three (93) west; thence easterly along the township line between townships twelve (12) and thirteen (13) south, to the southeast corner of township twelve (12) south, range ninety-two (92) west; thence northerly along the range line between ranges ninety-one (91) and ninety-two (92) west, to the southeast corner of township eleven (11) south, range ninety-two (92) west; thence easterly along the township line between townships eleven (11) and twelve (12) south, to the southwest corner of township eleven (11) south, range ninety (90) west; thence southerly along the range line between ranges ninety (90) and ninety-one (91) west, to the southwest corner of township twelve (12) south, range (90) west; thence easterly along the township line between townships twelve (12) and thirteen (13) south, to the southeast corner of township twelve (12) south, range eighty-nine (89) west; thence northerly along the surveyed and unsurved range line between ranges eighty-eight (88) and eighty-nine (89) west, to the northeast corner of township eleven (11) south, range eighty-nine (89) west; thence easterly along the second (2nd) correction line south, to the southeast corner of township (10) south, range eighty-nine (89) west; thence northerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west, to the northeast corner of township nine (9) south, range eighty-nine (89) west; thence westerly along the township line between townships eight (8) and nine (9) south, to the northeast corner of township nine (9) south, range ninety (90) west; thence northerly along the range line between ranges eighty-nine (89) and ninety (90) west, to the northeast corner of township eight (8) south, range ninety (90) west; thence westerly along the surveyed and unsurveyed township line between townships seven (7) and eight (8) south, to the northeast corner of township eight (8) south, range ninety-three (93) west; thence northerly along the range line between ranges ninety-two (92) and ninety-three (93) west, to the northeast corner of township seven (7) south, range ninety-three (93) west, the place of beginning."

FACILITIES FOR TRAVEL IN THE RESERVE AND MEANS EMPLOYED.

The Denver and Rio Grande Railroad, which follows the course of Grand River from Glenwood to Grand Junction, and from this point along Gunnison River to Delta, affords only a distant approach to the north and west boundaries of the reserve. From points on this road the reserve must be reached by other means of travel. Wagon roads also exist along the above route, and a branch connects, by stage, several post-office points in Plateau Valley with towns in the larger river valleys. Elsewhere in the reserve there are no regular facilities for travel, which must be performed entirely on horseback.

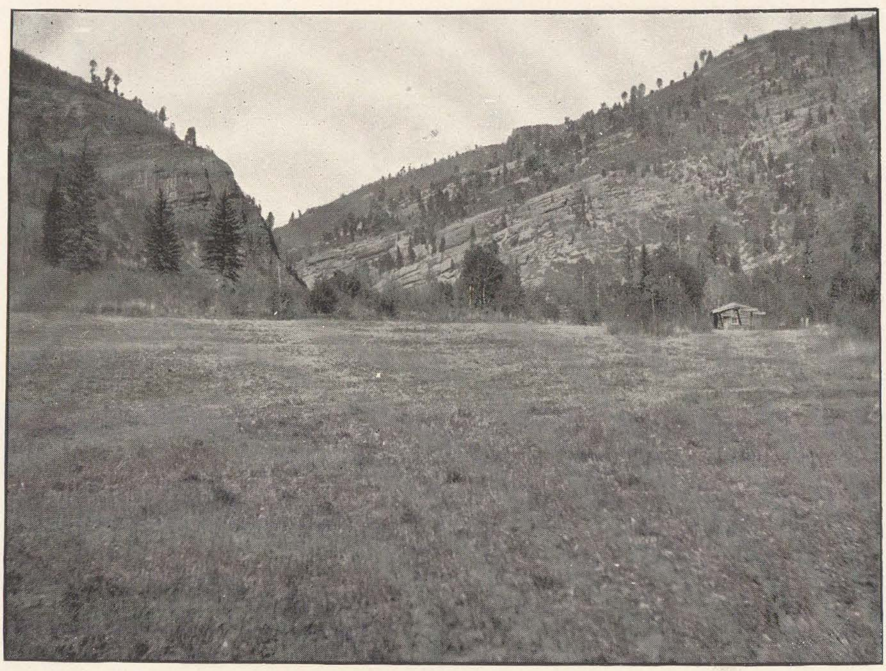
A partly-completed railroad is to connect Crystal River Valley (from Crystal City) with the Grand River Valley roads, chiefly for the purpose of reaching coal beds along Crystal River and similarly rich, adjacent tributary basins.

At present a wagon road from Grand River via Roaring Fork follows the valley and canyon of Crystal River (Pl. LX, *A*). From this road access to the west border of the reserve is gained by trails. The northeast portion of the reserve is reached by a wagon road from Roaring Fork via Fourmile Creek, passing the Sunshine coal mine, which delivers its output by a narrow-gage railroad to points on the Grand River. From the Sunshine mine the main travel is by irregular cattle trails to the valley and head waters of East Divide Creek. Still farther south on the Crystal River wagon road the eastern border of the reserve may next be entered at the mouth of Thompson Creek, thence upstream to the main forks, and then by trail to the head waters of the middle fork (Middle Thompson). Several coal mines have been "worked out" on lower Middle Thompson, the coal having been taken out on a narrow-gage road which was abandoned long ago when the supply of coal ceased. This coal road extends about 2 miles above the confluence of the three head forks of Thompson Creek, and thence to Grand River by the Roaring Fork road.

In the vicinity of Sopris Peak is also a difficult trail reaching upper Middle Thompson Creek, via Perham Creek, a small stream tributary to Crystal River, on the west of Sopris. The next entrance to the east side of the reserve, about 12 miles south of Sopris Peak, is via Coal Creek, also tributary on the west to Crystal River. A private wagon road enters this valley, and extends about 1 mile to the end of the ranch land (Pl. LX, *B*). From here, Coal Basin, the head of this creek, is reached by a trail, in part over a ballasted railroad bed, built by the Colorado Fuel and Iron Company about 1892. The creek penetrates the reserve 16 to 18 miles. It is said the company will shortly complete this road and connect it with the Crystal River Railroad, in order to take out coal from the mine at the head of the creek. The remaining point of access from Crystal River is by trail at a place about 3 miles north of Chair Mountain (Pl. LXII, *B*), entering the great basin formed by the head waters of the North Fork of the Gunnison River. After crossing the high divide on the west of Crystal River, this trail enters the above basin along Clearwater Creek. A short wagon road on the head channel of the Upper Gunnison (called Muddy)

A. CRYSTAL RIVER (ROCK CREEK) CANYON, 3 MILES SOUTH OF MOUTH OF COAL CREEK.

Shows scattered stand of yellow pine partly destroyed by fire.



B. LOWER VALLEY OF COAL CREEK.

Shows characteristic thin stand of yellow pine.

connects a few "cow camps" and one or two hay ranches in the basin; the latter has no outlet, except by trail southward along the Upper Gunnison Canyon to the vicinity of Anthracite Creek, where a wagon road is met following the main lower valley of the Gunnison River. Trails to the north leave the head waters of Muddy Creek and, crossing the divides, enter the head valleys of East and West Divide creeks; trails also run northwestward from Muddy Creek to West Muddy Creek. From a deserted cattle ranch on the head of the latter basin a wagon road follows this stream southward about 7 miles, and then crosses the divide on the west, and enters the head valley of Hubbard Creek. The road runs westward across this broad valley, and skirting low foothills, enters the upper valley of Terror Creek, and, crossing the high mesas to the south, reaches the Gunnison Valley. A sawmill road joins this road on the West Fork of Terror Creek and ascends to the head of the stream.

A cow trail takes the place of the wagon road which leaves West Muddy Creek, and continues downstream until it joins the main trail on the Upper Gunnison. On the south boundary of the reserve, west of the Upper Gunnison trail, there is a trail at the mouth of Terror Creek ascending to the east forks of this creek, and also connecting with the wagon road which crosses Hubbard Creek Basin from the east.

A trail from the head basin of the West Fork of Terror Creek runs westward over the low divide to the valley of Lereaux Creek. From here a wagon road runs southward to the Gunnison River via Lereaux Creek. A difficult and little-used trail runs from the upper valley of Lereaux Creek northwestward to the head waters of Plateau Creek, and soon merges into a wagon road which continues the entire length of Plateau Valley. Westward from the mouth of Lereaux Creek the southern boundary of the reserve is entered again by a wagon road extending from Gunnison River and following Surface Creek northward to its head waters. Crossing the lava rock divide at Leon Lake, this road reaches Plateau Valley via Leon Creek and through Leon Park. From the vicinity of Leon Lake, also, a wagon road goes northwestward and descends into Plateau Valley along Big Creek. This road was built by Plateau Valley ranchmen for the maintenance of reservoirs at the head of Big Creek.

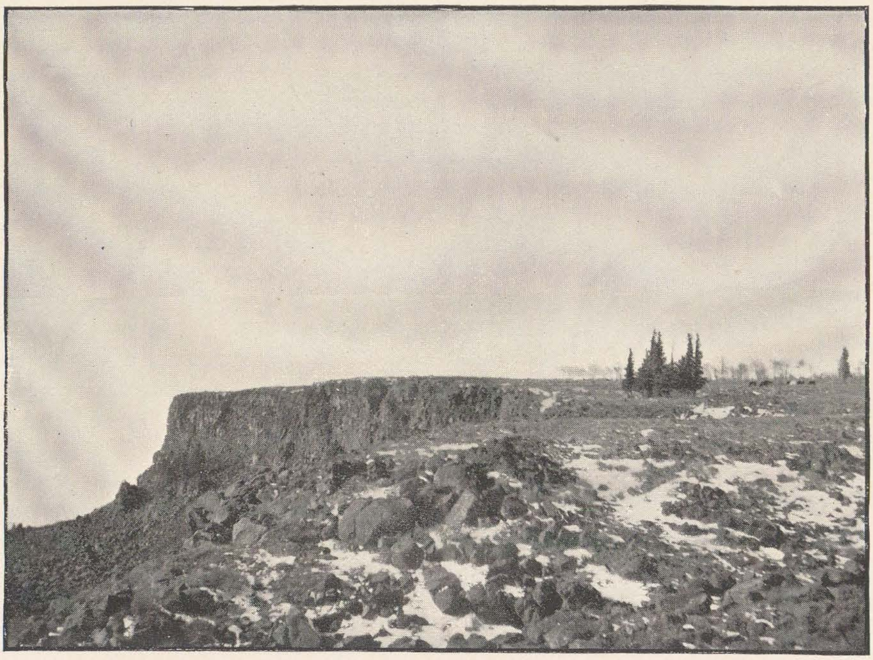
No roads or trails enter the reserve west of Surface Creek; in fact, the precipitous southern rim of Grand Mesa renders further entrance on this side impossible (Pls. LXI, *A* and LXV, *B*). A cattle trail, however, leaves the south prong of Grand Mesa on the north side, near the extremity, and descends into the valley of Kahnah Creek, and thence west to the Lower Gunnison Valley. On the north side of Grand Mesa wood roads are cut out along Mesa and Grove creeks, ascending from Plateau Creek to the north boundary of the reserve on this side (Pl. LXI, *B*).

A trail from the head of Buzzard Creek (connected with the Plateau Valley road) runs northward across the foothills to the east of Battlement Mesa and reaches Grand River via Cache Creek and also by Porcupine Creek. On the north side of Battlement Mesa trails reach the top of the mesa along Wallace, Battlement, and Beaver creeks. The east end of the mesa and foothills are reached by wagon road and trail along North and South Mam creeks. A wagon road extends from Grand River up West Divide Creek to within 2 or 3 miles of the north line of the reserve, from which the head of this creek is reached by cattle trails.

GENERAL TOPOGRAPHIC FEATURES.

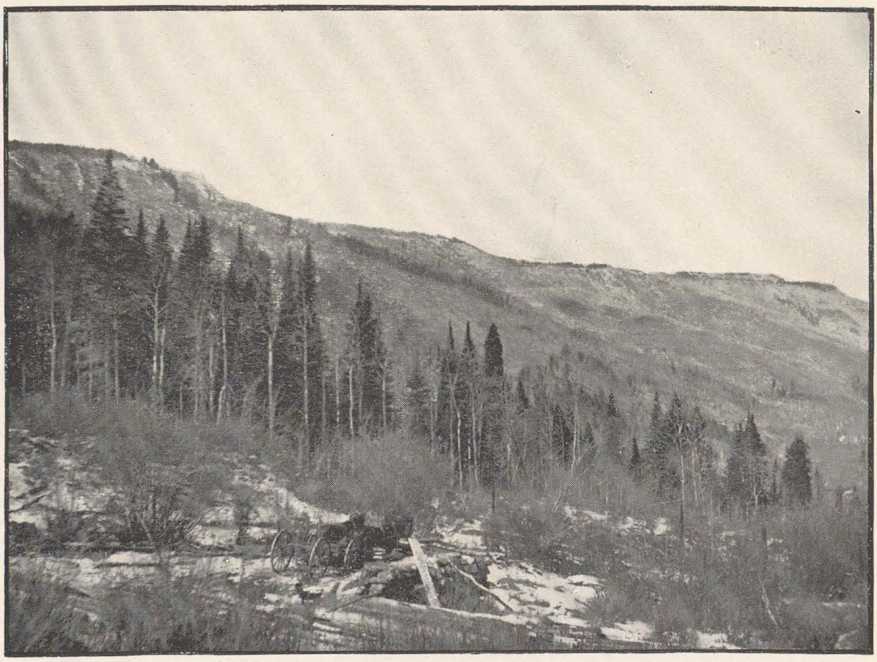
The most salient features in this reserve are the high mesas, known as Grand and Battlement mesas. They rise conspicuously from the valleys of the Grand and Gunnison rivers, presenting their rugged upper outlines in an apparently level plain, and, together with their long slopes of foothills, comprise the western half of this reserve. The approach to these mesas is by a long, often gradual, ascent from the river valleys below over low sage mesas, foothills, and broad benches to within 800 or 1,000 feet of the precipitous lava-rock wall which rises to the irregular rim of the upper plain. Numerous streams spring from beneath this rim and flow through deep gulches and narrow, rocky canyons to the larger streams below. Many beautiful rock-bound lakes are hidden in the deep hollows of the upper branches, some forming the heads of streams and others holding accumulated ice and snow waters in landlocked basins (Pl. LXIII, *B*). The upper levels of these mesas are for the most part long, broad, prairie-like plains, undulating, level, or roughly cut with broad, shallow, rocky gulches and low ridges. Grand Mesa presents a generally more level plain than Battlement Mesa, which rises highest in the center, sloping away gradually to the east and west ends. The former is also conspicuously marked by several high lava peaks projecting 500 to 600 feet above the general level (Pls. LXII, *A* and LXIII, *B*).

The eastern half of the reserve, on the south, is a direct continuation of Grand Mesa, but is broken into high lava ridges, which crown a broad divide between the head waters of streams flowing northward and westward to Grand River and those flowing southward into Gunnison River. As the heads of larger creeks are reached high lines of hills rise between the valleys and join this rocky divide in lateral spurs, forming a more or less connected chain which extends to the eastern border of the reserve, communicating with and ending in the long line of high hills and rugged cliffs on the west side of Crystal River (Pl. LXII, *B*). That portion of the reserve lying east of Battlement Mesa is made up of disconnected, short chains of hills on the middle courses of streams and isolated broad, high hills (Pl. LXXI, *B*). Extensive



A. SOUTH PRONG OF GRAND MESA, LOOKING NORTHWEST.

Distant thin line of trees is aspen growth.



B. NORTH SLOPES OF BATTLEMENT MESA, LOOKING WEST.

Shows partly burnt areas of alpine fir and aspen, from which ranchmen derive timber.

valleys mark the upper courses of the main streams in the eastern part of the reserve, Plateau Valley being the only notable interior valley in the western part.

The reserve is well provided with streams, the flow of which, however, is insufficient to supply water for the surrounding agricultural districts. In several localities the running water falls far short of immediate needs of settlers and is insufficient to develop the large tracts of agricultural lands in the adjoining Grand River Valley, in Plateau Valley, and in the upper basin of the North Fork of Gunnison River. Small parcels of land have been abandoned at various points for lack of water. The principal streams which drain the north and south slopes of Grand and Battlement mesas are largely supplemented in their natural flow by connection with lakes or artificial reservoirs on top or under the rim of the mesas. The head waters of several streams lie in long, low, natural basins, forming depressions in the rim of the mesa and extending back over it for one-half to 2 miles. Earth and rock dams 10 to 15 feet high are thrown across many such basins at the narrowest points, behind which immense quantities of accumulated snow water are held till the stream flow becomes insufficient, when a small head-gate is opened and the flow increased. The volume of landlocked lakes is increased by damming low sides, and the water is made available by connecting such natural reservoirs with some near water way.

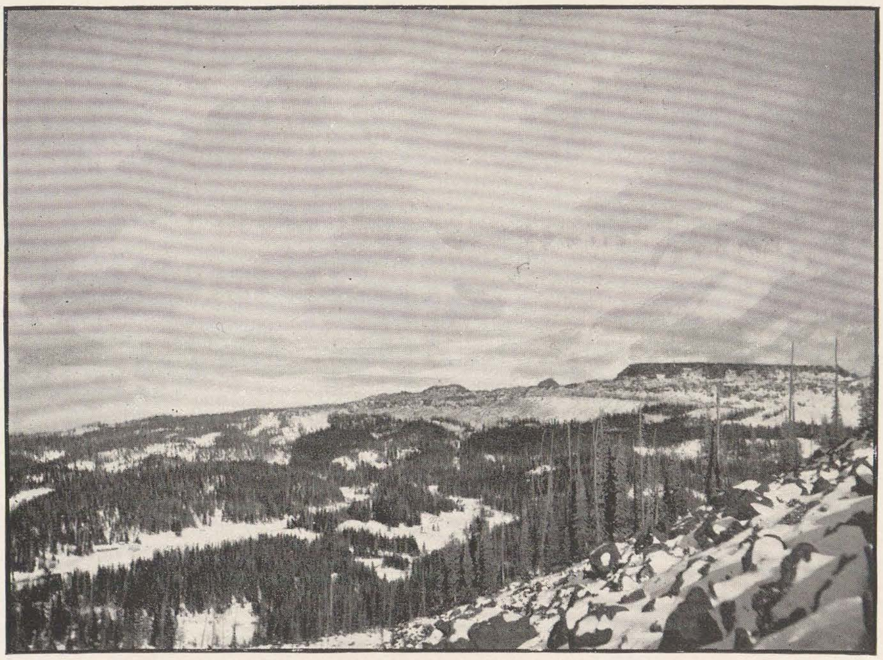
Considerable labor and money are annually expended by ranchmen in the building and maintenance of reservoirs, especially in the region of Grand Mesa and as far east as Lereaux Creek, on the head branches of which there are no less than four or five reservoirs. So-called companies of ranchmen, with mutual water interests, build and maintain these reservoirs. Wagon roads 10 to 20 miles long are sometimes built for the convenience of reaching and maintaining reservoirs. Cabins are also built near reservoir sites for temporary accommodation.

No very large streams are found within this reserve. The largest and most important one near the reserve is Plateau Creek, which drains the south slope of Battlement Mesa and the north slope of Grand Mesa. Its normal width in the broad valley region is 15 to 20 feet, with 8 to 15 inches of water during the summer months. Its many tributary branches are narrow, swift rivulets, from 1 to 3 feet wide, carrying 2 to 6 inches of water. Leon and Park creeks are the largest tributaries received on the south. They carry the drainage from Leon and Park watersheds and from parts of the rocky divide north of Gunnison waters. The lower portion of Leon Creek, 10 to 12 feet wide, with 6 to 10 inches of water, receives the water of Park Creek and descends to Plateau Creek in a narrow, deep canyon, with brushy benches, forming a rolling plateau 50 to 100 feet above the water level. The upper tributaries to these streams are small and rocky, coursing through shallow channels in broad, grassy parks. The principal head branch of Leon Creek receives water from Leon and another adjoining lake, lying immediately north of the lava rock divide between Plateau Creek and Gunnison River (Pl. LXIII, *B*). Other important creeks tributary to Plateau Creek from the north slope of Grand Mesa are Grove Creek, Big Creek, Cottonwood Creek, Bull Creek, and Mesa Creek. All have their head waters among the lava-rock ridges, hollows, marshes, broad benches, and numerous lakes under the rim of the great mesa. These streams vary in width from 4 to 8 feet and in depth from 3 to 6 or more inches. Myriads of tiny spring streams issue from the rocks and deep crevices and unite to form these larger branches, which tumble over bold, rocky ledges or flow silently across marshy benches within grassy and willow-grown banks, and, emerging again with increased volume, hasten with rushing speed down long slopes among bowlders, fragments of rock, and dead trunks. On the lower, gentler slope and among the foothills these streams run through deep, narrow channels with gravelly beds.

Several small creeks, the most important of which is Brush Creek, receive the south-slope waters of Battlement Mesa and empty into Buzzard and Plateau creeks. Many dry canyons and gulches mark this side of the mesa and in spring carry torrents of ice and snow water to the valley lands below. The principal creeks which drain the north slope of Battlement Mesa and flow into Grand River are Wallace Creek, Battlement Creek, Cache Creek, Beaver Creek, and Mam Creek, all similar in size to those described for the north slope of Grand Mesa. They are of the greatest importance to the broad stretches of agricultural land lying at the foot of this mesa and mostly too high above the Grand River water level for irrigation from that source. The waterflow from these creeks, together with that of Divide Creek, which furnishes the principal water supply for the northern side of this reserve, is far too small to meet the development of the large areas of still unclaimed agricultural lands in this region. These creeks deliver but little surplus water into Grand River after the existing irrigation ditches have taken their quotas.

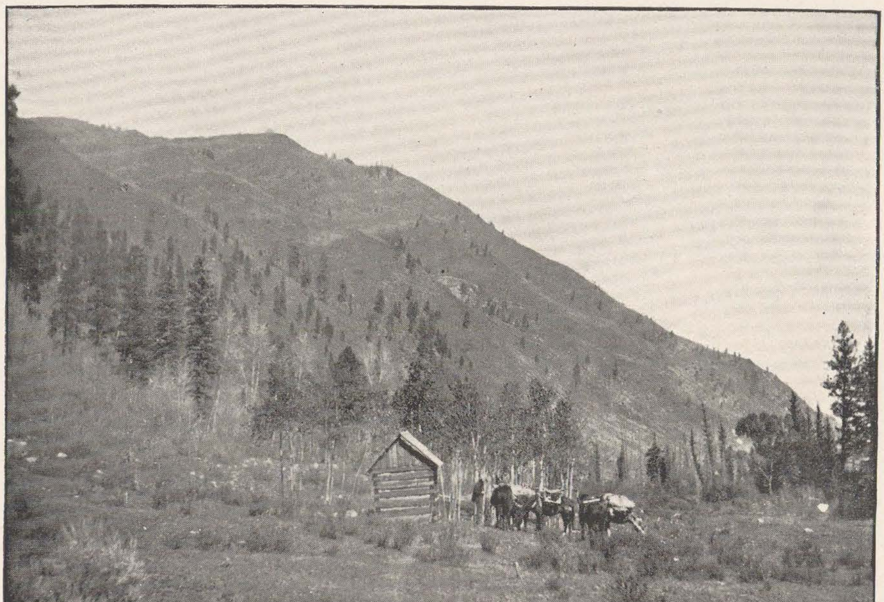
Divide Creek, with its eastern branch (East Divide Creek), is an important stream on the Grand River side, receiving drainage from the northeastern part of the reserve, its source extending southward to the divide on the head waters of the North Fork of Gunnison River. The lower channel carries a stream 12 to 16 feet wide and 6 to 12 inches deep, all of which is consumed by ranches north of the reserve boundary. When seen in September the deep, stony channel contained no running water below the ditch gates except stagnant pools left in the deeply-gullied bends of the stream.

Thompson Creek, a tributary of Crystal River, is about the same size,



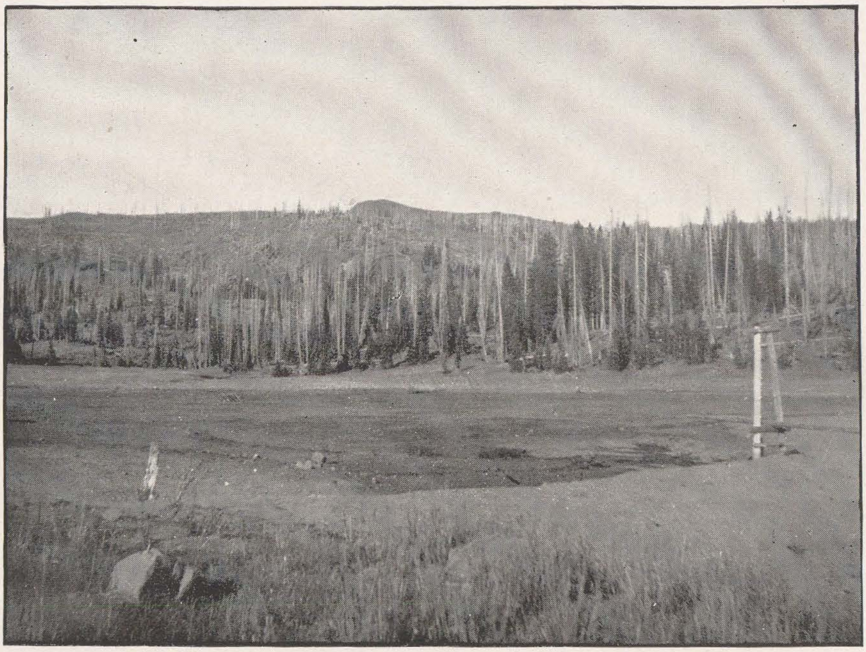
A. SUMMIT OF BATTLEMENT MESA, LOOKING NORTHEAST FROM NEAR HEAD WATERS OF WALLACE CREEK.

Shows Engelmann spruce and alpine fir forests, interspersed with grassy parks—characteristic of region.



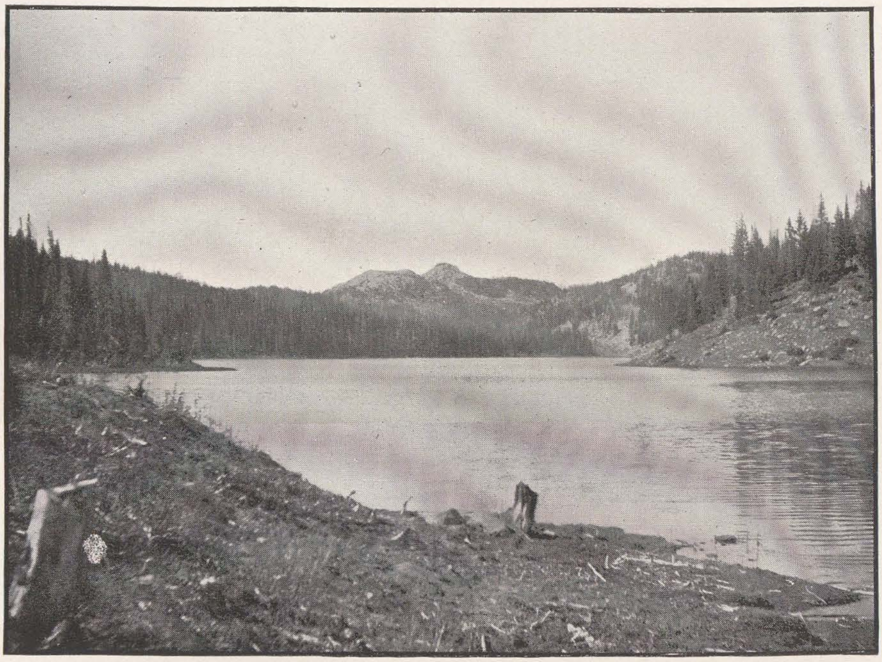
B. EAST SLOPE OF CRYSTAL RIVER (ROCK CREEK) VALLEY NEAR CHAIR MOUNTAIN, LOOKING NORTHWARD.

Shows scattered stand of yellow pine, partly destroyed by fire.



A. HEAD OF LEREAUX CREEK.

Shows Engelmann spruce and alpine fir forest partly destroyed by fire. Head gate of dry reservoir.



B. LAKE AT HEAD OF LEON CREEK.

Shows stunted Engelmann spruce and alpine fir forests about Leon Peak (in distance).

with three large branches penetrating the northeastern border of the reserve and draining all the slopes lying on the east of the head waters of Divide Creek. The three branches flow through deep valleys, above which the intervening benches form a long slope westward up to the divide. None of this water is used for irrigation within the reserve, but some is taken out below. Coal Creek is the next and only remaining stream of size on the east border of the reserve. It is a rather small stream, also emptying into Crystal River, and draining a long, narrow, rocky canyon on its lower course and the high slopes of an open valley about its head waters, which reach the high divide to the east of the head basin of the Upper Gunnison. Its swift waters have cut a very deep channel through yielding sand and coarse gravel along its upper course, as also in the short strip of agricultural land at its mouth. Only a small amount of Coal Creek water is used for the irrigation on this tract of land (Pl. LX, *B*).

The North Fork of Gunnison River, with its western tributary, West Muddy Creek, has the largest water system in the reserve. Its many head branches, exclusive of West Muddy, drain an immensely broad, open basin, 10 to 12 miles long and about 8 miles wide. The main tributaries are, however, small and weak in water, especially where there is available agricultural land. The main channel lies in a level bottom one-half to three-fourths of a mile wide, while most of the tributaries flow through very deep, narrow valleys. The broad tongues of bench land between these streams form a great sloping plain. At the lower end of the valley the main stream enters a narrow, rocky canyon, in which it continues 50 to 100 feet below the rolling slopes above, down to the mouth of West Muddy Creek (Pl. LXIV, *A*). From this point the stream runs in a broader canyon, one-eighth to one-fourth mile wide, with high, steep slopes, until Anthracite Creek is reached, where the river bends sharply to the southwest and continues in a wide valley. At the south boundary of the reserve the North Fork of Gunnison River is 16 to 20 feet wide and 6 to 10 inches deep, with evidence in the wide washing of the stream bed of much greater volume during the spring months.

The wide upper valley of West Muddy Creek and its lower course to the Gunnison are very similar in general appearance to those of the main stream, the amount of water carried being about the same. The two valleys are separated by a high line of hills which at the confluence of the streams merge into rolling benches above the canyons.

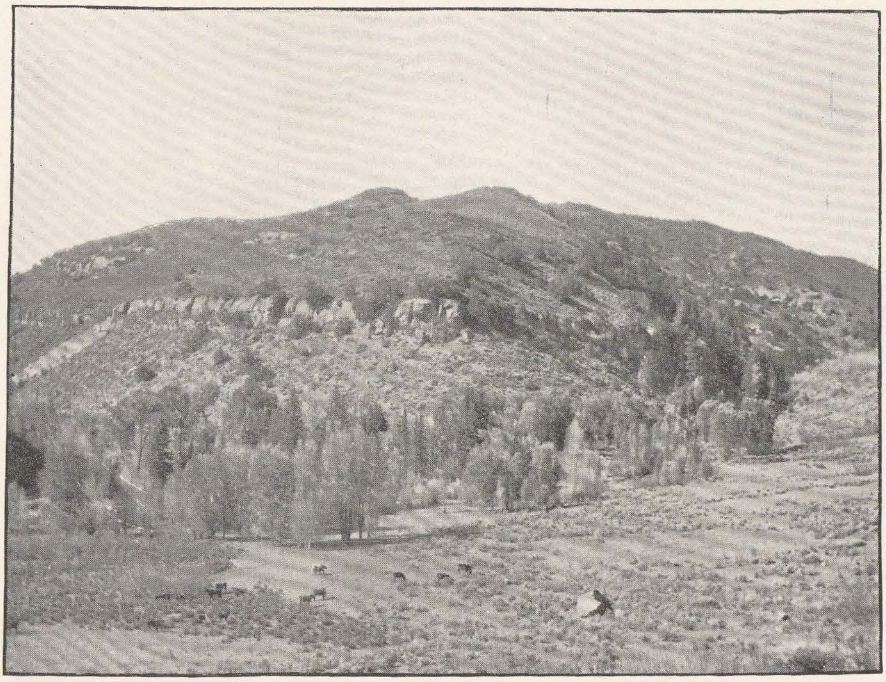
From 15 to 20 miles west of the mouth of Anthracite Creek the southern boundary of the reserve lies high up on the south slope of the North Fork of Gunnison River. For the most part this slope is composed of a steep or precipitous line of stony hills, cut at intervals by deep, narrow, dry gulches, and the far-reaching canyons of several streams (Pl. LXIV, *B*). The perpendicular walls of the canyons through which these streams flow afford but little or a dangerous footing to travelers. Hubbard Creek, which is the first stream of size west of Anthracite Creek, enters the Gunnison through a narrow-walled canyon, from which one would not suspect the existence of a broad valley 12 to 18 miles northward. Above the canyon of this stream, the upper grassy and brush-covered valley is about 10 miles long by 6 miles wide, and is watered by numerous small branches and springs.

For an apparent reason, to be discussed later, the southern boundary of the reserve excludes the greater part of this valley and the canyon of the stream. None of the water is, however, used in this valley for irrigation, but a part is taken out in a high-line ditch within the valley for irrigating high mesa lands, 5 to 6 miles farther east and south of the reserve boundary.

Three miles west of Hubbard Creek is a small stream known as Terror Creek, the head branches of which drain a high basin within the reserve, 4 to 5 miles long by 3 to 4 wide (Pl. LXV, *A*). A part of the water from the east fork of this creek is used for irrigating land lying 1,500 to 2,500 feet above the Gunnison River and south of the reserve, on the west verge of the creek's deep, narrow canyon. Water from the west fork supplies a sawmill and temporary settlement in connection. Otherwise the stream is of no importance, as but little agricultural land of easy development exists within the valley.

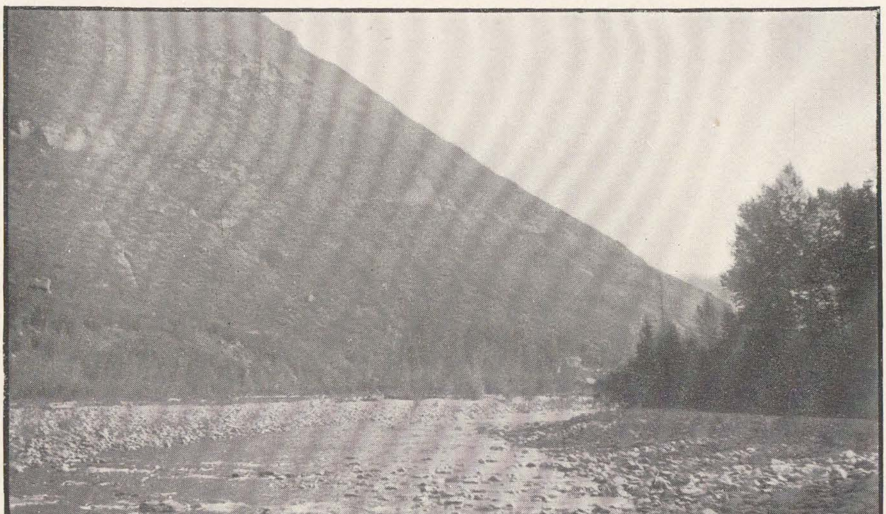
The remaining tributary of the Gunnison which penetrates the reserve on the south is Lereaux Creek, a rapid stream 12 to 16 feet wide, carrying 10 to 14 inches of water. Its head waters lie in a wide, open valley entirely within the reserve, while south of the boundary the stream runs in a deep channel several hundred feet below the sloping benches. At the south edge of the reserve this stream supplies water for a sawmill and small adjoining settlement, but the remaining flow is consumed for irrigating elevated mesas outside the reserve. The maintenance of a water supply is of vital importance to agricultural interests along the lower course of this stream. Late settlers in the region, not being able to secure a water supply from the natural stream flow, have constructed reservoirs on several head branches of Lereaux Creek, thereby accumulating a sufficient supply from the early rush of snow waters on the interior slopes. At present there are five reservoirs located on the head waters of this stream within the reserve (Pl. LXIII, *A*).

Surface Creek and Forked Tongue Creek, which lie 18 or 20 miles west of Lereaux Creek, have their sources within the southern boundary of the reserve on the broad, rocky bench, immediately below the rugged south rim of Grand Mesa. Many of the head branches are directly connected, through little trickling streams, with lakes which abound on this great bench (Pl. LXV, *B*). A few reservoirs are also



A. NORTH FORK OF GUNNISON RIVER JUST BELOW JUNCTION OF WEST MUDDY CREEK.

Grazing land, tree growth, narrow-leaf cottonwood, and blue spruce.



B. NORTH FORK OF GUNNISON RIVER NEAR MOUTH OF COAL CREEK.

Shows treeless south border of Battlement Mesa Reserve.

constructed on the head branches ("The Beavers") of Surface Creek, just below the lava-rock divide west of Leon Peak.

The southwest section of the reserve, comprising the two west arms of Grand Mesa, is drained chiefly by Kahnah Creek and Whitewater Creek, both of which are tributary to the Lower Gunnison. These streams are of great importance to agricultural land below the west boundary of the reserve, and also to a narrow strip of unsettled high mesa land included within the present west boundary. The head waters of Kahnah Creek, the larger and farther-reaching stream, lie almost wholly within the wide and deep canyon formed by the two arms of the mesa. The rugged surface of this interior canyon is made up of main benches 800 to 1,000 feet below the overhanging rims of the mesa, and thence down to the main channel the canyon has rocky, steep slopes, deeply cut by numerous dry gulches and water ways. A low depression at the upper angle of the canyon, between the two arms of the mesa, extends the source of this stream about 2 miles back over the top of the mesa. A wide, deep basin in conjunction contributes large quantities of water to this stream from the top of the mesa. There is a similar depression in the south rim of the north arm of Grand Mesa and a receding basin which delivers water into Whitewater Creek during the spring months, but the channel on the mesa is dry in middle and late summer (Pl. LXVI, *A*).

The water of most small streams within the reserve is pure and sparkling, but as seen in the agricultural districts below, it often becomes highly charged with alkali from the soil. Plateau, Buzzard, Mam, and Divide creeks are notable examples of this contamination. Some of the very small tributary streams which rise below the foothills carry water so full of alkali as to appear like streams of milk, marked along their sandy borders with the white, precipitated alkali.

SETTLEMENTS AND AGRICULTURAL LANDS.

Very little land has been settled within this reserve. The only permanent settlements found consisted of an occupied ranch on the canyon of the North Fork of Gunnison River, about 2 miles below the mouth of West Muddy Creek, and a cattle ranch on an upper west branch of the same river. The lower ranch comprised 80 to 100 acres, and the cattle ranch 200 to 300 acres. The entire valley containing the latter, amounting to probably 400 acres, is fenced for holding cattle, while only the lower portion is otherwise improved.

About 1 mile below the lower ranch mentioned is a settler only recently established. Sixty acres are partially fenced and new cabins erected. There are no signs of previous settlement, so that the present occupant is doubtless a "squatter." Between this parcel of land and the older ranch 1 mile above, is an unimproved block of about 80 acres, fit for ranch land, but claimed to be the property of the settlers above. From the general newness of this older settler's improvements, however, and great visible concern—even fear—betrayed by all the occupants, it is probable that the claim is fictitious.

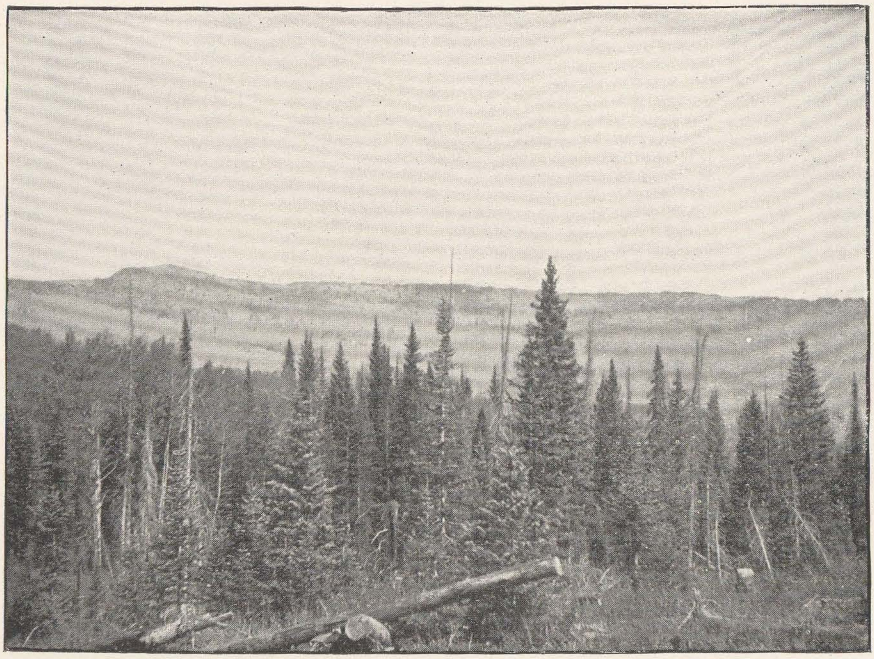
Some agricultural land in other parts of the reserve has been occupied and improved, but is at present abandoned. According to reports received in the vicinity, all such abandoned lands were held only by squatter's right.

Two to 2½ miles above the mouth of Clearwater Creek (tributary of Upper Gunnison) is a tract of good agricultural land, comprising at least 300 to 400 acres. It appears to have been fenced and ditched 10 or 15 years ago, but all is abandoned now, except the cabin maintained as a "cow camp" during the annual cattle "round-ups." The water supply in Clearwater Creek during October seemed to be inadequate for irrigating the available land in this vicinity, but the quantity of water would doubtless be much greater during the early summer months.

An abandoned ranch is situated on West Muddy Creek, about 4 miles below the head of the stream. Fences and buildings, used at present for a "cow camp," remain. From 400 to 500 acres of broken, rolling, or level grass land are available on this stream. Most of this land, however, lies so high as to make irrigation from the main stream impossible. The small head branches of the stream are, moreover, so insufficiently supplied with water that irrigation from these is alike impracticable.

Between 300 and 400 acres of abandoned ranch land were found on the east border of the reserve, near the confluence of the three Thompson creeks. Extensive dilapidated houses and stables remain on the land, together with the remains of irrigating ditches. This tract of land is now entirely under fence for holding several hundred cattle and horses. Aside from the fact that the former occupant's title was probably a "squatter's claim," the present very small supply of water obtainable for this land is a good reason for its remaining unoccupied. The abundant water of Thompson Creek is entirely unavailable for this land except at very great cost of delivery.

A newly-settled, small ranch of 40 or 50 acres was found on the head of Perham Creek (tributary of Crystal River, west of Sopris Peak), but from the few tillable acres and meager water supply it is agriculturally of little account and useful to the occupant chiefly as an abiding place. Many such settlers are found at various out of the way points in the reserve, at each of which a cabin has been built and a small plat of ground cultivated as a garden. The settler spends most of his summer on some distant cattle range earning his winter's "stake," and, in the case of the married settler, the wife is left alone for months to care for the little cabin home or "dugout" in the loneliest of wildnernesses.

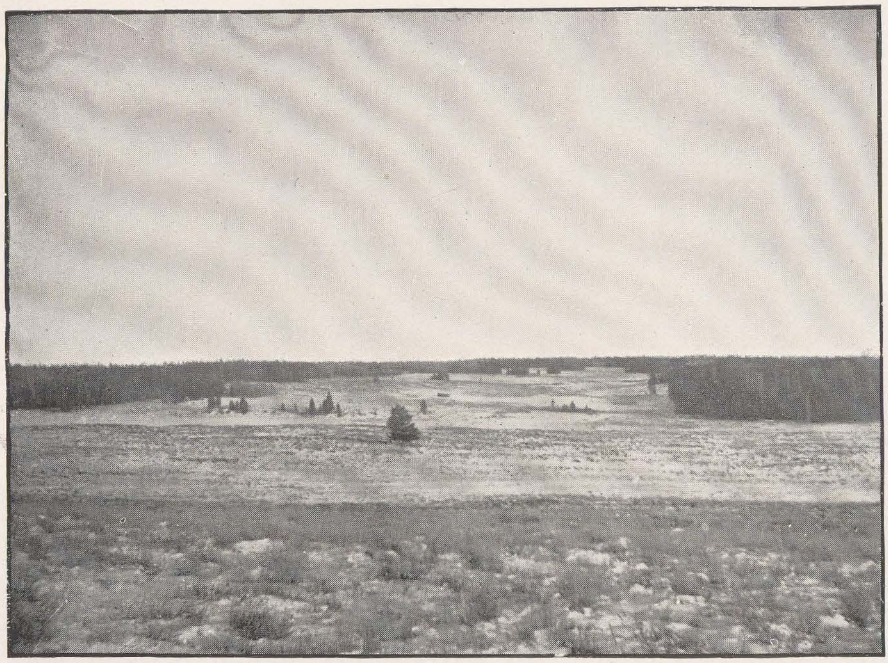


A. HEAD OF TERROR CREEK, LOOKING WEST TO AN ASPEN SLOPE.

Distant gray patches are aspen forests; Engelmann spruce in foreground.

B. VIEW OF SOUTH RIM AND SLOPE OF GRAND MESA.

Shows scattered forests of Engelmann spruce and alpine fir.



A. SUMMIT OF NORTH PRONG OF GRAND MESA

Shows termination of Engelmann spruce and alpine fir forests, succeeded westward by grassy plain.

B. ROCKY MOUNTAIN OAK ON THE HEAD WATERS OF HUBBARD CREEK.

A deserted hay ranch was found on East Divide Creek, near the northern boundary of the reserve. A level mesa of 300 to 400 acres in this vicinity produces a heavy crop of bunch grass which, 7 or 8 years ago, was annually cut for hay by a settler who built cabins, stables, and fences to some extent. A scarcity of hay in coal-mining camps in the region of Fourmile Creek, 12 to 15 miles east of here, afforded a good market. The crop was cut and baled by machinery, remnants of which still exist on the place. The deserted buildings are now kept up as a rendezvous for cattlemen. This land is probably unavailable for permanent settlement on account of the very meager flow of water in East Divide Creek.

Near the mouth of West Muddy Creek, on the south side, is a block of agricultural land, consisting of about 200 acres on a sage mesa. This mesa lies 10 to 25 feet above the creek level, rising gently to the south and west. A "cow camp" is maintained near by, on the north side of the creek, but the mesa seems never to have been settled upon. The soil is of excellent quality, and the general level of the land appears to be within reach of irrigation from the higher waters of West Muddy Creek.

There are several hundred acres of brush-covered benches and gentle slopes, with deep, rich soil, on the west side of Hubbard Creek Basin, which, if cleared, would prove excellent agricultural land. This land lies between the timbered slopes above and the broad grassy bottoms along the main stream. The elevated sources of the principal tributary streams would afford an easily-delivered supply of water. The clearing of these lands would in no sense endanger the conservative power of the brush and timber cover of the contiguous foothills and higher wooded slopes (Pl. LXVI, *B*). Doubtless, however, the great seclusion of this valley and the labor necessary to clear the land will long prevent it from being settled. At most it is likely to be used, as at present, only for grazing.

The occupied ranch of 200 acres lying at the mouth of Coal Creek (tributary of Crystal River) is, as near as could be estimated, mostly east of the reserve boundary. This ranch is interesting, however, in its alleged connection with the entire succeeding part of the canyon and valley, which is within the reserve but said to be owned by the Colorado Fuel and Iron Company, of Denver. The Fuel and Iron Company is said to have control of the ranch land, and with the creek bottom have a basis for exploiting the coal beds at the head of the basin. There are several small parcels of agricultural land in the upper part of this valley, and on benches ranging in size from 40 to 80 or more acres, for all of which it is believed there is sufficient irrigating water in Coal Creek and its tributaries. The railroad bed, which is completed to the mine, cuts up the bottom land badly by crossing and recrossing the valley.

Only one sportsman's resort was found in the reserve. This con sists of a large, double log house and stables built on the east side of Leon Lake (Pl. LXIII, *B*). A small plat of ground, including the buildings, is fenced. The name of the proprietor of this resort could not be learned, the buildings being closed for the season when the writer visited the place. The proprietor is said to have secured control of several small lakes in the vicinity for the purpose of stocking them with trout. The establishment appears to have been in existence five or six years, and furnishes rough accommodations for hunters, fishermen, and health-seeking invalids. The Leon Creek wagon road from Plateau Valley passes this point in crossing the divide.

The agricultural lands, described variously as settled, abandoned, and available, comprise all lands in the reserve likely to be permanently tenable for agricultural purposes. As pointed out in the remarks upon these lands, the scarcity of water supply for several tracts will make their full utilization problematical. There is, moreover, evidence that the insufficient water supply is growing less, and is likely to continue to diminish unless the land is protected from grazing, and especially from fire on the heads of streams near these lands.

A few parcels of grass land, fit in physical properties to become agricultural lands, have been omitted from consideration because of the impossibility of securing irrigating water for them. Several such areas lie on the extreme head waters of streams whose flow ceases with the disappearance of the snow, only the lower courses containing water throughout the year. A full representation, however, of all such lands has been made on the accompanying map (Pl. LIX), under the head of grass lands.

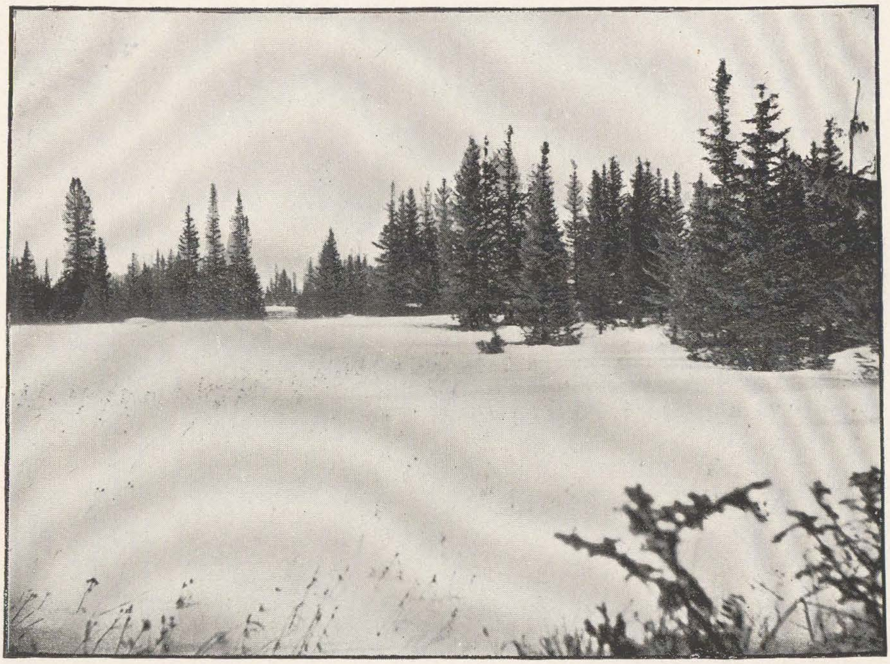
The general character of the soil in agricultural lands comprised in sage mesas is, for the most part, a deep sandy loam of light-brown color, with occasional admixtures of gravel. A few of the interior valley lands bear a deep, rich, dark-brown, mucky soil with sand and gravel, while the grass lands have yellowish, sandy, and gravelly loam soils.

The extremely remote situation of the small amount of available agricultural land within this reserve doubtless has been, and will be, a discouragement to its settlement. Moreover, this land is so isolated in small tracts as to prevent the formation of extensive settlements within the reserve.

TIMBER-BEARING REGIONS.

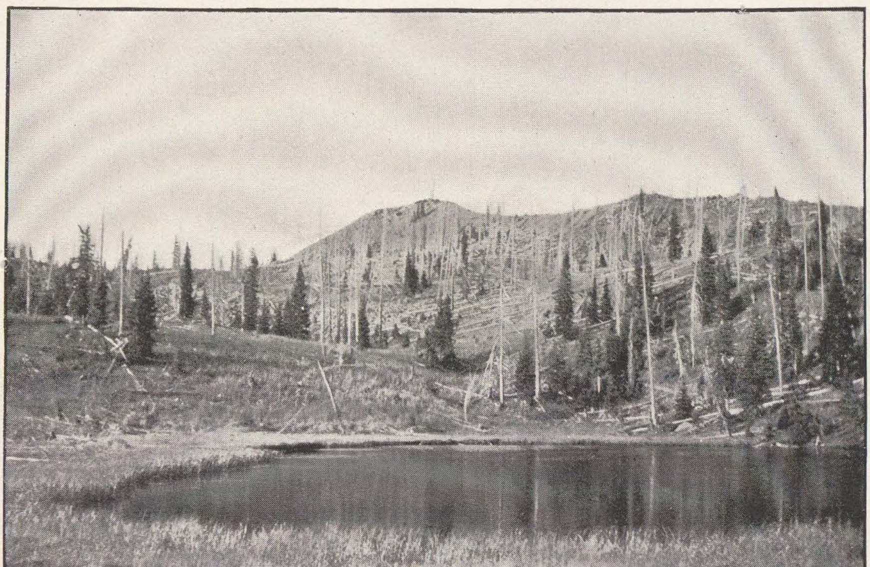
GENERAL REMARKS.

The same general features of disposition are common to the timber of this reserve as are noted for the White River Reserve. In fact, the topographical features of the two regions are strangely similar, differing only in minor details. The elevated plain-like surfaces of the



A. ENGELMANN SPRUCE AND ALPINE FIR ON SUMMIT OF SOUTHWEST PRONG OF GRAND MESA.

Shows characteristic open stand of timber; trees stunted by high winds.



B. HEAD WATERS OF LEREAUX CREEK.

Partly burnt forest of Engelmann spruce and alpine fir, showing slow reproduction.

two great mesas are similar in all respects to those found on the high plateaus of the White River Reserve, and the disposition of forest growth is of the same type; the only difference lies in the specific character of the stand. The same species are characteristic of the higher and lower timber levels of both reserves, and the highest elevations at which timber is found in both are practically identical (Pls. XLIX, *A*; LXII, *A*; and LXVII, *A*). The greater density of timber growth found on all the watersheds of the White River region has its parallel in similar situations in the Battlement Mesa Reserve; the relatively greater density of timber on northern, northeastern, and, in a less degree, on northwestern slopes is also true of this region. This reserve is very poorly stocked with commercial timber, being entirely outclassed in present productiveness by the more northern reserve. On the other hand, the Battlement Mesa Reserve has a forest cover on nearly all of its watersheds that may be regarded as effective and which, with adequate protection, will increase yearly in conservative power.

As shown on the accompanying map (Pl. LIX), the regions having the greatest area of timber are confined to the upper surfaces of the great mesas and the broad bench levels immediately below their rims, including also the high, rocky divide and the spurs and high parks which extend eastward from Grand Mesa. From these levels there are smaller extensions of timber about all the principal streams down to an altitude of about 9,000 feet, with scattered tree growths confined to creek and canyon bottoms down to 6,000 feet elevation, besides junipers and piñon-pine growth of lower elevation. A few isolated high hills and detached ridges in the region of upper broad valleys bear patches of timber on their northern and northeastern slopes and are peculiarly bare of coniferous growth on the opposite sides.

TIMBER AND OTHER TREE SPECIES.

The following list of coniferous species comprises all the commercial timbers found in the reserve, and with the exception of the lodgepole pine, the list is identical in species with that of the White River Reserve, and nearly so in the order of greatest abundance. The lodgepole pine appears not to exist in this region, as a careful search did not reveal it in any part of the reserve. The red fir is more abundant here than in the White River Reserve.

Engelmann spruce	Picea engelmanni Engelm.
Alpine fir	Abies lasiocarpa (Hook.) Nutt.
Red fir	Pseudotsuga taxifolia (Poir.) Britt.
Blue spruce	Picea parryana (André) Parry.
Yellow pine	Pinus ponderosa scopulorum Engelm.
One-seed juniper	Juniperus monosperma.
Piñon pine	Pinus edulis Engelm.
Rocky Mountain juniper	Juniperus scopulorum Sarg.

The deciduous species represented are, with the possible exception of the aspen, without commercial value and only a few are fit for domestic use. For the most part they are little known and usually designated as brush, including even the Rocky Mountain oak, so conspicuously arborescent in portions of this reserve. The list is arranged in order of greatest abundance.

Aspen	Populus tremuloides Linn.
Rocky Mountain oak	Quercus undulata Torr.
Western service berry	Amelanchier alnifolia Nutt.
Narrow-leaf cottonwood	Populus angustifolia James.
Paper-leaf alder	Alnus tenuifolia Nutt.
Dwarf maple	Acer glabrum Torr.
Western chokecherry	Prunus demissa (Nutt.) Walp.
Box elder	Acer negundo Linn.
Mountain mahogany	Cercocarpus ledifolius Nutt.

DISTRIBUTION AND CHARACTER OF CONIFEROUS SPECIES.

ENGELMANN SPRUCE AND ALPINE FIR.

The Engelmann spruce and its inseparable associate, the alpine fir, are the most conspicuous and abundant timber trees in the reserve, and cover the largest areas. In composition the spruce forms 70 to 75 per cent of the entire stand, where only the two kinds are represented. The range of these species is between 8,000 and 10,500 feet in elevation. The bulk of representative growth lies between 8,000 and 10,000 feet, while extra limital forms extend to the higher altitude, chiefly along the lava divide to the east of Grand Mesa, about the lava peaks on Battlement Mesa, and at similar points on the head waters of Coal and Lereaux creeks (Pl. LXVII, *B*). Toward the lower limit of altitudinal range the spruce and fir is often interspersed with small bodies of aspen (Pl. LXVIII, *A*), or in some places the three species are more or less equally mingled. Generally, however, the fir is the more abundant conifer in mixture with aspen, and very often, indeed, the only one.

In a few localities on the rocky benches below the rim of Grand Mesa, Engelmann spruce and alpine fir are mingled with red fir; this is especially marked in Kahnah Creek Canyon and on the middle course of Grove Creek and Big Creek.

The characteristic disposition of individual trees in the sections covered by Engelmann spruce and alpine fir is in no way different from that described for the White River Plateau Reserve, the description for which applies very accurately to these species as found in the Battlement Mesa Reserve.

The entire upper surface of Battlement Mesa east of the head waters of Wallace Creek was originally covered with Engelmann spruce and alpine fir in scattered bodies, interspersed with grassy "parks." West of Wallace Creek, the broad, gently sloping surface of the mesa is a

A. HEAD OF EAST DIVIDE CREEK.

Mixed forest of Engelmann spruce, alpine fir, and aspen.

B. ENGELMANN SPRUCE AND ALPINE FIR FOREST ON EAST END OF GRAND MESA.

Shows characteristic stand of dead timber peculiar to region.

grassy, treeless park, but with spruce and alpine fir approaching the edge of the park land from benches below. West of this park land the mesa is broken into rocky ridges, with small patches of spruce and fir clinging to the northeastern sides of gulches. Still farther westward the craggy foothills are covered with brush and aspen, and low down with juniper. The original growth of spruce and fir near the east end of the mesa has been nearly all swept off by an old fire, comprising an area beginning about 1 mile west of the Mam peaks and running eastward to Beaver Creek Canyon, varying in width from 1½ to 2½ miles (Pl. LXXIII, *B*). The timber on all the creek canyons cutting the rim of the mesa in this region remains intact, mostly in small, closely-associated groups, at a distance appearing like a continuous growth. From the lava ridges at the east end of Grand Mesa the spruce and fir extend westward to about the middle of the mesa, in somewhat closely-disposed groups (Pl. LXVIII, *B*), but thence to a point about 1 mile west of the head of Kahnah Creek Canyon on the south arm of the mesa, it occurs in widely scattered groups, with intervening parks of 200 to 300 acres. From this vicinity westward to the end of the arm, the timber ceases and is succeeded by a grassy plain (Pl. LXIX, *A*). In like manner the timber on the middle of the mesa continues westward on the north arm till the sink is reached at the head of Whitewater Creek, where spruce and fir growth ceases entirely (Pl. LXVI, *A*), and the remaining area is a broad, slightly-rolling, grassy plain, in every respect similar to the south arm.

The small size of the spruce and fir on Battlement Mesa and throughout the upper plain and watersheds of Grand Mesa is striking. Nor is this character of the timber materially different along the high rocky ridges and lower benches, which extend to the valley and canyons of Crystal River. The trees which struggle up from the lower wooded levels and find lodgement in the rough lava-rock slides at the top of this divide and about the peaks of Battlement Mesa appear in very thin stands and much reduced in size, but vigorously persistent. A similar but more storm-beaten growth of the same species is seen along the rocky verge of the western and southern rim of Grand Mesa, adjacent to the bare plain region (Pl. LXI, *A*).

There appears to be a constant difference between the form of spruce timber in the high plain regions and exposed slopes and that grown in more or less continuous stands in protected coves and on watersheds. The form of timber on the upper levels is conical (Pl. LXIX, *B*), while that in protected situations is much more cylindrical (Pl. LXX, *A*). The more rapid taper gives a decrease of 3 to 4 inches in diameter for every 16 feet in length, as compared with about 2 inches in the case of the more cylindrical form. The timber of watersheds is, therefore, more desirable for commercial purposes. Necessarily, also, the trees of open growth in exposed regions bear thickly-set, large limbs down to the ground, greatly reducing the lumber value. The timber of watersheds, being in a closer stand, bears fewer and more slender limbs, but usually down to the ground.

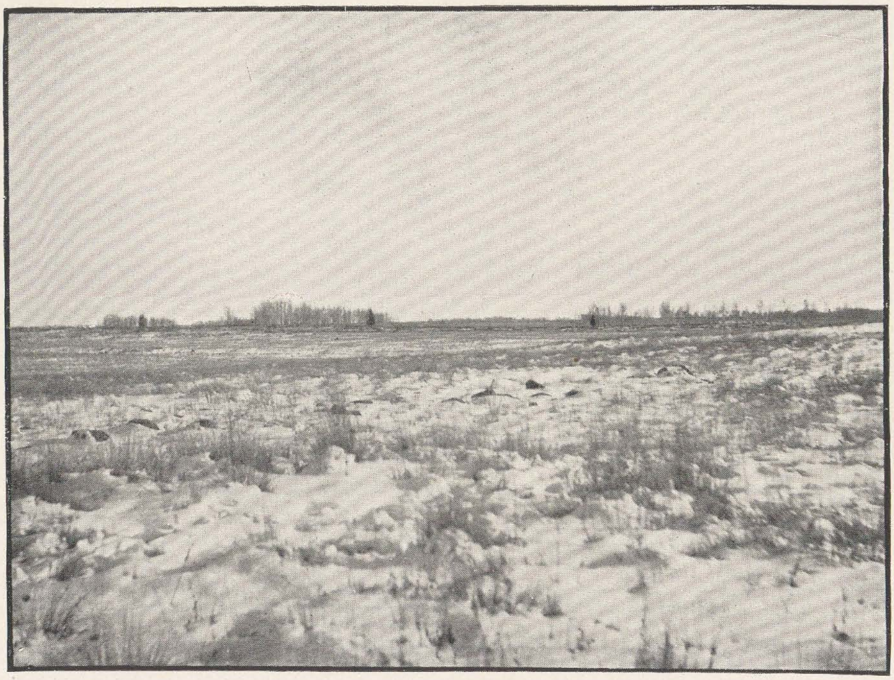
The soils where spruce and fir grow vary in composition from those with sand, coarse gravel, and a deep humus, along water courses and other similar localities, to thin, gravelly soils of the benches and summits of the mesas. The spruce and fir of this reserve exist under the same widely-differing soil conditions as those observed in the White River region. The trees are at home alike in a loose, rich, moist soil or in one of the poorest and driest kind. Indeed, it does not appear difficult for these species to establish a growth even on the shelving beds of bare lava rock.

Almost no difference is observable between the diameter development of spruce timber on the richer soils and that produced on dry sand and gravel. Greater height and better form for commercial timber are, however, always found in the moister, richer soils. From 40 to 60 feet in height and 6 to 14 inches in diameter are the extremes reached by spruce throughout the region. The common diameter growth is from 8 to 12 inches, with a height of about 40 feet. The age of such timber ranges from 160 to 180 years.

The figures given for the size development of spruce apply closely to alpine fir. As a rule, though, the fir reaches a greater height (40 to 70 feet) than the spruce, and under all conditions preserves a more uniformly tapering trunk, except on very exposed, wind-swept cliffs, where the trunk becomes highly conical. The age of fir ranges from 140 years to 170 years. Trees standing on bold cliffs may be only 8 to 12 feet in height and 3 to 6 inches in diameter, but are 80 to 100 years old.

The reproduction of spruce and fir is everywhere observable outside of burned districts. This young growth is from 2 to 4 feet high near groups of old trees, and shows a steady advance into the open grassy parks of from 4 to 20 feet. These seedlings and saplings are 5 to 15 years old. The seedlings establish themselves more thickly along north borders and immediately under the protecting branches of the mother trees. The small protected openings in large groups of trees nearly always show advanced reproduction. In some places the complete covering of such openings or the joining of two near groups of spruce and fir is plainly visible as the result of persistent seeding.

The season of 1897 was apparently a copious seed year for the spruce of this region, but no young seedlings were to be found in the vicinity of the mother trees. The fir bears seed, more or less, annually throughout the region, but much less abundantly than its congener. Young seedlings of this species are also exceedingly rare, especially in the "park" regions. Only a few were seen in the log and rock-strewn



A. SUMMIT OF SOUTH PRONG OF GRAND MESA.

Treeless, except scattered patches of aspen and solitary alpine fir.

B. SUMMIT OF NORTH END OF SLIDE MOUNTAIN.

Partly burnt forest of Engelmann spruce and alpine fir; dead trees show rapid taper of trunks, due to high winds.

gulches and deep hollows, where the older timber appears in open, continuous stands.

The remaining coniferous timber species to be considered are of comparatively small commercial value. They occur only in limited quantities and are so confined to certain soil conditions or exposure as to form but small additions to the more abundant and more widely-adaptive Engelmann spruce and alpine fir.

RED FIR.

The red fir occurs in small patches at various points just below the north and south rims of Battlement Mesa. A few isolated small bodies were also found on the steep sides of the higher foothills at the east end of this mesa (Pl. LXX, *B*). It occurs, similarly, on the north middle slope of Grand Mesa and is more widely dispersed in a scattered stand over the rough lava-rock benches and steeps in Kahnah Creek Canyon; thence it extends around the extremity of the south arm of the mesa to similar benches under the south rim of the plateau, spreading eastward over this rock-strewn surface for 3 or 4 miles from the west end of the mesa. Short, thin lines of stunted trees are also found on the upper south edge of this mesa, above the lower growth.

A few scattered groups are to be found on the canyon of the Upper Gunnison, 1 to 2 miles south of the mouth of West Muddy Creek, growing on small benches and in dry gulches.

Occasional trees and small groups of a dozen or more trees are met with on the steep slopes of several tributary creeks on the west side of Muddy Creek and also in the creek canyons and dry gulches which cut the south slope of the Upper Gunnison along the southern boundary of the reserve. The occurrence of these often greatly-isolated groups and single trees is very peculiar, since the trees of different stations are so widely separated as to have no visible connection in their origin. Several miles often intervene between a half-dozen trees on the steep side of a rocky gulch and the next single tree in a similar position.

The three branches of Thompson Creek once bore a dense stand of this species on the steep slopes of the stream, extending from the narrow creek bottoms to the upper edge of the canyons, 200 to 300 feet above, where it was mingled with the Engelmann spruce and alpine fir. An old fire has, however, killed most of this timber, leaving only a few widely-scattered seed trees throughout the burn. This red-fir growth extended from the junction of the three streams up the narrow canyons for 2 or 3 miles, where it is replaced by the spruce and fir of higher elevation. The lower, narrow, rocky canyon of Coal Creek, tributary of Crystal River, also has a scattered growth of red fir for about 3 miles up the stream.

There are a few adjacent, outlying stations for this species near the reserve. It occurs on the rugged sandstone ledges of Crystal River

Canyon, above the mouth of Perham Creek, where small but vigorous trees are thickly set in every crevice from the bottom of the canyon to the crest of the upper cliffs. It is found also in the Grand River region, where the great south wall of Book Cliffs shows isolated patches of this fir clinging to the numerous northern and eastern faces of rifts and channels along the upper border of the cliff.

Very little useful timber is available in the area described, and that in only small bodies. The most accessible and notable bodies are on the north sides of Grand Mesa and Battlement Mesa. On Grand Mesa the region of Big Creek affords a few groves on the eastern and northern faces of gulches and the deep channels of the creeks which cut the edge of the upper broad bench level. Similarly, on Battlement Mesa, the region of Wallace Creek has a few groves. The stands are usually dense, consisting of one-half to several acres, but more or less mingled with alpine fir and Engelmann spruce on the upper borders of the groves.

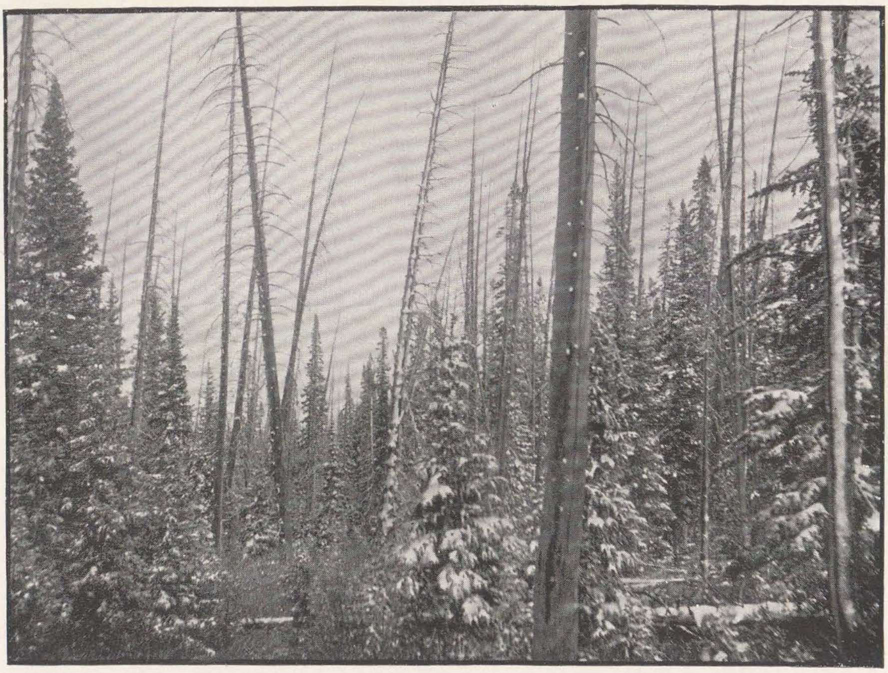
The altitudinal range of red fir in this reserve is from 6,500 to 9,800 feet, the main growth occurring at elevations between 7,000 and 8,000 feet. At the extremes the growth consists chiefly of straggling individuals, and at the highest elevations the growth is very much gnarled and stunted, but persistent.

The size of red fir is from 10 to 30 inches in diameter, but commonly from 10 to 16 inches, with a height of 30 to 65 feet. Under the most favorable conditions, in dense, pure growth, the trees range from 60 to 100 to the acre, while on bare, rocky benches the trees are much scattered, numbering only 25 to 40 to the acre.

Reproduction of red fir appears to be progressing, especially in the vicinity of open stands, where there are numerous seedlings 6 to 20 inches high, as well as small saplings. The dense bodies show but little reseeding in their midst or little advance from the borders through the aggressive aspen, which commonly surrounds the thick stands of red fir. Apparently the reproduction of this species is limited by certain degrees of shade, the extreme density observed for this region being about 100 standards to the acre, under which no further seeding takes place, while it goes forward rapidly wherever this stand is thinned by cutting or otherwise.

BLUE SPRUCE.

The blue spruce occurs only near and on water courses, also in the bottoms of canyons and connected dry gulches, between the altitudes of 6,800 and 8,500 feet. It is found frequently on all the tributaries of the North Fork of Gunnison River, also on the east and west branches of Divide Creek and Coal Creek. It occurs less commonly on Thompson, Hubbard, and Terror creeks, and was not seen at all in Plateau Valley. The most abundant stand once existed in the upper, narrow valley of



A. ENGELMANN SPRUCE AND ALPINE FIR ON HEAD WATERS OF HUBBARD CREEK.

Shows large percentage of dead timber peculiar to region; dead trunks show small taper of timber in protected situations.

B. RED FIR IN VALLEY OF NORTH MAM CREEK, NEAR HEAD OF BATTLEMENT MESA.

Coal Creek, but this timber has been mostly cut out for ties (Pl. LXXI, *A*). As seen on the head waters of the Upper Gunnison and of Divide Creek, it occurs in scattered groups of a few individuals or in thin lines bordering the low banks of the streams, but appears regularly throughout its altitudinal range (Pl. LIV, *B*). At a few stations on West Muddy Creek it leaves the creek bottom and is scattered over the grassy benches 50 feet above, or forms small groups of one-half to 1 acre on steep, sandy or gravelly banks 100 to 200 yards away from the stream. At its upper limit of growth the blue spruce is sometimes mingled with Engelmann spruce, and in its lower range it is associated with narrow-leaf cottonwood and willow brush at the water's edge (Pl. LXXI, *B*).

The soil where these trees grow varies from the moist, loose sand and gravel along the banks of streams to the richer dry, sandy loam of adjacent benches or the poor, gravelly, and stony soil of low, steep slopes.

The seed production of this species is most abundant, but very little reproduction was seen. Occasionally widely-scattered young trees, 3 to 4 feet high, were found near the old trees, but no small seedlings. The moisture conditions for germination appear to be excellent in the vicinity of streams, where, in the month of August, the mature trees annually disseminate millions of seed, yet seedlings under 1 foot are rarely found.

The blue spruce is a large tree in this region, the usual diameter being 12 to 30, and, exceptionally, 40 inches, with a height of 75 to 90 feet.

YELLOW PINE.

The yellow pine of this reserve is of little forest value, on account of its very limited occurrence. Likewise, it has little commercial importance at present, owing to the remoteness of the small supply of useful timber from other more plentiful species with which it could be lumbered. It occurs sparingly only in the canyons.

The only notable growth of this pine in the reserve was found on the steep, west slope of the Upper Gunnison River Canyon, about 2 miles south of the mouth of West Muddy Creek, and consisted of 20 to 25 acres. The stand is very dense for this species, the trees being 8, 10, 15, and 20 feet apart. This growth extends down the canyon to the great bend where the river turns sharply to the southwest. The pine found in this canyon is doubtless only a northern extension of the former more abundant growth in the lower river valley south of the reserve. A few scattering trees grow in the deep narrow canyons of Terror and Hubbard creeks, and also on the sloping red sandstone sides of Coal Creek Canyon (Pl. LX, *B*). There is also a thin, often widely-scattered stand on the east slope and rocky ledges of Crystal River, chiefly above the mouth of Coal Creek. The trees occur at long intervals, and have been greatly thinned in numbers by numerous fires (Pls. LX, *A* and LXII, *B*). In Thompson Creek Canyon there is now only a trace of the former abundance of this pine seen in a scattered growth extending as far up as the junction of the three head branches.

The range of this pine in altitude is from 6,200 to 7,200 feet. On Crystal River a few trees reach the exceptional altitude of 8,000 feet. The most abundant growth, however, occurs between 6,500 and 7,000 feet.

The size attained is 14 to 38 inches in diameter, with occasional trees 40 to 45 inches; height, 50 to 75 feet. In either an open or a rather close stand the trunks are uniformly clear of branches for 18 to 25 feet.

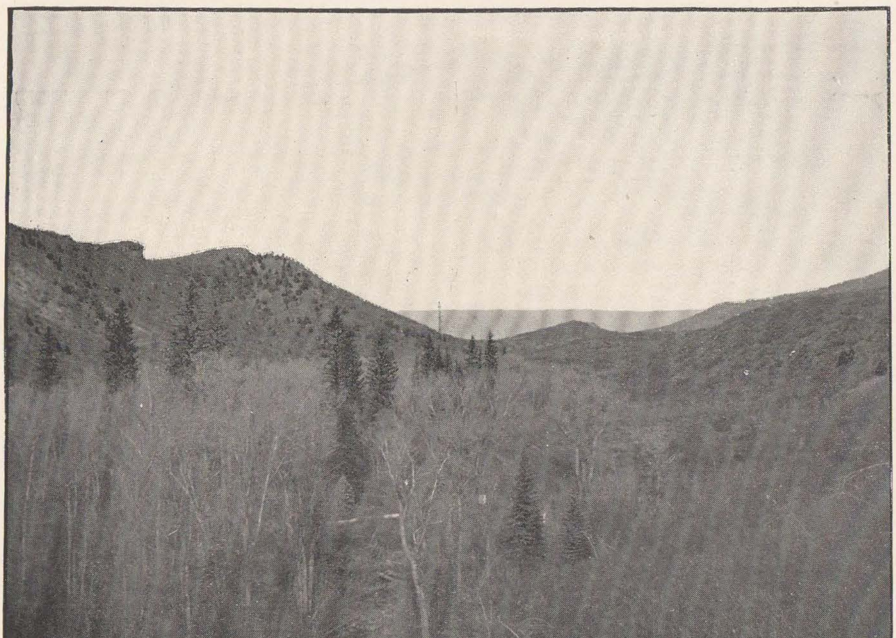
The reproduction of yellow pine in the reserve is hardly to be noticed. The trees bear seed more or less abundantly, but very few seedlings were found among the widely-spaced old trees. Doubtless the generally unfavorable condition of the surface—dry, unbroken, and thickly covered with grass—has much to do with this failure. In support of this a singular instance observed on the Upper Gunnison Canyon shows how prolific the species may be when soil conditions are fit for receiving the seed. A group of old, seed-bearing pines, with heavy grass about them, appeared to have failed to establish a single seedling until a landslide left freshly-exposed earth immediately to one side of the group. This bare earth is now bristling with a dense stand of young yellow pines, 1 to 3 feet high, as the result of at least two crops of seed sown under favorable conditions.

ONE-SEED JUNIPER.

The one-seed juniper occurs abundantly on all the foothills, sharp retreating ridges, and connected lower sloping mesas about Battlement Mesa. But little of this growth, however, is included in the reserve except that on the long line of ridges which form the declining western extremity of the mesa, where this juniper constitutes the only tree growth. The broad belt of juniper lying on the north side of the mesa in the Grand River Valley is almost entirely outside of the reserve. Similarly, also, the juniper on the low hills and elevated mesas in the region of lower Mam and Divide creeks is outside the reserve. Only a few isolated groups are included on the dry hills along the west branch of Divide Creek. The shaly foothills at the junction of the upper Thompson creeks bear a scattered growth which extends eastward to Crystal River, over the high ridges on the northeastern boundary of the reserve. Juniper appears again very abundantly on the north side of the Upper Gunnison River west of Hubbard Creek, and continues westward to the end of Grand Mesa, covering all the dry, sandy, and gravelly low knolls and higher benches ranging from a few feet above the river bottom up to 1,200 feet above.

A. COAL CREEK CANYON, 5 MILES ABOVE MOUTH, LOOKING UP.

Scattered stand of blue spruce; original heavier stand cut for ties.



B. BLUE SPRUCE AND NARROW-LEAF COTTONWOOD IN VALLEY OF WEST DIVIDE CREEK, LOOKING DOWN.

Almost all this growth lies to the south and outside of the reserve, and is connected with the spruce and fir timber of upper regions only by oak brush and aspen, which form a large portion of the cover on this great slope. The same belt of juniper extends from the Lower Gunnison River Valley over the foothills of Plateau Valley on the north side of the Grand Mesa.

The forest value of this species has already been sufficiently discussed for the White River region, where the growth of this juniper does not differ materially from that found in the Battlement Mesa Reserve. The situation of the growth, remote from all true watersheds, as well as its peculiar character, makes the tree unimportant here also as a water-conserving agency. In size it is also very similar in the two regions. Incidentally, the occurrence of this juniper in more extensive and denser bodies on rich, sandy loam mesas, lying 15 to 100 feet above the water levels, is a feature peculiar to the sections adjacent to this reserve, a feature, however, which appears to add no functional value to the growth as a true forest. No water-conserving humus or litter is accumulated. The earth remains bare and washed alike in a close and an open stand.

PIÑON PINE.

The piñon pine occurs as an occasional associate of the one-seed juniper throughout the areas occupied by the latter in and near the reserve. It is most abundant in the lower part of Plateau Valley, sometimes forming 50 per cent of the growth. Within the reserve only a few scattered individuals were found, along with juniper, on the middle course of Divide Creek; also at the head of Perham Creek and on the lower part of Middle Thompson Creek Canyon, and near the mouth of West Muddy Creek.

ROCKY MOUNTAIN JUNIPER.

The Rocky Mountain juniper was seen only at two places in the reserve, namely, at the junction of the three upper branches of Thompson Creek and on the canyon of Perham Creek. It is therefore mentioned only as a rare straggler, of no importance as a forest tree. It occurs with the one-seed juniper and under the same soil conditions as that tree, but always at the lowest level of juniper growth. It shows little tendency to spread, although the seed production is abundant. In the richer soils of the Gunnison River Valley, between Anthracite and Hubbard creeks, the few large and well-developed trees found among groves of narrow-leaf cottonwood show this species to be quite comparable in excellence of timber with the red-wooded eastern juniper. In protected bottoms it produces clean, straight trunks, 20 to 30 feet high, while on the upper, dry, gravelly hills it is only a low shrubby tree, with dense limbs down to the ground.

DISTRIBUTION OF DECIDUOUS SPECIES.

ASPEN.

The aspen is the only deciduous species of importance to be mentioned, and its greatest value lies in its sylvicultural relationship. Incidentally the dead, dry timber of this region has a commercial value for box boards, to be more fully described later. Aspen covers large areas throughout this reserve for the most part in pure growth, but frequently mingled with spruce and fir (Pl. LXV, *A*). It defies constant destruction by fire. Its feathery seeds are carried for miles by the wind and it quickly re-covers denuded areas. Where its own growth has been destroyed and often where other more valuable species have been burned off and are slow to return, it is the first to take possession of the land. In the region of Battlement and Grand mesas aspen occurs just above the juniper and oak brush, extending up to the rims of the mesas. On Grand Mesa thin lines and isolated groves cling to the wind-swept borders (Pl. LXI, *A*). It has also crossed the south arm of the mesa along the deep, wide basin at the head of Kahnah Creek, and is found also at the head of Whitewater Creek. Near the head of Kahnah Creek Canyon aspen is mingled freely with spruce and fir, but elsewhere on top of the great mesa it occurs in groups of gnarled, stunted trees covering from one-fourth to 3 or 4 acres (Pl. LXIX, *A*).

The altitudinal range is from 6,400 to 10,000 feet, with the area of greatest abundance and best development lying between 8,000 and 9,000 feet. At these levels small bodies are frequently mingled with those of spruce and fir throughout all the slopes and broad benches below the high plains of the mesas. East of Grand Mesa it is distributed in like manner over the north and south sides of the divide, between Gunnison and Grand rivers. In many places it occurs more frequently on southern, southwestern, and western slopes than elsewhere; but this is not invariably so, as it may sometimes appear independent of exposure. Doubtless it often appears more conspicuous in such positions, because there is little coniferous growth.

The wide valleys and slopes on the head waters of Divide Creek, North Fork of the Gunnison, including West Muddy Creek, Hubbard Creek, West Fork of Terror Creek, Lereaux Creek, and part of the lower valley of Leon Creek are fairly well stocked with forests of aspen. Throughout these regions there are always patches of a few acres at most of specially large aspen growing in the richer and moister soils of protected creek bottoms, gentle slopes, or on narrow benches, sheltered by surrounding conifers. The greater part of aspen is, however, a mixture of large and small saplings and brush. The rich, moist soil of upper West Terror Creek Valley and contiguous portions of Middle Lereaux Creek carry the largest amounts of large aspen found in the reserve.

The aspen of this reserve is smaller, both in height and diameter growth, than that found in the White River Reserve. The common size is 4 to 16 inches in diameter, and occasionally 18 to 20 inches, with a height of 25 to 40 inches. The trunks are clear of branches for two-thirds of their length, but very often are crooked and much scarred with knotty excrescences. Clean, smooth, straight trunks are rare. The aspen found on top of Grand Mesa is peculiarly stunted and gnarled, the crowns being much flattened and twisted, as a result of high winds and the sterile, rocky situations in which the trees grow.

ROCKY MOUNTAIN OAK.

The Rocky Mountain oak, locally known as "oak brush," is of widespread occurrence, chiefly as a thicket-forming brush, but also becoming a small tree to a greater extent in this reserve than in the White River Reserve. It has no commercial value. Its greatest importance is in checking the descent of mountain waters, and thus protecting lower treeless hills from violent washing.

Large areas are densely covered with this growth, usually ranging from the low sage mesas, 7,000 feet, up to the aspen belt, 8,000 to 8,500 feet, patches of both oak and aspen often mingling.

As a brush, which is the most common form, its dense thickets cover all the dry, sandy, and gravelly knolls and foothills below the forest-forming timber trees. As a tree it is confined entirely to the deep, rich soils of bench lands and gentle slopes, mingling more or less with groves of aspen. Groups of this tree, with bent and twisted trunks, occur at close intervals, forming a loose, low forest cover on areas of 1 to 50 acres (Pl. LXVI, *B*).

The brushy forms are slender and from 2 to 12 feet high. Tree forms range from 4 to 10 inches in diameter, and frequently 14 to even 24 inches, while the common height is 12 to 25 feet. Growths of this kind were found only on the long west slope of Hubbard Creek Basin, and on the west side of the middle course of West Muddy Creek. Occasional thickets of much smaller trees occur on some of the rich, narrow benches in the region of Wallace Creek, on the north side of Battlement Mesa.

While, as stated above, the brushy form of this species furnishes a generally conspicuous cover between the sage lands of the lower valleys and the lower levels at which aspen occurs, it becomes much more conspicuous in some of the broad interior basins. The high benches on the head waters of the Upper Gunnison River, West Muddy Creek, Hubbard Creek, and Divide Creek are instances in which the vast areas covered by this brush deeply impress the observer.

WESTERN SERVICE BERRY.

The western service berry, locally called "sarvice," is a frequent associate of the Rocky Mountain oak throughout the latter's range, and with it forms thickets of the most rigid and impenetrable character. Its common form is a low, broad, hedge-like bush, with innumerable stiff, angled, and almost spinescent branches, quite as unyielding as the more abundant oak. It rarely attains the form of a tree, and then only in moist, rich soils under the protection of aspen, with which scattering individuals are sometimes found. The slender stems are 8 to 12 feet high, and 1½ to 2½ inches in diameter. The large, sweetish fruit, similar to a whortleberry, is much prized by the settlers.

NARROW-LEAF COTTONWOOD.

The narrow-leaf cottonwood is found in the immediate vicinity of all the large creeks, forming thin lines along the eroded, moist, gravelly banks, or occurring in narrow strips of dense growth 10 to 20 yards wide on either side of the stream, in all cases within the area of the moist creek bottom (Pls. LXIV, *A* and LXXI, *B*). In this denser growth it appears as a true forest-forming species.

Its altitudinal range in the reserve is between 6,000 and 8,000 feet, descending to 5,500 feet in the Grand and Gunnison river valleys, outside of the reserve. The more or less continuous growth of this tree in outlying river valleys is almost never extended uninterruptedly along the tributary streams into the reserve. The cottonwood within the reserve is, in most cases, remote from or unconnected with that of the river valleys, and occurs in small groups or in broken stretches of several miles, suddenly ceasing and reappearing farther on. It is chiefly the main creek channels which carry this growth, it being found elsewhere only occasionally and in limited numbers on the small tributary streams. At its upper limit of distribution the cottonwood is often mingled with the blue spruce (Pl. LXXI, *B*), while at its lower limit it is associated with a few alders, or is more often the sole tree growth.

All the tributaries of Plateau Creek on the slopes of Battlement and Grand mesas bear hedges of this tree near their mouths, but in no case does the tree extend into the reserve. The large creeks which drain the north slope of Battlement Mesa have borders of cottonwood, but the tree was found within the reserve only in a side canyon of Wallace Creek. The same is true of all the streams on the south side of Grand Mesa. No large amount of this timber exists anywhere. The most abundant growth of cottonwood found in the reserve is on the West Fork of Divide Creek and a few larger tributaries; also on the Upper Gunnison, between Henderson and Coal creeks, and also on West Muddy Creek. In these valleys it extends to an elevation of 8,000 feet. A few trees grow on lower Thompson Creek, Coal Creek (tributary of Crystal River), Hubbard, and Terror creeks.

The wood is of small value and is applicable only to the local uses of settlers. As a forest concomitant it is of some minor importance. The larger and even the smaller bodies exert a decided protective influence in checking the rapid descent of waters in spring, which otherwise cause destructive erosion in the contiguous agricultural lands below. On the other hand, every conservative function of a lowland forest is exerted by this cottonwood on small areas adjacent to the streams, in many localities. A deep, moist humus is preserved beneath the shade of these trees, where, with the added density of willow brush, little oozing springs are preserved to give up their mites of water to the overdrained streams.

The reproduction, size, and general character of the tree are in all cases similar to those recorded for the White River Reserve.

PAPER-LEAF ALDER.

The paper-leaf alder is very much scarcer in this region than in the White River Reserve, and is uniformly of small, brushy size. It rarely penetrates the reserve farther than 1 or 2 miles, occurring most commonly outside, mingled with narrow-leaf cottonwood and brushy willows, along the immediate banks of streams. It shows no preference in point of soil, but forms thickets alike on the most rocky, gravelly borders and on soft, mucky banks. Aspen and oak brush often combine in covering the adjacent higher stream slopes, and, with the alder, form a retaining growth down to the water's edge. This continuous cover effectually resists the rushing torrents of snow waters without washing. Aside from this protection to the banks of streams, the alder has no further value.

WESTERN CHOKECHERRY.

The western chokecherry is abundant throughout the reserve as a shrub. It is constantly associated with oak and service-berry brush, but is most frequent in the richer soils of bench lands and gentle slopes, where pure thickets of a few rods square are often seen. It is nowhere more than 2 to 4 feet high, with slender stems. It is most abundant on the brush-covered valleys of Divide Creek, the Upper Gunnison River, and Hubbard Creek. Where sufficiently abundant the acerb fruit is gathered by the settlers.

DWARF MAPLE.

The dwarf maple is exceedingly rare, being found only on the head waters of Terror and Perham creeks, in both cases at about 8,000 feet elevation. On Terror Creek it appeared as a slender, shrubby tree, 8 feet in height and 2 inches in diameter, growing with aspen in rich, moist soil on a north slope. The Perham Creek trees are the largest found anywhere in the two reserves examined, being 15 feet in height and 3 to 4 inches in diameter. In all, about a half dozen trees grow in the moist, rocky bottom of the canyon. It is forestally and economically of no importance and mentioned only to complete the list of trees found in the reserve.

SHRUBS.

The mountain mahogany (*Cercocarpus ledifolius*) is a rare, low, sprawling shrub, seen in the reserve only near Thompson Creek, on a bare, gravelly range of hills at about 9,000 feet elevation.

A number of unimportant shrubs occur in the reserve, growing for the most part either among low thickets of aspen or oak brush, or less conspicuously along streams. The coniferous forests are entirely without undershrubs, and the pure forests of aspen, or those of mingled aspen, spruce, and fir, admit very few. The snowberry (*Symphoricarpos racemosus*) and a species of rose are the most abundant and conspicuous. These are variously mingled with oak, service, and small aspen, forming a very dense ground cover 2 to 3 feet in height. To these shrubs are to be added many wild grasses, which flourish throughout the brush-covered regions.

The next most conspicuous brush forms are species of willows, abundant from 6,000 to 9,000 feet in the vicinity of streams flowing through grassy valleys. Impenetrable thickets, 3 to 8 feet high and varying in extent from a few yards square to several acres, are often formed in the moist bottoms, about "spring heads," and along the tributaries of larger creeks. The forest fires which have swept off the timber of adjoining slopes also spread over the grassy bottoms, burning the willows to the ground, but the usually uninjured roots respond with numerous sprouts. The immediate value of the more extensive of these willow thickets in conserving water is considerable. In some places the willows also combine with the narrow-leaf cottonwood in forming the only close cover along larger water ways.

The shrubby, black-fruited haw (*Cratægus saligna*), known to settlers as "black haw," and found so abundantly on the White and Williams rivers, is comparatively rare in this reserve. A few small thickets among young aspen and willows were found on Thompson Creek, near the junction of the head branches; but elsewhere it was not seen.

The gray sagebrush (*Artemisia tridentata*) is the common shrub, 2 to 6 feet high, covering all the sandy, gravelly mesas, and portions of many high valleys. It extends from a few feet above the creek bottoms up to the oak brush, and, in places, even to the aspen, with which it mingles in small patches. The presence of sagebrush invariably indicates an alluvial, sandy, or gravelly loam soil, such as represents the better agricultural lands. This shrub appears to be entirely oblivious to elevation, ranging from the river mesas of 5,000 feet elevation up to 8,000, and even 9,500 feet on the west arms of Grand Mesa, always growing in soils of the same character. A thin growth of "blue-stem" grass thrives among sage bushes; otherwise the surface of the soil is bare and more or less gullied by spring torrents.

But little sage land exists in the reserve. Aside from the small areas lying in the basin of the Upper Gunnison River, on Clearwater Creek, on the lower course of West Muddy Creek, and on Thompson Creek, most of this land lies outside and adjacent to the borders of the reserve. The immense area of sage land on lower Divide and Mam creeks is a part of the great sage plain in Grand River Valley, which extends to the north border of the reserve. Entering the reserve on this border there are scattered patches of sagebrush among the brush-covered foothills.

VALUE AND USES OF TIMBER TREES.

The Engelmann spruce, alpine fir, red fir, blue spruce, and yellow pine are the five species valuable for timber. The first two are, however, the only ones of commercial importance. Moreover, from 25 to 40 per cent of spruce and fir, including all the largest timber, is dead. The possible output from these is small, while that from the other kinds would at present be inconsiderable. To the spruce and fir also may be added a small amount of aspen available for pulp and box boards.

The best quality of timber in the forests of this reserve is exceedingly poor—second- or third-rate, from which almost no clear lumber could be expected, owing to the numerous deep-set limbs in all trunks.

Very little sawed spruce and fir is used by settlers in the vicinity of the reserve; the lumber seen was knotty and was employed for rough weatherboards and roof boards. Dead spruce timber supplies nearly all the building and fencing material used in the region. The stronger and more durable spruce is preferred to the lighter, softer, and less durable fir, although to a certain extent the two kinds are used without discrimination. Very little green spruce or fir is used for either house logs or fencing purposes; the abundant dead timber is always preferred on account of its greater lightness, especially as most settlers are obliged to haul the logs from 12 to 20 miles.

A small number of ties are said to be cut from this spruce and timber for use on the principal railroads in the vicinity; no cutting of this kind was seen in the reserve. The only tie cutting in sight was done along the partly finished railroad in the upper valley of Coal Creek (tributary to Crystal River). Between 8,000 and 10,000 of the ties cut were from alpine fir and were piled along the prospective roadway, where they have remained unused for six or eight years. Most of them are now of little value, being decayed and badly cracked, often so deeply as to split the ties in two. A considerable quantity of spruce and fir was also used in this basin for timbering the coal tunnel and for fuel.

The superior quality of red fir timber is well known to all settlers, but, owing to the small size and limited amount of this timber accessible, it is rarely cut for domestic building purposes. Besides, there is very little dead timber of this kind to be found, while dead spruce and alpine fir are always abundant. Occasional green red-fir fence posts and corral poles, 4 to 6 inches in diameter, were seen on ranches near bodies of this timber, but otherwise the red fir is rarely used by settlers.

Red fir is much sought for railway ties, being superior for this purpose to any other timber in the region. The average life of ties under heavy traffic is 4 to 5 years. The coal-mining operations in Coal Creek Canyon, have drawn heavily on the local supply of red fir adjacent to the railroad under construction. Still earlier, considerable quantities were cut for ties and for timbering coal tunnels on Middle Thompson Creek.

The present small size of nearly all red fir in the reserve fits it for use as railway ties, and the occasional larger trees for small piling; but, as already stated, the available supply is too limited to be worthy of consideration.

Yellow pine appears to have been used very little in the reserve, except in the valley of Thompson Creek, just below the confluence of the three upper forks. The remains of an old sawmill at this point indicates the cutting of considerable quantities of yellow pine for building purposes in the mining settlement near, for timbering special points in the coal tunnel, and for bridge planks.

Blue-spruce logs are seen in many old log cabins throughout the reserve, in the vicinity of creeks and on abandoned squatters' ranches. They were put in green from the near creek bottoms, probably in the absence of the present abundant supply of fire-killed timber of other kinds within hauling distance. No other uses were discovered. Besides an occasional large trunk prostrated and long since decayed, no dead blue-spruce timber was found. Although often nearer at hand than the dead timber of other kinds of spruce, doubtless the great weight and hard character of the green timber exempts it at present from local consumption by settlers.

A considerable forest of this spruce once standing in the valley portion of Coal Creek furnished 10,000 to 15,000 railway ties for the railroad already referred to in that region (Pl. LXXI, *A*). The ties have been cut and piled along the course of the road for six or eight years, but are at present in a good state of preservation. While apparently less durable for tie timber than the red fir, the blue spruce is the next best timber in the region for this purpose, owing to its superior strength and toughness.

The one-seed juniper has no commercial value; its sole use is among settlers for fence posts and fuel. The large quantities of juniper timber accessible in and near this reserve make it the constant resource of settlers in the Grand and Gunnison river valleys for fuel and for fence posts. The green timber is preferred for posts, the average life of which is about fifteen years. Nearly all ranch fences are of barbed wire, but in the case of ranches nearest to dead timber in the reserve, fences are more often built with aspen or spruce poles lashed to juniper posts with wire. Only the dead juniper, of which there is always 8 to 10 per cent, is used for fuel.

Perhaps no greater boon could be afforded the settlers of this region than the inexhaustible supply of juniper which, for the most part, lies within easy reach, while if they were dependent upon the less desirable dead spruce and aspen timber for fuel, the labor of hauling would be very greatly increased.

The Rocky Mountain juniper in the reserve is too small and scarce to furnish material for use. It is found more or less abundant in the Gunnison River Valley outside the reserve, and is prized for its lasting qualities.

No piñon pine is cut within the reserve. At various points outside, in the lower valley of Divide and Mam creeks, considerable quantities are cut for railway ties.

The principal domestic use made of aspen is for fence and corral poles. Dead timber is preferred to green, as it is lighter to haul, and in the peeled, well-seasoned state in which it occurs is far more durable. A few settlers had recently cut 12-inch to 14-inch green aspen logs for house building. The cuttings are on the head waters of Beaver and Cache creeks. The logs are sometimes cut to length, skidded, and left to season during the summer, and later hauled out. In other cases they are hewed in the forest and, after several months' seasoning, hauled out. Green timber is preferred for house logs on account of its more presentable appearance, and also from the fact that it is often difficult to find sufficient dead timber of suitable size. Settlers haul aspen building and fencing logs from 12 to 20 miles (Pl. LXI, *B*).

Dead aspen timber is used to some extent for fuel throughout all the settled regions contiguous to the reserve, but, as already stated, the greater part of fuel used is from the more accessible juniper.

The only commercial use made of aspen in this reserve is for fruit boxes, which are superior to those made from coniferous woods because of their entire lack of odor. Dead aspen is always preferred on account of its extreme lightness, the thoroughly-seasoned condition of such timber always preventing any troublesome warping after the lumber is cut. A waning supply of dead timber has led to frequent trial of green aspen for box lumber, but with little or no success. The violent warping and checking of the green lumber renders it wholly unfit for use. The checking which takes place in the seasoning of dead trees is also severe; one or two deep checks usually traverse the entire trunk and often penetrate to the heart.

The method of cutting aspen logs into box boards is exceedingly economical, giving a full utilization of all suitable material. The logs used are 8 to 12 inches in diameter and 10 to 16 feet in length. Instead of being sawed into lumber, the logs are "slabbed" very lightly on four sides and afterwards crosscut into 1 and 2 foot lengths. The shorter blocks are then run through a box saw for headings three-fourths of an inch thick. The longer blocks are similarly reduced to boards one-fourth of an inch thick. Subsequently, both classes are carefully selected and tested for soundness. Probably 80 per cent of dead aspen thus milled is sound.

Much of the green aspen timber in the reserve which is fit for pulp wood is accessible by roadways already made, and to other bodies roads can easily be built. A full utilization of the considerable quantities of this aspen, down to and including trees 8 inches in diameter, should give an attractive output for pulp mills. These could be located temporarily within the reserve, within easy reach of the more productive aspen forests. It is believed that it would be impracticable to place mills along roadways in the Gunnison River Valley to utilize the timber on this south slope and on contiguous interior basins. The haul of exceedingly heavy timber would thus be increased to 18 or 20 miles with a great loss of profit. Sufficient pulp timber would be available along the north border of the reserve, in Plateau Valley, and, also, in the valley of East Divide Creek.

The cutting of all large aspen would be decidedly beneficial to the present and future condition of the forests. At 12 to 16 inches in diameter, aspen is in danger of being broken by wind. Younger trees are more elastic and suffer but little. The rapid reproduction of this species is greatly impaired by allowing mature timber to stand and await natural destruction. The timely removal of ripe wood both increases the wonderful productiveness of the species and decreases the amount of dead and fallen timber, which is a menace as food for fire.

The Rocky Mountain oak was seen nowhere in use except occasionally for fence posts. Rarely, also, the dead stems are used for fuel. The more accessible juniper supplies better posts and a fuel lighter to handle. The latter is within easy reach, while the oak is 15 to 20 miles away. Unquestionably, however, oak fuel is far superior to the more inflammable juniper. The great fuel value of this oak, however, appears to be little known to Colorado settlers, many of whom could, by proper management, obtain from these oak groves a much more lasting winter fuel. The thrift of Eastern settlers and the livelier appreciation of good and poor fuel would soon utilize this scrub oak.

Narrow-leaf cottonwood is occasionally used by settlers for house and other building logs. This use appears to have been greater in the past, ten to twenty years ago, than it is at present. A large number of dilapidated squatters' cabins built of cottonwood are visible at many points in and near the reserve. Two or three buildings only were found to have been recently built from this timber.

The timber appears to be less durable, even under cover, than the aspen. A few temporary fence posts and poles were seen in use by the poorer settlers along streams where the cottonwood is conveniently at hand. The dead timber is also occasionally used for fuel by this class of settlers.

The necessity to which some poor settlers are driven is, in some cases, extreme. The successful ranchmen possess facilities for hauling the better class of building, fencing, and fuel material 12 to 20 miles. The almost penniless squatter or possessor of a poor and little-improved ranch usually has nothing but his hands to work with. To him the few cottonwoods that chance to be convenient are a blessing indeed. They are his only material for cabin or "dugout," fencing, and fuel.

CONSUMPTION OF TIMBER, SOURCES OF SUPPLY, MARKETS, AND PRICES.

No settlers within 25 miles of this reserve are obliged to buy sawed timber for building purposes. The majority live in log cabins, house their stock in log buildings, and fence their ranches with pole timber, or juniper posts and barbed wire. The timber is hauled from the reserve forests. Necessity compels the least ingenious to have earth floors in their cabins. A few hew slabs for floors, while most settlers buy 150 to 200 feet of rough, knotty lumber for this purpose. Wear smooths the boards and many sweepings fill the cracks. The roof of earth is in keeping with the rough log walls; it sheds rain as effectually as shingles, and is many times warmer. Interior finish is commonly a skillfully-pasted accumulation of weekly newspapers. The very poor settlers live in "dugouts," the construction of which requires about twenty 6-inch poles and an earthen roof to cover this cellar-like house.

Among these general conditions, the prosperity of an occasional settler allows him to build a house of half logs and boards, with a shingled roof. A painted factory door and glazed sash take the place of the old plank door and port-hole window. Sometimes a painted clapboard house is seen.

The general spirit of the settler in this region is to buy only what is necessary. His comfort is subserved by a well-built log house, involving a total expenditure for lumber not exceeding $5. It is only his occasional vanity that pushes him to the use of more lumber.

The actual demand, therefore, for lumber among ranch settlers is comparatively small. The chief consumption of lumber for this region is in small towns lying in or adjacent to the Grand and Gunnison river valleys. All are distant from the reserve 15 to 30 miles, and most of them are connected by railroads. Small supplies of lumber are on sale at most of these towns, sufficient to meet the few demands of the settlers and townspeople.

The settlers in the Grand River Valley, along the north side of the reserve, procure lumber from Newcastle, Rifle, Parachute, or De Beque. The settlers of Plateau Valley find supplies at Colebran, Mesa, and De Beque, while settlers in the Gunnison River Valley secure lumber at Hotchkiss, Paonia, Delta, and other places.

It may well be asked where these local supplies come from. Considerable lumber is shipped in from the Northwest and from Denver, including all the first-class "yellow" and white pine, red fir, etc. Second-class lumber, such as is commonly used by settlers, consists of alpine fir and Engelmann spruce, and is presumably cut by mills in the region of this and the White River Reserve. As already pointed out, at least some of the spruce and fir lumber consumed at Newcastle is derived from the White River Reserve.

The spruce and fir forests of the Battlement Mesa Reserve include nearly all the large bodies of timber suitable for lumber between the Grand, Gunnison, and Crystal rivers. Ranches have no saw timber. There is no other local source of supply. Avowedly, all ranch settlers throughout these great valleys procure their house and fence logs from the reserve. Three illicit sawmills are known to be producing lumber from these forests for local consumption, and other outlying mills are reported.

The price for rough spruce and fir lumber is $10 to $16 per thousand feet B. M.; surfaced, $18 to $20. The local mills are said to receive $10 to $12 per thousand on the ground.

An increase in the local demand for lumber will probably not be immediate, as the present financial status of most settlers in the region demands careful economy; and this condition is likely to remain unchanged for some time. The demands of the average settler are simple, and are confined to wholesome necessities. His log house, more suitable to the rigors of the climate than a cheap frame dwelling within his means, is likely to serve him for at least another decade or longer. The country settlements are, for the most part, new and crude, but are composed of intelligent people, remarkably in touch with modern ideas.

With increased lumbering operations in the reserve forests, the possible supply of lumber is not great, owing to the low acre yield of this timber land. Furthermore, the poor grade of lumber produced must always render the output of mills unsalable except for coarse construction.

DESTRUCTION OF TIMBER.

Included under this head are damage and destruction of timber by natural agencies, such as snowslides, rockslides and landslides, storms, or related death agencies; by illicit lumbering operations, cutting of ties, piling, etc.; and by recent and old fires.

DESTRUCTION BY NATURAL AGENCIES.

The high, wooded mesas are subjected to terrific winds from early fall to spring, but no green timber was found to have been destroyed by wind during recent years. This immunity is due, however, to the low stature and small size of the timber, which easily withstands any storm short of a cyclone. The trees are very elastic, but show the effect of constant high winds in a strong conical trunk form (Pl. LXIX, *B*). The same species in sheltered valleys has a more cylindrical contour (Pl. LXX, *A*).

The more brittle aspen often succumbs to the force of these winds. From 2 to 5 per cent of the trees from 14 to 18 inches in diameter are broken and thrown down. Much of this aspen is defective in some part of the trunk, thus favoring damage by winds.

While no green timber has been destroyed in recent years by winds, there still remains a large amount of standing dead spruce and fir. This timber is constantly falling to such an extent that travel in the denser forest is exceedingly dangerous, especially when high winds prevail. Tangled masses of prostrate trunks make travel very difficult, in some localities impossible.

The death rate is remarkably uniform among the oldest and largest trees. The percentage of dead timber ranges from 25 to 40 (Pl. LXX, *A*). The dying of this timber has had the same effect as selective cutting. All the high shade being removed, the open spaces have been thickly reseeded. A study of the young growth started since the death of the large timber indicates that the latter succumbed twenty to twenty-five years ago. The dying of the timber appears to have taken place within a period of five to six years.

An interesting feature of this phenomenon is that the dying of timber so general in this region probably has its northern limit in a belt of spruce and fir in the southern part of the White River Reserve. How prevalent this dying of spruce and fir is south of Battlement Mesa Reserve could not be learned. There are no forests of this kind within at least 30 or 40 miles of the south boundary of the reserve. The White River timber is larger and the percentage of dead trees is considerably less than in this region, although the condition of the surviving younger timber is quite the same in both regions. No evidence of injury is observable; on the contrary, the growth is vigorous throughout.

A careful examination of this timber failed to suggest any cause for death further than the conjectures advanced for the White River region (see page 137).[1] If anything the study of the Battlement Mesa timber and surrounding conditions seems to strengthen the theory that this timber dies from a failure of a long-accustomed soil moisture. The uniform death of all the oldest and largest trees appears to be too strangely selective to be attributed to any other cause.

No appreciable amount of green timber is destroyed by snowslides, rockslides, or landslides. Numbers of fire-killed spruce, fir, and aspen trees are frequently uprooted and broken by snowslides. The thin growth of red fir on the lava benches on the west arms of Grand Mesa shows damage from falling masses of rock which constantly break away from the overhanging rim. The trees are rarely broken, but are often "barked" and splintered, suffering only slight injury, from which they usually recover with little permanent damage.

DESTRUCTION BY DEPREDATION.

No large amounts of timber have been taken from the reserve through illicit depredations. A few red-fir ties have been cut, and limited quantities of Engelmann spruce and fir have been sawed into lumber at three points in the reserve. The following notes describe the full extent, character, and location of such depredations.

A steam sawmill was found at the head of the West Fork of Terror Creek. The mill is located in the middle of a broad valley. A small settlement, including half a dozen log cabins, is established in connection with the mill for the accommodation of workmen. About 80 acres were under fence.

The mill was established at this point in 1894, and was running at the time the writer examined this region, October 7, 1898. The daily capacity is said to be 7,000 feet B. M., with an annual run from June to December. Rough lumber is cut from green Engelmann spruce and alpine fir, and fruit-box lumber from dead aspen. The lumber is hauled by wagon to Paonia. The annual output of fruit boxes (the lumber being cut to size and sold in the "flat") for 1897 was 90,000, representing about 600,000 feet B. M. The annual output of spruce

[1] Since the above was written notes and photographs illustrating this peculiar death of Engelmann spruce and alpine fir were submitted to Prof. A. D. Hopkins, of West Virginia. Professor Hopkins has made exhaustive studies of the bark beetles known to kill spruce and pine in the East, but writes that at present there is no evidence to prove a similar destruction in the West. He states that there are, however, several Colorado species of bark beetles (*Dendroctonus*) closely allied to the Eastern species (*Dendroctonus frontalis*), which is known to have killed large quantities of spruce in West Virginia from 1890 to 1892. He believes that one or two of the Colorado bark beetles may be the cause of the death described for the reserve spruce and fir.

and fir lumber could not be learned owing to the suspicious reticence of the management.

The lumber and fruit boxes produced by this mill are said to be sold at Paonia for local use in the Gunnison River Valley. The price for the fruit boxes is $10 a hundred, with a growing demand. In fact, the proprietor of this mill stated that he could not supply the present market.

All the timber cut by this mill is taken from the immediate vicinity, the longest haul for logs to the mill yard being about 2 miles. The spruce and fir timber is cut from the upper part of the slope on the south and west sides of the basin. Aspen was also taken from the lower part of the same slope, and considerable is still derived from this locality, but the bulk of aspen is now being taken from the large body on the north side (south slope) of the basin (Pl. LXV, *A*). No green aspen is cut except for skidways.

It is difficult to follow all the cutting of spruce and fir in this basin, as a number of fires of comparatively recent date have run over some areas which appear to have been lumbered over. All trace of cutting is obliterated. Selective cutting has been carried on throughout the valley, the largest timber being taken first. The several old cuttings required to secure all timber down to 10 inches in diameter has in no case resulted in denudation, as at least 50 per cent of the original stand was undersized and still remains on areas untouched by fire. About 75 per cent of the spruce and fir timber was cut when green, and the remainder cut was dead or fire killed. Some peculiar fire spots of recent origin, involving many of the best groups of spruce, appear on the south slope of this valley. They were caused by surface fires, which were in all cases just sufficient to kill the trees, the largest of which were promptly utilized.

The cutting for this season's supply of logs covers about 200 acres, lying within one-fourth of a mile of the top of the south side slope, and extending in a narrow strip from the head of the basin eastward for about 1 mile. Part of the logs from this cutting were lying in the mill yard when the examination was made They were accumulated during July and August, and, with others being cut and hauled at the time, were to be sawed in November. Probably 600 or 800 spruce and fir logs were sawed during June—the exact number could not be learned. The logs in sight, however, which may be taken as an approximation of half the summer's cut, were estimated at 1,000. About 75 per cent of these were green Engelmann spruce and 10 to 15 per cent alpine fir; the remainder, fire-killed spruce and fir. From 100 to 150 dead aspen logs, lying in the yard at the time, were not included in this estimate. The spruce and fir logs were from 12 to 16 feet long and 10 to 23 inches in diameter; the majority from 10 to 14 inches. The estimated cut of these logs is placed at 75,000 feet, to which may be added 75,000 feet for logs cut during part of May and June, and during October and November, 1898. The dead aspen cut for boxes would probably amount to 600,000 feet, giving a daily cut for the season of about 4,000 feet.

The spruce and fir-timber land culled by this mill during its four years of activity amounts to about 600 acres. A safe estimate of the total amount of timber taken out from 1894 to 1897, inclusive, would be 500,000 to 600,000 feet, or a total to date of 750,000 feet.

No sawed lumber of account was found at this mill.

The waste in logging spruce and fir on this tract is considerable. Nearly every tree cut has a waste of unused top, amounting to from 300 to 600 feet per acre, or a loss of 30 to 50 per cent of the good timber per acre. In the milling operations of the East all such material is at present utilized for slats, laths, etc. The much lower yield of spruce and fir in this reserve should stimulate an equally close economy.

A small steam sawmill was found on the upper waters of Lereaux Creek, at a point about 19 or 20 miles from Hotchkiss, Colorado. The mill is located near the junction of the main two head forks of the stream, and is probably just inside of the southern limit of the reserve. Three cabins are built near the mill to accommodate a small force of workmen. The mill is said to have a daily capacity of 7,000 feet and runs from June to December. It was established in 1895 and was in operation October 8, 1898. Engelmann spruce, alpine fir, and dead aspen are the timbers cut; for the present season aspen has been the principal output. The spruce and fir are cut for rough lumber, and the aspen for fruit boxes, the entire output being taken to Hotchkiss for disposal.

The timber sawed at this mill was taken mainly from the eastern slope of the creek, from one-half mile to 2 miles distant. There appears, however, to have been only a small amount of fir and spruce in this vicinity; it was scattered among the more abundant aspen and killed by an old fire. Most of the spruce and fir lumber cut was, therefore, from dead trees, which gave logs 10 to occasionally 20 inches in diameter, together with a few green spruce and fir 10 to 14 inches. The total area cut over is about 200 acres, with a possible total yield of 200,000 feet. No green spruce and fir timber was cut this season.

The lumbering of spruce and fir here appears to have been incidental, as the principal work of this mill is directed to the cutting of aspen fruit-box lumber. The location of the mill has commanded a large quantity of dead aspen, but this supply is now pretty thoroughly worked out within a radius of 2 miles of the mill. The usual sizes cut are 10 to 12 inches in diameter, but owing to the waning supply the logs used this season ranged from 6 to 12 inches. Very few logs were on hand at the mill. The proprietor stated that he intended to move the mill to a point 2 miles farther east, on the south slope between Lereaux and Terror creeks, where a good supply of dead aspen could be obtained.

The site of a recently-operated small steam sawmill was found on Grove Creek, at a point 9 miles above the point where this stream enters Plateau Creek. Sawing at this mill was discontinued about September 6, 1898, on account of a fire which ran through Plateau Valley, involving the mill site. The machinery was with difficulty hauled out before the fire reached the mill.

No reliable information could be obtained as to the date this mill began operations. Evidently its period of activity was short; judging from the amount of timber cut in the vicinity, probably one to two years. The lumber cut was Engelmann spruce and alpine fir, chiefly under 12 inches in diameter. The greater part of the output consisted of fir, as the standing timber in the belt including the mill site contains about 75 per cent of this species.

The small area lumbered over was so severely burned by the recent fire that it was quite impossible to follow the cutting. It is estimated that about 100,000 feet were sawed. Only a small number of fir logs were on hand when the mill was moved.

The output of this mill found sale among the settlers and in the small towns of Mesa and Colebran, in Plateau Valley. The samples seen were of poor quality.

The mill was not reestablished for the remaining season, but from information given by settlers it is believed sawing will be resumed at some point within the reserve, along the south side of Plateau Valley—possibly even at the original site—in order to profit by the road already constructed. There is sufficient fire-killed and green timber in the vicinity for the purpose of this mill, which seems to have operated irregularly, with a very small output.

No other mills were found in this reserve.

About 200 red-fir ties have been cut within the north line of the reserve on the West Fork of Wallace Creek. The cutting was done five or six years ago. It is related that the contractor was to deliver red-fir ties at a point on the Grand River opposite Wallace Creek. Under the impression that ties could be lawfully cut within 8 miles of the railroad, the contractor built a road, 8 or 9 miles long, up Wallace Creek. But the distance from the timber to the railway is not less than 12 miles. He was cautious and seemed to feel the need of further justification. It is reported that he got the permission of his neighbors to take the timber. When about 200 ties had been cut, his neighbors are said to have informed a "timber agent" of his depredations, which were at once stopped. It is alleged that his neighbors subsequently hauled out the ties and sold them.

The only extensive tie cutting in the reserve was done in the lower canyon and upper valley of Coal Creek. In all about 30,000 ties were cut, and are still lying along the creek (Pl. LXXI, *A*). Red fir was cut from the ledges and small benches in the lower or canyoned part of the creek. Blue spruce was practically stripped from the succeeding or middle valley portion of the creek, while Engelmann spruce and alpine fir, which were abundant on the slopes at the head of this basin, furnished the largest number of ties, the latter supplying at least 75 per cent. This timber was especially abundant along the north side of the stream adjacent to the projected railroad.

Considerable Engelmann spruce, with a small percentage of fir, was also cut for timbering the coal mine at the head of the basin. Excellent spruce was also cut for fuel for running machinery in the mine; a considerable quantity was found near the mine.

The cutting in the vicinity of this mine is most wasteful. Large quantities of sound trunks and tops are lying throughout the cut area. The tie cutting along the creek below the mine appears to have been much cleaner work. Most of the trunks were utilized up to 5 and 6 inches in diameter, leaving but little waste.

The area cut over for ties and all other timber along the course of this stream is very irregular. The cut-over land is estimated at 400 acres, and the amount of timber taken is placed at 500,000 feet B. M. The yield per acre is comparatively low, ranging from 800 feet along the main course of the creek to about 1,200 for the heaviest stand at the head basin.

The cutting of a few "sets" of green aspen house logs in this reserve has already been referred to. About 100 such logs, 10 to 14 inches in diameter and 16 feet in length, were seen at several points within the north boundary of the reserve, near the head waters of Cache and Beaver creeks. The logs are used by settlers in the adjacent Grand River Valley.

STATUS AND POLICY OF TIMBER DEPREDATORS.

Little can be added to the remarks made under this head for the White River Reserve. The main facts recited there apply equally well to depredators in this reserve. The general spirit of the settlers toward such men is the same.

The only depredators met in the present region were mill operators, and with one exception they seemed to enjoy the entire sympathy and moral support of the settlers. The exception was the mill located on Grove Creek, south side of Plateau Valley. It is reported that the fire which compelled the proprietor to move his mill was purposely set to drive him out of the valley. All other mill operators were in good standing with the settlers; so much so that, suspecting me to be "after" the proprietors, several settlers took special pains to inform me that the mills in question were not in the reserve. One said: "They used ter be on the resarve, but we had the line shifted. But this 'ere aint no forst anyhow."

The men operating mills on Terror and Lereaux creeks were not at all of a vandal type in appearance. Evidently alive, however, to the dangers of their undertaking, they were extremely suspicious of my presence. Most of the information concerning the working and establishment of the mills was secured from the less suspecting workmen. Proprietors were singularly noncommittal.

The general policy here, as elsewhere, is to have no accumulation of sawed lumber in the mill yard. Green logs are run through the mill first, leaving dead timber to come last. The mill operator is said to have nothing to do with log cutting, possibly because it is believed to be a safer plan. This work is done on contract by other parties, who make their headquarters at the mill.

In general the settlers of this region are fully aware of the penalty for theft of green timber. Indeed, in some localities the fear of transgression extends so far as to make them even doubt their right to take dead timber for domestic uses. The writer found no expressed antagonism to reserve regulations or willful intent of violation among ranch settlers. It is even possible, in the case of mill operators, that they are misled by incorrect maps as to their situation with reference to the reserve boundaries. From indications, they were at least in doubt. The State maps in use among settlers do not include certain bodies of timber apparently in the reserve. According to one of these maps the timber being cut by the Terror Creek mill lies entirely outside of the reserve. On this map the source of this creek does not enter the reserve, while the more carefully made atlas sheets of the Hayden survey make the south boundary of the reserve include at least 2 miles of the head course of this stream, and hence all of the timber on this basin. The same may be said of the supposed location of the mills on Lereaux and Grove creeks. A number of settlers seemed to believe that the mills were outside the reserve, whereas the mills and their depredations were plainly within. As an illustration of the difficulty experienced even by some of the fire guards in determining boundary lines, one of these men was in doubt whether a certain fire was inside or outside the reserve and, therefore, whether it should be put out or not. The indications of this map led him to believe the fire was just outside, and, therefore, to be neglected.

OUTLYING MILLS.

No mills were found outside of the reserve. As stated in another connection, no accessible timber of account exists outside of the reserve limits. The patches of spruce and fir on the crests of the high mountains, along the east side of Crystal River, on the east boundary of the reserve, are, by reason of their inaccessible position, safe from mill operators.

A small steam sawmill is reported to be at work on Piñon Mesa, which, as nearly as could be learned, lies 20 to 25 miles or more west of this reserve. Lateness of the season prevented an examination of this region. It is possible that small patches of red fir and yellow pine may be accessible in the rocky canyons of the vicinity.

DESTRUCTION BY FIRES.

Forest fires have been very prevalent throughout this reserve. The same is true also of outlying regions on the northeast, east, and southeast, both in respect to old and recent fires. All of the interior valleys and canyons of the reserve are more or less marked with old and new fires. In some instances the conflagrations have been widespread, while in others, small burned areas are scattered through the wooded or brush-covered regions. All the great slopes about Grand and Battlement mesas bear the marks of fierce fires which have swept off hundreds of acres of young timber. Nor have the high wooded plains of the big mesas been exempt, Battlement Mesa having suffered the greater loss. Much of its upper wooded surface is so directly connected with the lower canyons and valleys, that fires from these lower levels easily find their way to the summit. The forests on top of Grand Mesa have escaped destruction because of the cliffs which surround it. Fires on the lower slopes have usually found here an impassable barrier, so that the timber of these upper plains is burned only in small spots, which are chiefly near depressions in the rim.

All the timber species in the reserve have suffered from fire. Blue spruce has been burned the least, while Engelmann spruce, alpine fir, and aspen have suffered most.

The old fires, which have involved Engelmann spruce, alpine fir, and red fir, occurred at about the same time. These fires vary in character, however, from very deep to shallow surface burns. The general conformity in age of the aftergrowth, and the condition of the fire-killed standing and fallen timber support this view. There is, moreover, considerable connection between all the more extensively-burned areas. The forests of the entire east portion of the reserve were evidently connected. The burning on the slopes of Fourmile Creek had a direct connection over a low timbered divide with the broad valleys of Divide Creek. The fires which spread along the east slope of Crystal River crossed the divide and entered the valleys on the head waters of the North Fork of Gunnison River. The burning in this immense stretch of brush and timber has connections with the Divide Creek fires. From the valleys of the Upper Gunnison and West Muddy Creek the westward connections of fires are easy. There are no natural barriers to fire between these basins and that of Hubbard Creek, and from the latter to Lereaux Creek Basin there was an unimpeded march. Fires could not go directly westward from here to the region of Surface Creek, on account of the impassable southern spurs of the divide which forms the eastern end of Grand Mesa. But they easily traveled along the aspen and brush-covered foothills and ridges which form the south slope to the Gunnison River. Wherever connecting wooded ridges offered fuel to the flames, they mounted to the very edge of the bare, rocky divide (Pl. LXXII, *A*). Farther westward the well-defined south rim of Grand Mesa was an impassable barrier to fires ranging northward to the wooded upper plains. But little burning took place west of Surface Creek, only a few spots being seen on the great south slope of the mesa where, in places, the fire followed the straggling, stunted spruce and fir up the less precipitous side of the mesa.

On the north side of Grand Mesa the fire-marked areas of Plateau Valley have a far-reaching connection eastward with those on the head waters of Plateau, West Muddy and Divide creeks. The fires of Plateau Valley were also unimpeded in their advance northward across the grass- and brush-covered hills on the head of this valley to Buzzard Creek, and thence to the eastern foothills of Battlement Mesa, although the fires which have attacked the largest amount of timber on Battlement Mesa have been communicated mainly from the northern slope of this mesa.

The regions of heaviest burning in timber lie in the eastern half of the reserve. Fires in the western part have been confined mostly to grass and brush. The timber destroyed in this region is in small lots, composed chiefly of aspen, with little fir and Engelmann spruce.

The old fires were the most widespread and destructive of useful timber. The fires of recent origin, including those of the present season, were confined chiefly to grass, brush, and small aspen. Burning in green spruce and fir timber was limited to small patches in the gulches and canyons within the broad creek basins. Much of the original stand of spruce and fir in these valleys was consumed long ago by fires, which have left scattered bodies of timber, some of which have been attacked by recent fires communicated through the general brush and aspen cover.

Specifically considered, old forest fires swept off an immense area of Engelmann spruce, alpine fir, and considerable red fir from the slopes and benches on the head waters of Thompson Creek. The fire, however, reached only about half way up the general eastern slope in this vicinity, leaving an important body of spruce and fir still intact near the top of the divide. The once generally wooded north slopes of Fourmile Creek are denuded, excepting a narrow strip of timber lying along the top of the divide between this stream and the East Fork of

Divide Creek. The lower part of Fourmile Creek, which lies outside of the reserve, is entirely stripped of its original stand of red fir on the lower slopes, and of Engelmann spruce and alpine fir on the higher ridges.

A large part of the timber high up on the canyon sides, and valley part of Coal Creek, has been burned off by old fires. On the east boundary of the reserve the yellow pine, once plentiful on the east slope of Crystal River, between Coal Creek and Chair Mountain, is almost entirely burned off (Pl. LX, *A*).

The great basin of the North Fork of Gunnison River is marked throughout by fires. Almost all the spruce and fir has been consumed up to within half a mile of the surrounding divides. At present only isolated groups and single trees indicate the once prevalent coniferous forest of this region; and vast areas of partly-burned and uprooted trunks show the fierceness of the flames that swept through this basin. The conifers are struggling to regain some of the denuded territory, but the more rapidly-growing aspen is everywhere more conspicuous (Pl. LXXII, *B*). The lower brush-covered benches have been burned over, but show little sign of it now, save in occasional fire-marked stubs of scrub oak. The lower canyon of the Upper Gunnison also carries many marks of successive fires which have nearly bared the west slope down to the southern border of the reserve. The spruce and fir that formed a sort of apron about the northern and eastern base of Ragged Mountain were nearly destroyed by old fires. The few surviving patches stand out in bold relief above the fire-swept lower slope of the mountain now covered with aspen.

The long, wooded divides between the Upper Gunnison Basin and West Muddy Creek, and between the latter and Hubbard Creek, bear great fire patches throughout. Bodies of mingled spruce, fir, and aspen still cover the crests, but with deep cuts on the border where the fire of the lower slopes has eaten into the forest. Barkless fallen trunks and glistening spars mark the trail of destruction.

North of these basins, and more or less connected across the divide, the same widespread burning can be traced throughout parts of the East and West Forks of Divide Creek. Northwestward also, from the head of West Muddy Creek, the fire in this basin spread across the low wooded hills and ridges to the valley of Plateau Creek. A large area of spruce and fir was destroyed along the northern slope of this stream as far down as Park and Leon creeks. Westward along the north slope of Grand Mesa a continued old burn made deep inroads into the spruce, fir, and aspen. Then a long, narrow, wooded ridge communicated the fire to Mesa Creek timber, and with renewed fury it swept westward again in an uninterrupted stretch nearly to the end of the mesa. Sometimes the burning is confined, as in the region of Big Creek, and Cottonwood and Bull creeks, to a few hundred acres.

A. OLD DEEP-BURNING GROUND FIRE IN ENGELMANN SPRUCE AND ALPINE FIR AT HEAD OF SURFACE CREEK.

B. OLD SURFACE BURN AT HEAD OF WEST DIVIDE CREEK.

An old burn reaches from the valleys of Hubbard and Terror creeks to the upper basin of Lereaux Creek. Devastation in the latter region is widespread and complete. It extends from the southern boundary of the reserve northward, mainly on the east side of the basin, to the rocky divide at the head of this stream. Hundreds of acres of spruce and fir went down before an all-consuming fire (Pl. LXXIII, *A*). The roots were burned deep into the ground, where now great hollows mark the track of the fire.

The burning on the west side of Lereaux Creek seems to have been interrupted, as it did not consume all the spruce and fir timber on the divide between this basin and the narrow upper valley of Surface Creek. But the fire of Lereaux Valley reached Surface Creek by a detour through aspen and brush south of the coniferous belt. Destructive burning took place in the spruce and fir on the ridges at the head of Surface Creek, but far less extensively than on Lereaux Creek. The burning is very deep and complete (Pl. LXXII, *A*).

Only a few scattered fire spots were seen west of Surface Creek. They are small and chiefly in thin stands of spruce, fir, and aspen below the south rim of Grand Mesa. In some instances stunted trees along the top edge of the mesa were burned, and in still rarer cases such burns extended short distances back from the rim into groups of timber on the plateau. A small body of spruce, fir, and aspen was burned on the south side at the head of Kahnah Creek Canyon. Elsewhere the great upper plain of Grand Mesa escaped from the surrounding conflagrations.

Battlement Mesa was less exempt. The entire eastern part, especially in the region of Mam peaks, is denuded (Pl. LXXIII, *B*). The burning was deep, and over most of the area included the timber was completely exterminated. Only a few outlying fringes and small groups of the original spruce and fir remain. The principal burning elsewhere is on the north slope of this mesa, at the head of Wallace Creek. The timber destroyed is mostly aspen and fir, with an occasional spruce. This fire extends from the oak brush on the middle of the slope to the top edge of the mesa.

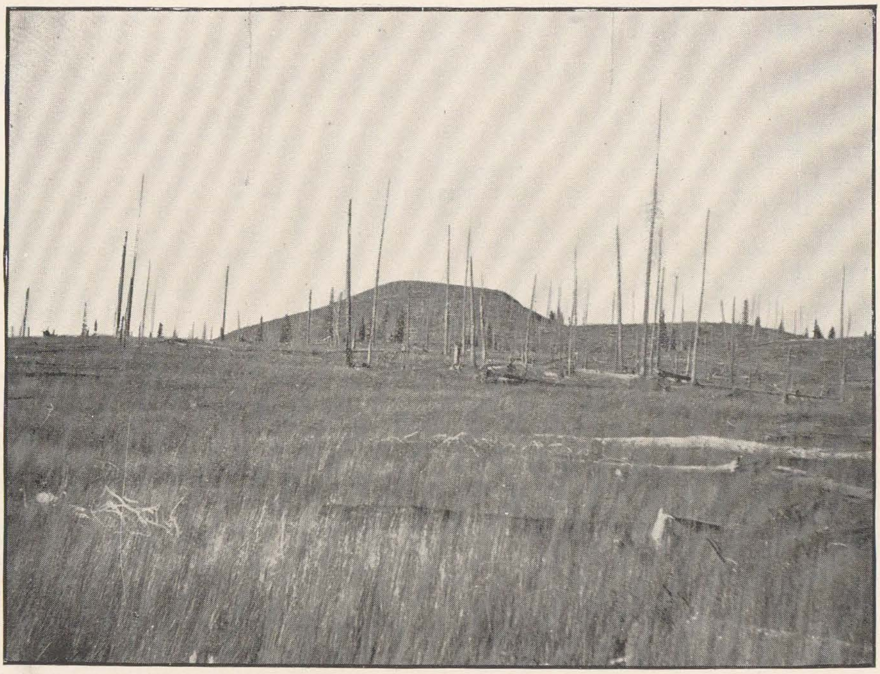
The late summer and fall of 1898 witnessed a large number of fires in forest, brush, and grass land, both in and outside this reserve. The area burned over is large, but the damage to valuable timber is small. The burning of former years left large areas with quantities of fallen timber. Much of this land has been re-covered by aspen brush. Patches of coniferous timber were also left in the burned regions, surrounded by inflammable masses of fallen timber, and connected directly with the extensive grass and brush lands below. The recent fires have run through such regions, quickly passing from the grass, brush, and aspen to the scattered groups of spruce and fir. Burning of this character took place in the head basin of West Divide Creek, connecting with the head branches of the North Fork of Gunnison River. Muddy and Henderson creeks were also centers of persistent burning. From Muddy Creek the fire ran westward into West Muddy Creek, here burning almost entirely in grass and small aspen (Pl. LXXIV, *A*). Driven northwestward, this fire swept over the low hills between West Muddy Creek and the head of Plateau Creek. Here the damage done to timber was slight, as nearly all the area burned was previously denuded by an old fire. Much young aspen was badly scorched, and the decayed, half-buried aspen logs were mostly consumed (Pl. LXXIV, *B*).

A surface fire spread through the brush and aspen along the high ridge, on the west side and near the mouth of West Muddy Creek. It followed the west side of the Upper Gunnison Canyon southward to the region of Anthracite Creek, in several places descending to the bottom of the canyon. Here a few patches of red fir and yellow pine, growing in low gulches and on rocky benches, were killed by deep, persistent fires.

The fire on the head of Plateau Creek spread northwestward through grass and brush on the low foothills. It also went in a westerly direction through the dry grass along the bottom of the upper valley. Simultaneously several fires, caught from the Plateau Creek hills, were burning in the aspen brush and small patches of spruce and fir on the southeast slope of Battlement Mesa. The fire among the green conifers burned deep into the humus, while in the brush and aspen it ran over the surface.

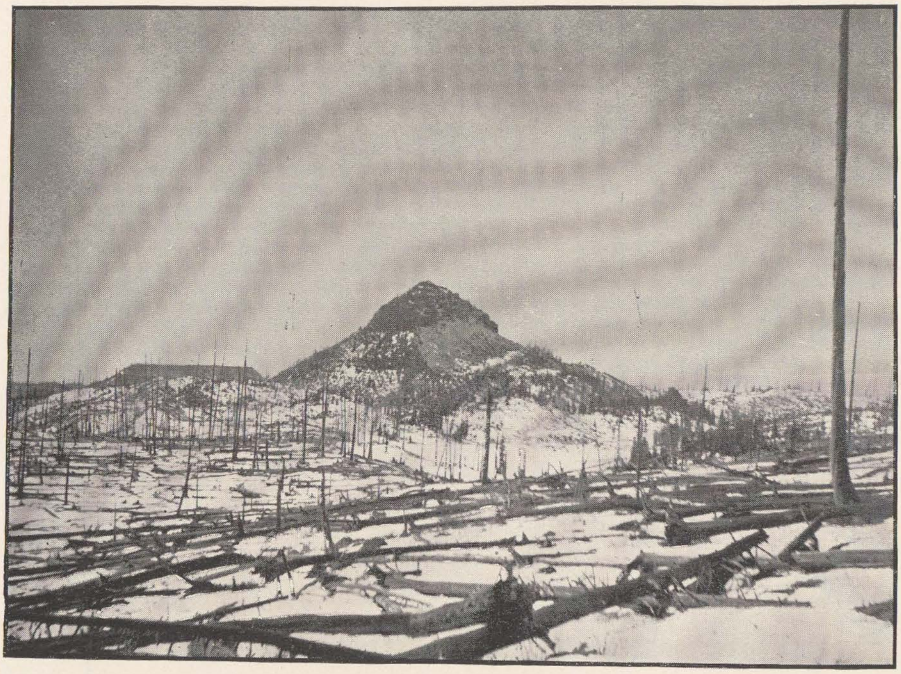
About the same time a fire was started a few miles below Grove Creek, on the south side of Plateau Valley. This fire came eastward along the south slope of Plateau Valley to Leon Creek, and then ran southward 2 or 3 miles along the west slope of this stream. Patches of spruce and fir were scorched in the region of Grove Creek, but chiefly aspen was burned on Leon Creek. The Grove Creek fire forced the owner of the sawmill in that locality to move out.

A fire also broke out 2 or 3 miles up Leon Creek and burned all the aspen from the narrow ridge between this stream and Park Creek. It joined the fire on the west slope of Leon Creek and spread along the east side of this valley. This side carries a mixed growth of small aspen, with a few spruce and fir. The lower edge of this timber was scorched for about 2 miles. Leaving this timber, the fire continued northward, downstream, for 3 miles, burning in brush. It also traveled northeastward to the south slope of upper Plateau Creek and thence eastward, reburning an old fire-marked area partly stocked with aspen. Much of the aspen was scorched and all the dead logs were consumed. Pl. LXXIV, *B* illustrates the work of this fire. Catching the grass in Plateau Valley, this fire made swift advances toward several ranches



A. OLD DEEP-BURNING GROUND FIRE ON HEAD WATERS OF LEREAUX CREEK.

Shows almost complete destruction of Engelmann spruce and alpine fir.



B. NORTH MAM PEAK, BATTLEMENT MESA.

Shows almost complete destruction of Engelmann spruce and alpine fir by old deep-burning ground fire.

far out in the valley known as the "meadows," but was fortunately arrested by a light fall of snow.

The fires occurring in grass and brush were uniformly surface fires; those in aspen were both deep and shallow; deep ones occurred only where large quantities of decayed logs supplied material. The fires which burned through pure growths of spruce and fir were mostly of a deep nature. Under such circumstances most of the timber is undermined and quickly felled (Pl. LXXII, *A*), while in the surface burning, among pure aspen, or mixtures of aspen, spruce, and fir, the timber is killed, but remains standing long afterwards. The reason for this appears to be that the humus of the coniferous growth is much drier and more inflammable than that of aspen growth. Moreover, the decay of deciduous litter is rapid and complete, resulting in an earthy, less inflammable mold than that furnished by conifers. Being highly charged with resin, coniferous litter decays slowly. In early spring or summer the same factors will largely determine the type of burning, but the greater amount of moisture in the soil and humus will retard most deep burning.

The date of the old fires in this reserve is obscure. No information could be obtained from settlers relating to this point. Most of the settlers came to this region during the last ten to fifteen years, while it is believed that the majority of the old fires occurred prior to these settlements. Some smaller fires have overrun the old burns from four to six years ago. But being of no concern to the settlers, who are, as a rule, remote from immediate danger, these late conflagrations have been little heeded, especially in a region where forest fires are frequent. Settlers are accustomed to see them, and are apt to remember only those that endangered or actually destroyed ranch property. But these are few.

From present evidence the oldest and most widespread forest fires are believed to have occurred in 1878 to 1879. Less extensive burning took place in 1883 to 1885; and still smaller fires appear to have occurred in 1890 to 1892.

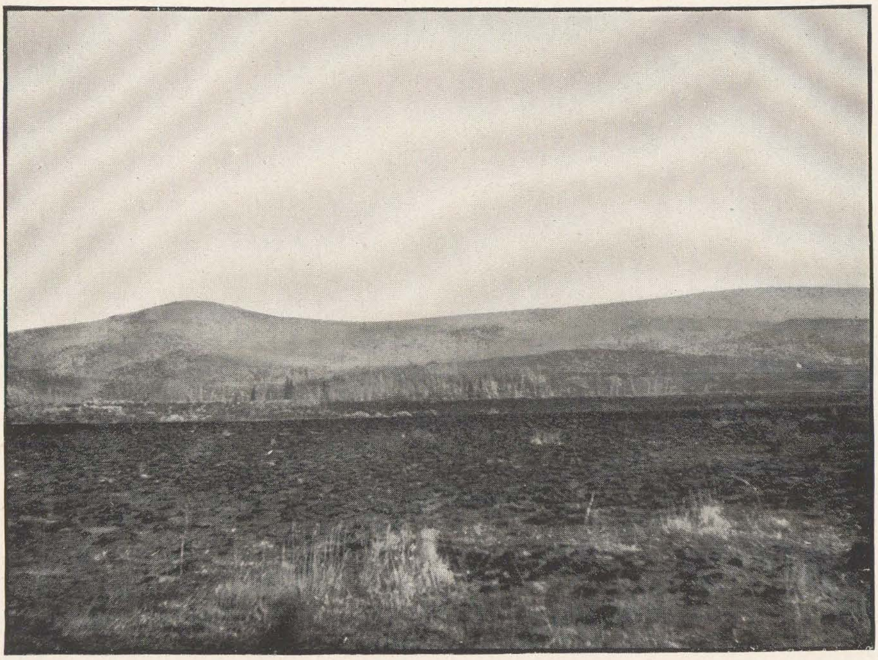
The mature timber in this reserve is from 180 to 200 years old; most of this, though dead, is still standing. There is no evidence of a preexisting forest destroyed by ancient fires. The high, wooded plains of the big mesas should show evidences of this kind, but none were found. An occasional large, dead spruce, standing, or long since fallen and decayed, indicated, however, that the forerunners of the present forest were few. These trees are 250 to 290 years old, and are found only on the high mesas. They are far apart—one among an isolated group of 20 to 30 of its offspring. The size and age of the latter show that the mother trees stood alone many years before suitable conditions produced the present stand.

The origin of the oldest fires is unknown. They are not even accredited, as in the White River region, to the Ute Indians. Those which occurred from 1890 to 1898 are said to have had their origin in neglected camp fires. The single exception to this is the reported malicious setting of the fire on Grove Creek for the purpose of destroying the sawmill in that locality.

While the general belief among settlers that most fires are due to careless campers is true in the main, there are also other agencies. The extensive coal mining carried on at various points in and near the reserve, with the constantly burning "slag piles," can not fail to be a prolific source of ignition. The big coal mines in the Grand River Valley between Newcastle and Grand Junction are so far away from large, wooded areas as to cause but little damage. The early coal operations which took place on Thompson Creek from 1880 to 1885 are doubtless more culpable. The timber in close proximity to these mines, roads, and camps is all severely burned; in some places stripped from the slopes. It is reasonable to suppose that the reckless handling of fires incident to these operations was entirely the cause of such conflagrations. It appears probable that the parties who were cutting ties and building the road to Coal Basin, on Coal Creek, are accountable for the burning in this region, for the fire spots are confined to the immediate basin and are of a date corresponding with the coal company's period of activity. A large number of men were at work and in camp along the line of this creek. Settlers in the vicinity allege that the work of the engineers on this railroad caused the fire. At that time and at the present time the responsibility of creating a forest fire was and is held too lightly.

The red fir, Engelmann spruce and alpine fir, which have disappeared from the lower course of Fourmile Creek, undoubtedly owe their destruction to both the ax and the fire of the coal mines in the vicinity. This district is outside of the reserve, but is adjacent and stands as a possible menace to reserve timber.

There is one other source of fire. A number of cowboys admitted that to facilitate their search for cattle and travel through the dense oak brush they have tried to burn out certain thickets. Unsuccessful attempts have been made in the large grazing basins, such as Divide Creek, Hubbard Creek, West Muddy Creek, and the head waters of the Upper Gunnison River. The fires were set in the spring, when the ground was too damp for fires to spread. The greatest inconvenience is felt by cowboys at this season in driving cattle to the summer range. The animals are usually weak and difficult to drive, and they take advantage of the cowboys by hiding in every accessible oak-brush thicket. It is impossible to ride through these barriers, and it is little wonder that the exasperation suggests fire as a means of dislodging a cunning old range cow and of opening up a troublesome thicket.



A. RECENT SURFACE BURN IN GRASS AND YOUNG ASPEN ON HEAD WATERS OF WEST MUDDY CREEK.

B. RECENT BURN ON PLATEAU CREEK.

This followed an older fire, which destroyed Engelmann spruce and alpine fir.

But the practice is dangerous if resorted to in the dry season. It should be rigidly prohibited.

The total area burned over by old fires is estimated at 103,000 acres. The timber destroyed on this area amounts to 52 million feet B. M. Of this 40 million feet were Engelmann spruce; 10 million feet alpine fir; 2 million feet red fir. The amount of yellow pine burned inside the reserve is inconsiderable. No account was taken of aspen timber killed or destroyed by fire. The accompanying map (Pl. LIX), however, indicates the acreage of burned aspen.

The area burned over by fires during the season of 1898 is estimated at 70,000 acres. It comprises 60 to 80 per cent of brush and grass land and 20 to 40 per cent of variously mixed aspen, Engelmann spruce, and alpine fir. The amount of commercial spruce and fir involved is placed at 10 million feet B. M.

GENERAL CONSIDERATION OF FOREST FIRES.

Conditions favorable to fires.—The conditions already described under this head for the White River Reserve are essentially the same for the Battlement Mesa Reserve.

Possible perpetrators.—The presence of forest fires early in September, both within and near this reserve, prevented hunters and campers from subsequently entering the region usually frequented by them. Much of the large game was also driven out by these early fires; but as the reputation of this reserve for large game and fish is by no means so great as that of the White River Reserve, even in seasons free from fire, fewer campers and hunters are likely to visit it. A larger number of cattle range in this reserve than in the White River country, and this is a check to the presence of large game. In a very thorough examination the writer met but two hunting parties, while literally hundreds were seen in the northern reserve. However, it is reported that ordinarily a considerable number of hunters come here, the influx beginning late in August or early in September. The fact that fires were started three weeks before the writer reached this reserve accounts for the paucity of hunters and campers seen. Those on the ground were compelled to flee to save themselves from being surrounded by fire.

As elsewhere described, campers and hunters who visit this reserve consist of ranchmen from the immediate vicinity, people from small towns, and a few from the large cities. Cattle men are riding and camping throughout the grazing regions, especially from September to November.

Besides campers, hunters, and cattlemen and their cowboys, likely to be in the reserve during summer and fall, there must be added also sawmill operators, logging crews, a few prospectors, and for the last two seasons a crew of men camping and working on a large irrigation ditch. The ditch runs from the head of Hubbard Creek to high mesas near Terror Creek. No active coal mining was seen, but it was reported that operations were to begin on Coal Creek in the spring of 1899.

During the spring and fall companies of ranchmen are engaged in repairing or constructing reservoirs on the borders of the reserve. These men live in temporary camps, or in log cabins in the vicinity of their work. In addition to these, the two wagon roads which cross Grand Mesa from Plateau Valley and descend into the Upper Gunnison Valley are more or less traveled. Ranchmen come to the reserve from long distances for the purpose of cutting and hauling dead timber and live in temporary camps for a week or ten days.

Last, but least evident, was a reported band of 3,000 sheep, with herders, in the valley of Hubbard Creek. They could not be found, but in so extensive a region may have been overlooked in the cursory search made for them. The report seemed reliable, and accredited ownership to a man in Hotchkiss, Colorado. Sheep men are charged with starting fires to improve the pasture.

Hunters, cattlemen, sheep herders, sawmill operators, logging crews, ranchmen, settlers, and transient travelers are the people responsible for fires originating in the reserve. Doubtless some are blameless, while others are guilty of neglecting camp fires.

Relation of circumstantial interests to fires.—Little can be added under this head beyond what has been stated in regard to the White River Reserve. The ranchmen receiving water from the streams whose head waters lie within the Battlement Mesa Reserve are fully alive to the necessity of preserving timber along these water courses. Only a few believe that there is no relationship between water supply and forest cover. The former are directly interested in the suppression of forest fires, and not likely to set fires in the reserve except through inadvertence.

Likewise the cattlemen, who place large herds of cattle in the reserve, are solicitous concerning forest fires. Extensive burning on the range means not only loss of feeding ground for one or two seasons, but possible destruction of cattle. The present season saw something of this. Cattle and horses were burned at several points in the reserve. The cattlemen's interests are to suppress fires. They are not, however, able to infuse the same interest into all of their hired cowboys. Some of the latter are careless, not maliciously so, but listless.

The people in this region, as elsewhere, whose lack of interest in the reserve allows them to be careless with fire, are the hunters from beyond the reserve. Pleasure campers, unattended by native guides, and other transient travelers from a distance belong to the same category. To these may also be added sawmill operators, logging crews, and irrigation ditchers. Circumstantial evidence, at least, points to these parties as the most likely perpetrators, as recent fires of greater or less extent were found in close connection with their work. It is reasonable, therefore, to conclude that the greatest danger from fire lies in the presence of these people.

Willful and pernicious perpetrators.—No fires were discovered in the reserve which are known to have been set with willful or pernicious intent. Only two reports of such fires came to my notice during the season of 1898. One fire, already referred to, occurred in the region of Grove Creek. It is alleged to have been set for the purpose of destroying or forcing the removal of the sawmill located on the above mentioned creek. Personal enmity toward the owner is said to have been the instigating cause. The fire was set in timber below the mill, and a strong wind depended upon to carry it to the mill. The mill was moved before the fire reached it.

The other reported case of malicious burning took place on the divide between Hubbard and West Muddy creeks. It is reported by cattlemen in the region that this fire was set by sheep herders in the vicinity of Hubbard Creek Basin, and also by those from the region outside and southeast of the reserve. If there were sheep in Hubbard Creek Basin the fire set on the east-side divide was not likely to disturb the sheep, as the prevailing southwest wind carried the fire away from this basin. The purpose of this act was to cast the blame of setting the fire on the cattlemen, who are known to be the most conspicuous rangers in the reserve; also to do every possible damage to the range and cattle on the Upper Gunnison. There is said to be a perennial war in western Colorado between cattle and sheep raisers. The men prevented by present regulations from holding sheep in the reserve resent the privilege enjoyed by the cattlemen. It is even said that several attempts of sheepmen to secretly establish their herds in the reserve have resulted in the killing of large numbers of sheep by cowboys.

Suppression of forest fires.—The remarks made under this head for the White River Reserve apply equally well to the conditions observed in the present region.

Without exception the fires of this season could have been extinguished before they became uncontrollable. There were at least two favorable opportunities. The fires which afterwards became the most widespread were seen by the writer at a distance, 15 to 20 days before they began to spread. It was a prime opportunity to extinguish them. On October 9, when the fires in the region of West Divide, Muddy, Henderson, and West Muddy creeks were at their height, 6 inches of snow fell and quenched all the surface fires and much of the heavy burning, except where buried deep in log heaps. The entire country was cleared of the flames and dense smoke which had obscured the region for miles about. Half a dozen small columns of smoke marked the burning at as many different points. This lasted for several days. A second opportunity was offered for extinguishing the smoldering embers. But in a week of fair weather they had gathered strength. Smoldering embers grew into leaping flames. A driving gale carried them for miles over grassy vales, through dense thickets of brush, and up mountain slopes into forests, and the sun's rays were obscured by clouds of smoke. Then it was too late. Only the heavy fall of snow several weeks later could check the fierce headway.

RECAPITULATION OF TIMBER DESTROYED BY FOREST FIRES AND ILLICIT LUMBERING.

Following is a statement of the total amounts of different kinds of timber cut and burned in the reserve:

	Feet B. M.
Spruce and fir burned	60,000,000
Spruce and fir cut	1,050,000
Red fir burned	2,000,000
Engelmann spruce, alpine-fir, and red-fir ties cut	30,000

STANDING COMMERCIAL TIMBER.

The amount of standing commercial timber in this reserve is small. The phenomenal dying of all the largest trees throughout the wooded areas leaves but a small stand of green lumber trees (Pls. LXVIII, *B* and LXX, *A*). The most thinly-stocked areas are confined to the great mesas and to the benches immediately below. The smallest timber is also found in these forests. Slightly more productive, and more densely wooded, are the slopes on the head waters of streams near these mesas. The difference, however, is so slight and irregular as to be unimportant. Practically, a comprehensive statement of acre yield can be made for the entire reserve.

It is estimated that of the entire 858,240 acres in this reserve, 35 per cent bears scattered bodies of Engelmann spruce and alpine fir, including also small patches of red fir. Only about 25 per cent of this area is actually wooded. Twenty-five per cent of the reserve bears aspen and arborescent oak. Forty per cent of the reserve is made up of brush, grass, and agricultural land, claimed and unclaimed. About 10 per cent of all lands are marked with fire.

The same method was used in examining timber of this reserve as was employed in the better-stocked forests of the White River region. On account of the inconsiderable amount of saw timber available and the very general uniformity in the occurrence of small-sized timber, detailed tables of measurements are omitted. A statement of average sizes is given instead.

It is believed that the limited quantity of timber in this reserve will not be desirable for any but small milling operations. The small size of the timber limits the use to very ordinary rough building purposes.

The thin stand of lumber trees necessitates long haulage, which is expensive. The moving of mills from place to place, in order to reach the timber of certain regions, is also expensive, owing to extensive road building.

The available saw timber is chiefly under 12 inches in diameter, trunks 14 to 15 inches being exceptional. The average height is about 60 feet. The rapidly-tapering trunks, 2 to 3 inches in 16 feet, rarely give more than two log lengths per tree, and often, as cut by lumbermen, only one log. The number of lumber trees per acre varies from 30 to 50; the average is about 35.

The average acre yield of Engelmann spruce and alpine fir is estimated at 1,500 feet. On some areas it falls to 500 feet per acre, and in others amounts to 2,000 feet. Alpine fir forms 25 to 30 per cent of the total stand. The estimated amount of spruce and fir is 150 million feet. The proportion of red fir included in this estimate is too small to be taken as a separate yield. The few scattered patches available for tie timber can be profitably cut only in connection with the more abundantly associated Engelmann spruce and alpine fir.

The dead standing spruce and fir timber throughout the forests of this reserve amounts to 2,000 feet per acre, or a total of 170 million feet for the entire wooded area. The average age of this timber is about 200 years, which, barring the theories advanced for its death, may be taken as near the limit of its profitable rotation. Cut before its death, eighteen to twenty years ago, the average acre yield of these forests would have been at least 3,500 feet, or a total of 200,400,000, as compared with the present possible cut of 150 million feet. The average age of the green spruce and fir saw timber is about 170 years.

Total amount of standing timber.

	Feet B. M.
Engelmann spruce	112, 500, 000
Alpine fir	37, 500, 000
Dead spruce and fir	170, 000, 000
Aspen suitable for pulp timber	65, 000, 000

EFFECT OF DEFORESTATION BY VARIOUS AGENCIES ON SUBSEQUENT FOREST GROWTH.

EFFECT OF ILLICIT LUMBERING.

The practice of lumbermen in this reserve is not different from that of operators described for the White River region. There is no evident design on their part to perpetuate the forest growth. The saw timber is taken in the most wasteful manner, large quantities of unused material in tops being left on the ground.

The thin stand of log trees in these forests has, however, lessened the possible damage from careless lumbering. The cutting of trees at such wide intervals has inflicted little permanent damage upon the remaining young stock (Pl. LXV, *A*, foreground). The interlucation in pure stands of spruce and fir has in many cases been beneficial in relieving too densely crowded groups; but in other instances the cutting of log trees scattered among aspen has deprived some sites of all seed trees. The standing spruce and fir are so distant from the thinned-out sites as to require many years to regain the scattered outposts so unwisely taken. A selective cutting looking to the proper maintenance and extension of existing lumber species would have wisely preserved all the hard-earned advances of these conifers and taken only the large trees from crowded groups.

Viewed as a whole, the illicit lumbering in this reserve happens to have done little damage to the remaining stock, and has in no case resulted in permanently changing the character of the subsequent growth. The thinning out of scattered spruce and fir seed trees in aspen forests has retarded, but not entirely prevented, the increase of these conifers. No original growths have been exterminated. It is, therefore, reasonable to expect that the general character and composition of the lumbered areas will remain unchanged.

EFFECTS OF FIRE.

The various phases of reproduction following shallow and deep burning have been fully discussed in the report on the White River Plateau Reserve. The same types of destruction by fire exist in the present region, and the same results are observed to follow in reproduction. No lodgepole pine exists in this region, which seriously lessens a rapid recovery of many severely-burned areas. Regeneration of valuable conifers is here confined mainly to the forest-forming Engelmann spruce, alpine fir, and red fir. Their capacity to reestablish themselves after severe burning has been shown to be far inferior to that of the lodgepole pine. The dependence of spruce and fir for reappearance in thoroughly denuded areas upon surviving seed trees in the vicinity has also been pointed out.

Fortunately, the most extensive burned areas have their surviving groups or scattered single seed trees. Some are near the borders of these great burns (Pls. LXIII, *A* and LXIX, *B*) and others are scattered over the greater part or whole of the burned areas (Pl. LXVII, *B*). In a few cases the denuded areas are so remote from surviving seed trees that the process of reclaiming will be exceedingly slow. Areas of this kind were found on the east side of Battlement Mesa, on Slide Mountain, on the head waters of Plateau and Lereaux creeks, and less extensively on Surface Creek (Pls. LXXII, *A*; LXXIII, *A*; and LXXIV, *B*). The Plateau and Lereaux creek burns will undoubtedly be re-covered mostly with aspen or in parts with a mixture of this species with Engelmann spruce and alpine fir. The other areas cited are so distant from the aspen belts as to escape seeding from this species.

A. OLD BURN, DESTROYING ENGELMANN SPRUCE AND ALPINE FIR, ON WEST SIDE OF COTTONWOOD CREEK.

Shows reproduction of fir where grazing is excluded by fallen timber.

B. OLD DEEP-BURNING GROUND FIRE ON EAST SIDE OF COTTONWOOD CREEK.

The patches of Engelmann spruce and alpine fir have escaped the fire.

They are subject to a slow but certain recovery by Engelmann spruce and alpine fir.

A small amount of yellow pine has been killed by surface fires. The usually scattered stands of this species appear to admit only of this kind of burning, as there is little débris or litter among the trees except dry grass, low shrubs, and small aspen to feed a fire. This is soon burned off. With their inflammable crowns high above the ground, these pines often escape with little more than a harmless scorching. Wherever they are killed there is no appreciable change in the after growth. Aspen usually invades the ground in dense thickets, but not to the exclusion of scattered young pines. There are almost always surviving seed trees, but the reappearance of seedlings is very slow; a fact which is due, as shown elsewhere, more to the unfavorable condition of the surface cover than to any tendency of the species to disappear after it has been burned off.

The principal burning of red fir which took place on the forks of Thompson Creek has been followed by a sparse reseeding of the same species from a few trees left along the stream. With the exclusion of further fires a full recovery of the slopes originally held by this species is sure to follow. The young growth now established is 10 to 15 years old and is visibly increasing.

Aspen succeeds itself indefinitely, even under repeated severe burnings. Several localities in the reserve show the destruction by fire of three to four successive generations of aspen. The frequency of late fires is evident in the smaller-sized trees of recent forests. Old growths were 14 to 20 inches in diameter, while those of the last two generations were 6 to 12 inches, and growing quite as rapidly as their predecessors. It is impossible to say with certainty how general these conditions of successive regeneration and destruction by fire are, as the sites where evidence is found are widely separated and have no visible connection. These sites are, moreover, isolated in point of their rich, moist soil—so favorable to rapid grow thand to the production of large timber. The intermediate regions are less favorable to the growth of large aspen, and the fires which probably swept over all from time to time naturally left but little trace in these thinly-stocked regions.

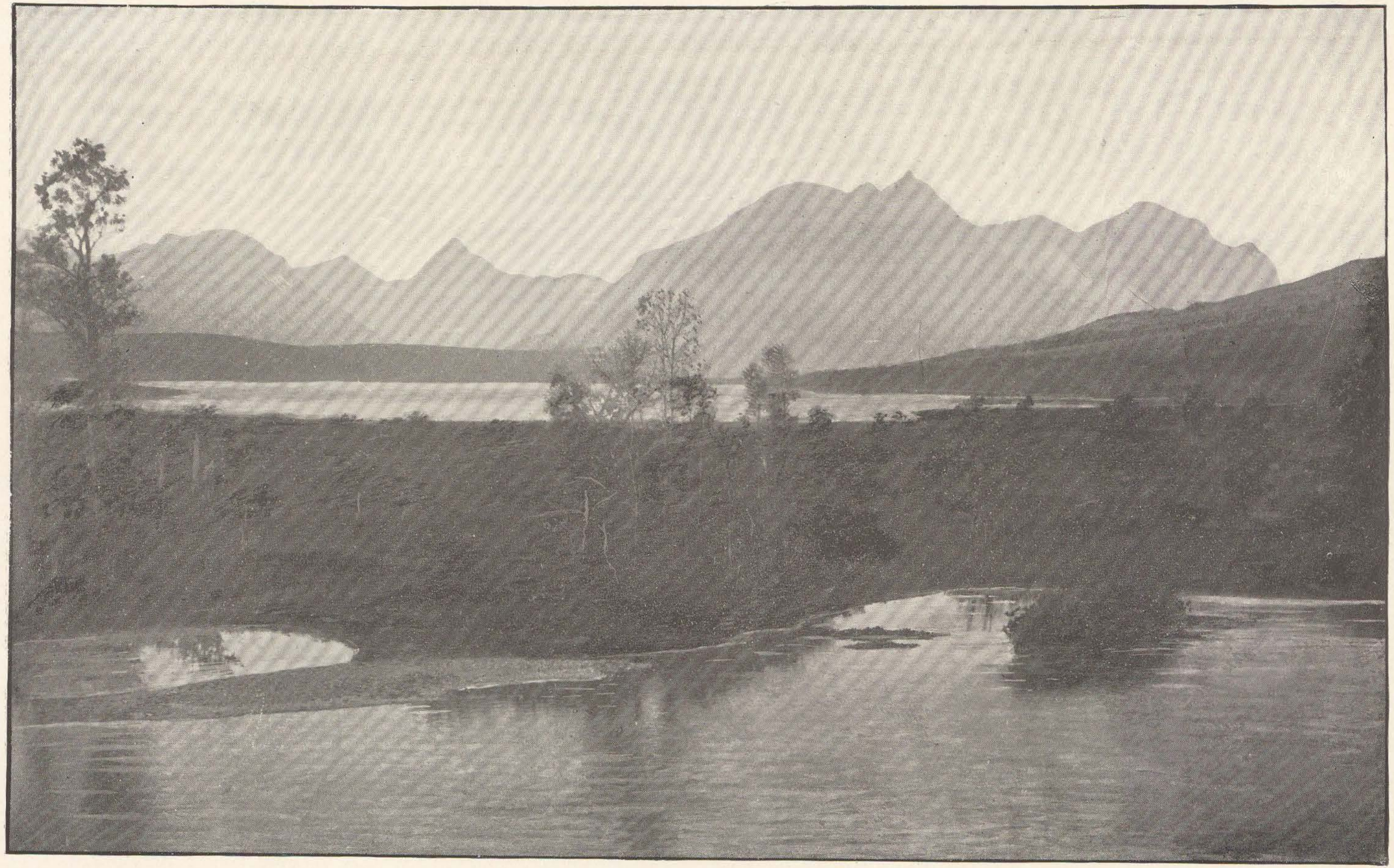
Reviewing the present and future possibilities of complete reforestation in all districts partially or wholly denuded by old and recent fires, it may be said that, with adequate and continued protection from fire, these areas will be reclaimed by the original timber species. Wherever swept off by fire, spruce and fir are in all cases returning to the land once held by them. Where seed trees are near, recovery is rapid, complete, and absolutely unimpeded by débris (Pl. LXXV, *A*). Where mother trees are distant the return is correspondingly slow, but certain (Pl. LXXV, *B*). The returning conifers shown in the above illustrations have established themselves in five to twenty years. Further advance will be more rapid, as the young trees will soon give additional seed. These conditions are most prevalent and most encouraging. Less encouraging, but of limited extent, are denuded areas to which only an occasional spruce and fir have returned during the past twenty years (Pl. LXXIII, *A*). The reason for such slow reproduction is the great distance of seed trees from the burned area. Complete reforestation of these areas must, however, be considered as finally inevitable; but, unaided, it will require many years.

Luckily, this long standing denudation will not have a great effect on the water flow of the region. The burned areas are near the main stream, but the head waters of these streams are mostly protected by green timber. Yet these protecting forests are directly connected with burned districts, where there are masses of dry logs, and through which, except for the greatest vigilance, most destructive fires may be carried to the surviving timber. This danger is a constant menace also to the thousands of seedling conifers which have slowly crept across so many blackened wastes. Their inflammable crowns are all within reach of even the lightest blaze that may run through the abundant grass of the region. If fire should enter, every vestige of promising young forests would be swept from thousands of acres. The scanty reforestation which the last twenty or more years have effected in these regions could not be reproduced in fifty years. Each successive burning removes the elements of a possible return of original species by at least a score of years. The limit at which safe recovery can be expected from destruction by forest fires has been reached in this region. Greater inroads upon these depleted forests are sure to bring far-reaching effects to the vitally connected agricultural interests of this vast territory.

GRAZING AND GRAZING LANDS.

REGIONS GRAZED AND EFFECTS OF GRAZING.

The grazing of cattle and horses is carried on throughout this reserve. The proportion of cattle far exceeds that of horses, as there is at present a greater profit in beef herds. Nearly all the settlers located on land adjacent to the reserve use some portion of the reserve as a range for cattle and horses. In addition to these settlers, parties residing in small towns in the region have large herds of cattle and horses in the reserve. How many cattlemen from distant cities hold herds in the reserve is not known; but by chance the writer met a man from Pennsylvania, with 4,000 cattle in the reserve. Probably a much larger number of cattle are ranged in the reserve by residents of towns and distant cities than by ranchmen settled in the immediate vicinity of the reserve.



ROCKY MOUNTAINS, FROM ST. MARYS LAKE.

Red Eagle Valley in left center; St. Marys Valley on right.

At various points throughout the reserve there are evidences of the early settlement of cattlemen. The favorable opportunities for grazing small herds in the many grassy valleys were great, and appear to have been fully utilized by these earlier comers. Nearly all of these settlements are now abandoned. The dilapidated buildings are occasionally used for temporary shelter by cowboys and hunters.

The general accessibility of this reserve over outlying grazing lands makes it especially desirable. Herds can be taken in and out easily and are held in certain favorable localities with little difficulty.

The interior portions of the reserve are the regions most heavily grazed, and comprise the valleys of East and West Divide creeks, North Fork of Gunnison River, West Muddy and Hubbard creeks, Lereaux and Leon creeks, and the west arms of Grand Mesa (Pls. LXI, *A* and LXIV, *A*). Without doubt the latter region carries the largest number of cattle. Almost all of the smaller creeks with their sources in the reserve are grazed by small herds of cattle. Through these valleys the border slopes of the reserve are reached more or less by grazing animals.

"Cow camps" and corrals are established in the larger grazing valleys, where cattlemen and cowboys rendezvous from May to November in the care of their herds. No fencing for holding cattle has been done in the reserve except near Thompson Creek and on the southwest arm of Grand Mesa. Between 200 and 300 acres are fenced near Thompson Creek. The fence built on Grand Mesa runs from the head of Kahnah Creek southward across the south arm of the mesa. This fence is an attempt to limit the range of cattle to the grassy and thinly-wooded arm of the mesa (Pl. LXIX, *A*), but is not altogether successful.

The early spring and summer grazing of herds is in the pure grass lands lying along the principal streams. From here, as the season advances, the animals range into the adjacent brush and thence into the thickets and open forests of aspen, spruce, and fir. The vast areas on which old fires have leveled the timber also form a part of the land grazed. The rapid disappearance by decay of logs left by these fires facilitates the entrance of stock. In localities where spruce and fir predominated, the much longer-enduring tangles of fallen trunks quite effectually prevent grazing, much to the advantage of the aftergrowth (Pl. LXXV, *A*). The logs often lie waist deep, with little diminution by decay. Range cattle are entirely excluded from such areas. None but the nimbler deer venture in after the rich crop of wild oats and rye grass which abound there.

The water supply in most of the grazing regions are usually sufficient to enable cattle to remain throughout the season; so that practically all the grazing lands of this reserve are worked from early spring till late in the fall.

The most marked effects of cattle grazing are always seen in the vicinity of the water courses, where the animals congregate more and more as the summer advances. The bunch grass of the pure grass lands becomes tough and unpalatable during the later summer months, and, where possible, the cattle abandon their easier ranges and push into the open timber land and old burned areas in quest of shaded and more tender feed. The dense ground cover of succulent weeds and shrubs is trampled flat by the cattle in search of grass. Wherever the animals find entrance among the logs of fire-marked districts, incoming small conifers are trodden to death. The willow and alder thickets which surround springs or border numerous rivulets in the narrow upper valleys of streams bear innumerable cattle trails and thousands of hoof marks. On the two western arms of Grand Mesa the grazing of thousands of cattle extends eastward from the pure grass land to portions carrying scattered bodies of spruce, fir, and aspen (Pl. LXVI, *A*). The cattle graze the interspersed grassy parks, feeding close up to all bodies of timber. Numerous hoof marks and hard-trodden earth on the borders of many of these groves attest it. Animals enter the more open groves in search of the thin grass or for protection from the heat.

It can not be denied that the tramping of thousands of cattle in these localities destroys all existing tender seedling conifers. It can not be denied that this treatment effectually prevents further seeding along forest borders. The rare instances in which seeding conifers survive such ordeals are the exception. The rule is, if started at all, that they are trodden to death during the first or second year.

In conclusion it must be said that while the destructive influences of cattle grazing are not uniformly evident throughout all wooded areas, they are prevalent in the localities discussed.

ACTUAL AND PROVISIONAL GRAZING LANDS.

Although the greater part of this reserve is used as a range, there are certain parts, purely grass and brush lands, which are adapted only to grazing. The natural advance of forest cover over these regions is too remote or impossible for practical consideration. The most profitable use, therefore, of these areas is for grazing. Other parts of the reserve are properly forest land. In the burned and otherwise denuded portions they happen to afford advantages for grazing, but this does not furnish a reason for further appropriation to this purpose. Because grass grows in the fence corners of a grainfield there is no excuse for destroying the more valuable grain crop by letting in cattle to pasture on the grass. There are natural tendencies and facilities pointing to a complete recovery of these lands by the forest-forming species once present there. This recovery has been, is, and will be slow, with every protection against further fires and grazing;

too slow, in fact, for the needed ameliorative effects on water supply. With injury from either of these agencies, recovery must be impaired. The needs of grazing interests are directly antagonistic to the requirements of successful reforestation. And while a full realization in the interest of cattle raising can be promoted by a partial restriction of grazing to lands applicable to this purpose, the fullest reforestation can not be realized except by exclusion of grazing from forest land. The two interests are incompatible on the same ground.

What are here considered actual grazing lands consist of pure grass lands and adjacent lands covered with oak, sage, and other small brush. For the most part these lands lie along interior water courses and include the large tracts of grass lands on the west arms of the Grand Mesa (Pl. LXIX, *A*). A greater supply of grass occurs in such districts than in either the wooded or fire-marked areas.

What may be termed "provisional grazing land" consists of unusually large areas of grass land—"parks"—confined to the middle portion of Grand Mesa (Pl. LXVI, *A*).

The region including these grassy parks carries small bodies of spruce and fir, the tendency of which is to encroach gradually upon the grass land. This is easily demonstrated by a study of the various groups. They have enlarged from small beginnings. Moreover, the area held by the present generation of trees is much larger than that covered by the parent trees. Examples were found where the present stand of one-eighth to one-half an acre was originally represented by only from 1 to 5 trees in each group. The rotted remains of these mother trees and the greater numbers of living trees which have succeeded them afford strong evidence of certain encroachment upon the grass land (Pl. LXVII, *A*).

In consequence of this slow advance it is believed that provisionally a considerable portion of this thinly-wooded area should be made available for grazing. The entire loss of pasturage by excluding cattle from these localities seems to be unnecessary.

The larger areas of grass land can be readily fenced, so as to exclude stock from grazing in and near the timber, and at the same time allow sufficient space for all reproduction. As timber approached the fence, the latter could be moved out. The flight of spruce and fir seed under a heavy wind rarely exceeds 50 or 100 yards from the mother trees. Space could thus be allowed that would include all possible extension for twenty years.

The vast timberless plains on the western arms of Grand Mesa can be easily cut off from the timber lying to the east by fences running north and south from rim to rim on each arm. The south arm should be fenced west of the timber on the head basin of Kahnah Creek, an inlet to the basin being allowed for water. The north arm of the mesa should be fenced along the east side of Whitewater Creek Basin

(Pl. LXVI, *A*). With a failure of water in this basin provision can be made to reach it on the first bench below the north rim of the arm. A low depression in the edge of the mesa connects the upper plain with this bench and a head branch of Mesa Creek. A band of horses was found fenced in on this bench. They were feeding on the small patches of grass interspersed among the mixed growth of aspen, spruce, and fir.

The confining of cattle to the natural grass and brush lands on the interior basins referred to can also be accomplished by fencing. A few natural barriers can be utilized. Where these fail to prevent stock from entering wooded and burned districts in process of recovery they should be supplemented by fences.

An abundance of dead standing and fallen timber is generally available near the necessary fencing lines.

The expense of constructing the needed fences would doubtless be vigorously opposed by the cattlemen using the reserve ranges, on whom this work should properly fall. The present unlimited privileges, enjoyed without price, carry the fullest encouragement to all cattle producers; but the small price of fencing would be far outweighed by the profit accruing from the otherwise free use of the reserve ranges.

The combined water interests of ranchmen in the vicinity of this reserve have readily led them to bear the joint expense of constructing reservoirs and roads. Similarly, ranch settlers in the vicinity would find it profitable to unite in inclosing a sufficient range for their cattle. A just disposition of such privileges should first benefit all settlers owning agricultural lands in the vicinity. The natural effect of such discrimination would be to discourage and curtail the range privileges now enjoyed by cattle speculators from distant points, who have no land interests near the reserve, or even in the State.

VALUE OF BRUSH LANDS TO FOREST COVER.

The general relationship of brush land to adjacent forest covers has been fully discussed for the White River Reserve. The extensive brush lands included in the present reserve lie in the same relative position to existing forests, and are, therefore, of equal importance as an auxiliary cover.

For the sake of extending to these lands the much needed protection of a regular fire service, it seems advisable to retain them permanently within the present reserve limits.

ADVISABLE EXTENSIONS OF PRESENT BOUNDARIES.

Certain extensions of the present boundaries of this reserve are deemed advisable. The cut-out which excludes the major part of Hubbard Creek Canyon and Valley comprises one township, and should be included in the reserve for the reason that it contains no agricultural land likely to be taken up. The lower part is very rough and inaccessible, and of exactly the same general nature as the adjacent regions on the east and west of it. It seems proper to retain the land lying on either side of this cut-out, and there is no good reason for excluding the intermediate township.

An extension of the present boundary in the region of Surface and Forked Tongue creeks seems advisable and should include about two and one-half townships. The area included is mainly a broad, sloping bench, beginning at about 800 feet below the rim of the mesa and extending down to Forked Tongue Creek and the upper waters of Surface Creek. The surface of this extension is generally rough and rocky. Its southern border is covered mostly with small aspen, oak brush, and one-seed juniper. The middle and northern portions bear scattered small bodies of Engelmann spruce and alpine fir (Pl. LXV, *B*). There are also a large number of lakes in this region. The coniferous timber corresponds in character and situation with that found on the north side of this mesa. It is a part of the irregular belt of coniferous timber which lies on the south side of Grand Mesa and the great slopes on the north side of the North Fork of Gunnison River. There appears, therefore, to be no good reason for longer excluding this tract from the reserve.

An extension is recommended on the south side of the Plateau Valley, including a much broken slope similar to that shown on Pl. LXI, *B*. This area, covered mostly with aspen and small patches of fir and spruce, bears a number of fire spots. All the foothills lying to the north and lower down the slope carry a dense cover of oak brush. The region is entirely unfit for agriculture, and in its present status forms a connected fragment of thin forest cover belonging naturally to the main wooded area already included in the reserve. The Grove Creek sawmill was situated in this strip of scattered timber, and the recent fires from Leon Creek have marked the timber. For the safety of adjacent timber in the reserve this outlying fragment must necessarily be patrolled.

From these facts there appears to be every reason for including this fraction and none for excluding it.

MINING OPERATIONS.

Aside from a few parties found prospecting in the eastern part of this reserve, no active mining operations were going on in the summer of 1898. There appear to be numerous deposits of coal, especially at several points on the east and south borders of the reserve, and at least one point (Coal Basin) within the reserve. The mining in this reserve has been confined chiefly to coal. The presence of gold and silver deposits is indicated only by the work of a few prospectors.

The several coal mines opened on Middle Thompson Creek, about 1885, are entirely exhausted, and were abandoned at least ten years ago.

As already mentioned elsewhere, there is a prospective coal mine in Coal Basin, at the head of Coal Creek. Work ceased on this some time in the spring of 1893. Prior to this date operations had been carried on about two or three years. Exact information could not be secured on the ground. The cause of discontinuance was the breaking of an air compressor. All the machinery is still intact at the entrance of the tunnel. It is reported that in the spring of 1899 work will be renewed on both the coal mine and railroad extending from the mine to Crystal River.

Various stories are extant among settlers and coal miners in neighboring towns as to the status of the land in this valley and canyon. It is alleged that the coal deposit to be taken out lies entirely beyond private ownings; that the land controlled is used only as a base from which to operate in coal beds lying on reservation lands. The truth or falsity of these stories did not, of course, come within the scope of the writer's investigations, so that no steps were taken to verify them.

An important consideration, however, in connection with the future operations in this mine is that its handling of fire, both at the mine and on its railroad, is sure to endanger the wooded slopes connected with Coal Creek Basin. Some of the largest bodies of spruce and fir lie on the high divides adjacent to the ridges bounding Coal Basin. The greatest precautions are necessary, therefore, to prevent disastrous fires in this valley. It is so completely shut in by precipitous walls as to be inaccessible, except at the mouth of the canyon on Crystal River.

The coal mines on Fourmile Creek are outside of the reserve, but very near the northeast corner. Extensive fires have emanated from the burning "slag piles" in this vicinity, involving all the neighboring wooded slopes. Special care is needed to prevent fire at this point from spreading to the reserve timber, which is only a few miles distant, and is connected with it by intervening grass, brush, and burned areas, with quantities of fallen timber.

Several small coal mines have been opened on the east side of Crystal River, outside and near the east border of the reserve, principally between the mouth of Coal Creek and the head of Clearwater Creek. Indications of coal veins were also found on the south border of the reserve, between the mouth of Anthracite and Hubbard creeks. A short dry canyon on the same border, about 3 miles west of the mouth of Hubbard Creek Canyon (Coal Basin), contains coal veins. At present these are operated entirely for local domestic use.

More distant outlying coal mines in active operation are situated on the Grand River in and near Newcastle.

Active prospecting for gold and silver within the reserve was observed only in the narrow canyon of Perham Creek, the region directly west of Sopris Peak. Numerous openings were seen also in the rocky canyon of Coal Creek, where prospecting was carried on several years ago, but is now abandoned.

POPULAR SENTIMENT TOWARD THE RESERVE.

The settlers who derive their water supply from streams protected by the forests of this reserve recognize to the fullest extent the importance of preserving this cover. Their feeling toward the maintenance of this reserve is generally favorable. They recognize in it a benefactor, and appreciate that its safety is assured only under the special protection of the Government.

What might be termed provisional antagonism is expressed by settlers who are uncertain as to whether the administration of the reserve will deprive them of some necessary privileges within it. For example, if the maintenance of the reserve means a restriction to them of domestic fuel, building timber, water rights (reservoirs), etc., they are opposed to the reserve policy. If these privileges are granted, the reserve is considered a benefaction.

The majority of settlers are entirely uninformed as to the policy of the Government and its administration of the reserve. Many have "heard" of a penalty for cutting timber. As a rule their common sense has prompted them to believe that they are entitled to use dead timber for domestic purposes, notwithstanding the fact that in 1898 several settlers were actually warned by "timber agents" not to take it under penalty of arrest. These warnings were given in the region of Wallace and Cache creeks. Regarding other privileges, however, they are less venturesome and are eager to be informed.

The attempt to reach these people by distributing "rules and regulations" through fire rangers appears to be altogether inadequate. A few postmasters and prominent settlers may get copies, but the mass of interested people are entirely without information. It seems urgent that the people of the region should be acquainted with the Government's policy respecting the administration of this reserve. An effectual plan of reaching them would be to require of all local postmasters a full list of people receiving mail at their offices. With such lists in hand, the General Land Office could supply settlers with copies of "Rules and regulations governing forest reserves," with the surety of giving much-needed information. It is not desirable to send supplies of this publication to postmasters and officers of the reservation fire service, and rely on these persons entirely to distribute "copies where they are needed." The method is too desultory.

THE FLATHEAD FOREST RESERVE.

By H. B. Ayres.

BOUNDARIES.

Beginning at the southwest corner of township thirty-three (33) north, range twenty-five (25) west, principal meridian, Montana; thence easterly along the surveyed and unsurveyed eighth (8th) standard parallel north, to the northeast corner of township thirty-two (32) north, range twenty-two (22) west; thence southerly along the range line between ranges twenty-one (21) and twenty-two (22) west, to the southeast corner of section thirteen (13) of said township thirty-two (32) north, range twenty-two (22) west; thence easterly along the unsurveyed section line to the point for the southeast corner of section thirteen (13), township thirty-two (32) north, range eighteen (18) west; thence southerly along the unsurveyed range line between ranges seventeen (17) and eighteen (18) west, to the northwest corner of township thirty-one (31) north, range seventeen (17) west; thence easterly along the township line between townships thirty-one (31) and thirty-two (32) north, to the northwest corner of section two (2), township thirty-one (31) north, range seventeen (17) west; thence along the section lines, southerly to the southwest corner of section twenty-three (23), and easterly to the northeast corner of section twenty-five (25), said township; thence southerly along the range line between ranges sixteen (16) and seventeen (17) west, to the southeast corner of said township thirty-one (31) north, range seventeen (17) west; thence easterly along the unsurveyed township line between townships thirty (30) and thirty-one (31) north, to the point for the southeast corner of township thirty-one (31) north, range sixteen (16) west; thence southerly along the unsurveyed range line between ranges fifteen (15) and sixteen (16) west, to the point for the southwest corner of township thirty (30) north, range fifteen (15) west; thence easterly along the unsurveyed township line between townships twenty-nine (29) and thirty (30) north, to the point for the southeast corner of said township thirty (30) north; thence northerly along the unsurveyed range line between ranges fourteen (14) and fifteen (15) west, to the point for the southeast corner of section thirteen (13), said township thirty (30) north, range fifteen (15) west; thence along the unsurveyed section lines, easterly to the point for the southeast corner section sixteen (16), and northerly to the point for the northeast corner of section four (4), township thirty (30) north, range fourteen (14) west; thence easterly along the unsurveyed township line between townships thirty (30) and thirty-one (31) north, to the point for the southeast corner of township thirty-one (31) north, range fourteen (14) west; thence northerly along the unsurveyed range line between ranges thirteen (13) and fourteen (14) west, to the point where it will intersect the west boundary of the Blackfeet Indian Reservation, as said boundary is defined and described in the act of Congress approved June tenth, eighteen hundred and ninety-six, entitled "An act making appropriations for current and contingent expenses of the Indian department and fulfilling treaty stipulations with various Indian tribes for the fiscal year ending June thirtieth, eighteen hundred and ninety-seven, and for other purposes;" thence northwesterly along the boundary of said Indian reservation to its point of intersection with the international boundary line between the State of Montana and the British possessions; thence westerly along said international boundary line to the point for the unsurveyed range line between ranges twenty-five (25) and twenty-six (26) west; thence southerly along the unsurveyed range line between ranges twenty-five (25) and twenty-six (26) west, to the ninth (9th) standard parallel north; thence easterly along said parallel to the northeast corner of township thirty-six (36) north, range twenty-six (26) west; thence southerly along the range line between ranges twenty-five (25) and twenty-six (26) west, to the southwest corner of township thirty-three (33) north, range twenty-five (25) west, the place of beginning.

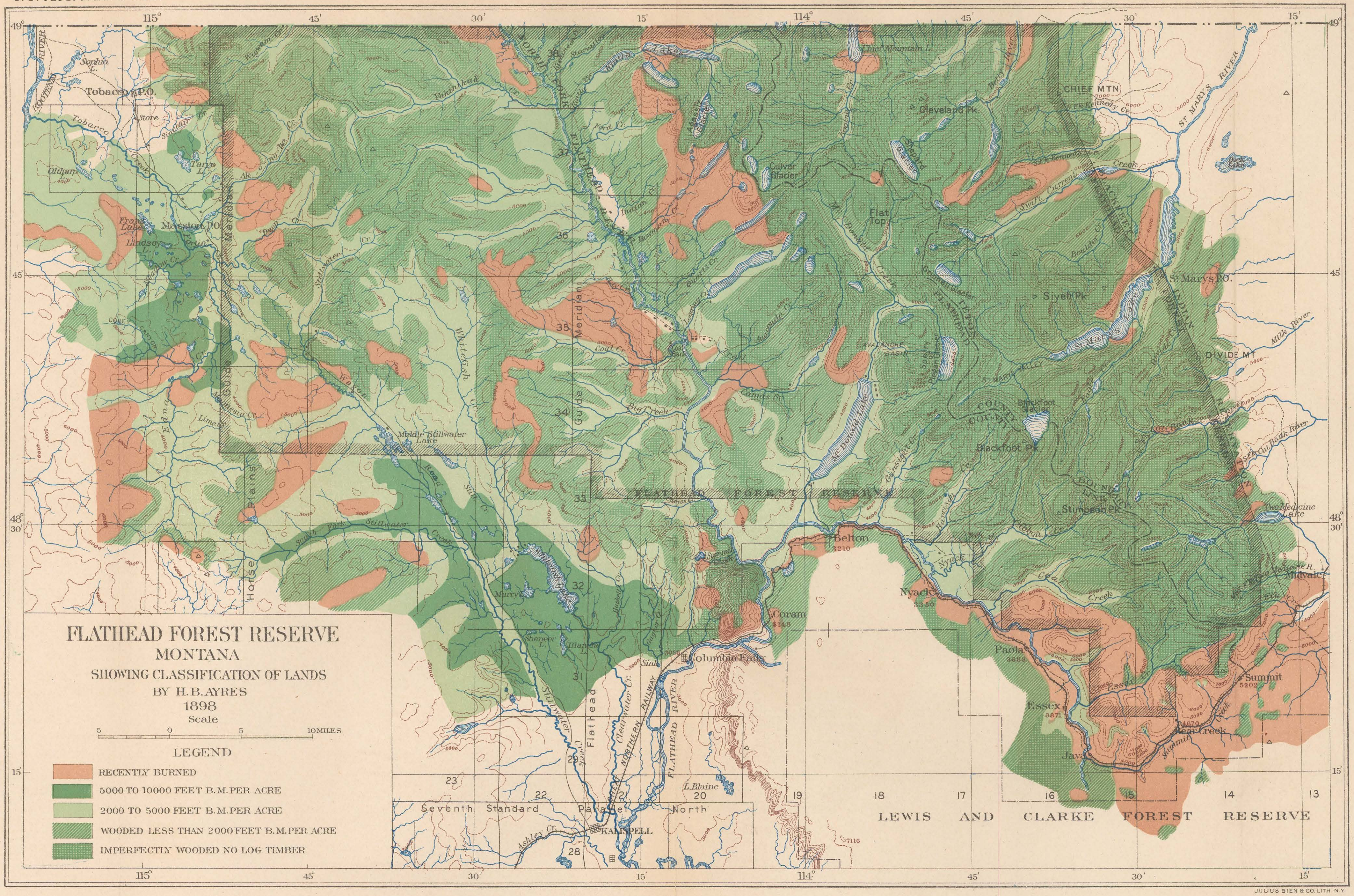
TOPOGRAPHY.

Mountains.—The two mountain ranges bearing southeastward across this reserve are each wider on the international boundary than on the Great Northern Railway. They are also higher and more rugged northward. The western or Whitefish Range is about 6 miles wide and 6,000 feet high along the railroad, while along Grave Creek Pass it is about 20 miles wide, and the highest points are about 8,000 feet, as determined by Mr. Louis Nell in 1883. The eastern range, on which lies the Continental Divide, is about 16 miles wide, with peaks 7,000 to 9,000 feet high along the railroad, while near the international line it is some 25 miles wide, with the highest peaks about 11,000 feet, as determined by Mr. A. H. Thompson in 1898.

The western range is characterized by pyramidal peaks, with long combs leading up to them and deep gorges between, while the mountains of the main divide are flat topped, with precipitous sides, and deep, glaciated, U-shaped canyons. In the western range few drifts and slides of snow linger through the season, but in the main range are many snow fields and glaciers.

Valleys.—The two mountain ranges are separated by the valley of the North Fork of Flathead River, which, including the morainic ridges between tributary valleys, continues about 15 miles wide from the boundary to near Camas Creek, over 30 miles from the boundary, where it is interrupted by ridges from the east. The river here leaves the valley and cuts across a spur of the Whitefish Range to join the Middle Fork below Belton, while, excepting the ridges about McDonald Lake, the valley continues southeastward up the Middle Fork. West of the Whitefish Range a broad, continuous valley leads across the low divide between Tobacco Plains on the Kootenai and Columbia flats on the Flathead drainage.

Drainage.—The waters from this reserve are divided between four great river systems. The Kootenai drains about 200 square miles, the Flathead about 1,500, the Saskatchewan about 280, and the Missouri about 180. The North Fork and Middle Fork of the Flathead leave the reserve as rivers. The North Fork early in October is



JULIUS BIEN & CO. LITH. N.Y.

usually about 300 feet wide and 2 feet deep at its mouth, and is rapid. The Middle Fork, which receives about half of its waters from the Flathead Reserve and half from the Lewis and Clarke, brings to the junction about 75 per cent as much water as the North Fork. Other streams as they leave the reserve are not large, Kootna, Belly, Swift Current, and St. Marys being the only ones that might be called rivers. These are usually fordable. They were easily forded in September, 1898.

CLIMATE.

Notes were made of the days on which rain or snow fell, as follows:

Date.	Rain or snow.	Date.	Rain or snow.
July 13	Rain.	Sept. 8	Rain.
18	Rain.	22	Snow squalls.
19	Rain, with snow on peaks of Whitefish Range.	27	Snow.
		28	Snow.
22	Rain.	29	Snow.
23	Rain.	30	Snow.
Aug. 3	Showers.	Oct. 1	Snow.
4	Rain.	2	Snow.
8	Sprinkle of rain.	10	Snow and rain.
21	Heavy thunderstorm.	11	Snow and rain.
22	Rain.	13	Mist.
23	Rain.	14	Snow and rain.
26	Light rain.	15	Snow and rain.
31	Rain.	18	Heavy snow in evening.
Sept. 1	Rain.	22	Rain.
3	Rain.	23	Rain.
4	Rain, with snow on mountains.	31	Variable.
		Nov. 3	Snow.

Rain or snow was frequently noticed on the mountains, while the large valleys and the plains east of the mountains remained dry. Such storms were especially common during September and October east of the mountains with west wind (Pl. CIV, *A*).

THE TREES.

Mr. Sudworth has kindly furnished the latest botanical names for the trees of the following list.

Some doubt exists as to whether black spruce grows within the reserve. It is therefore marked with an interrogation point.

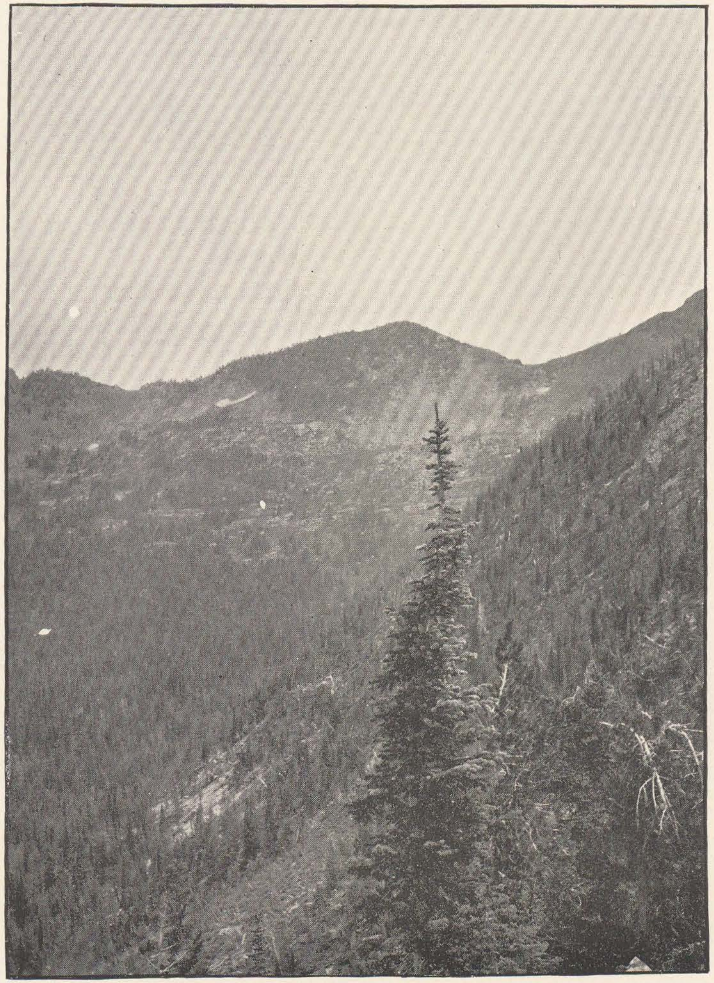
White pine............... Pinus monticola Dougl.
Limber pine.............. Pinus flexilis James.
Nut pine................. Pinus albicaulis Engelm.

Yellow or bull pine	Pinus ponderosa Laws.
Lodgepole pine	Pinus murrayana "Oreg. Com."
Larch	Larix occidentalis Nutt.
Mountain larch	Larix lyallii Parl.
Black spruce (?)	Picea mariana (Mill.) B. S. P.
White spruce	Picea canadensis (Mill.) B. S. P.
Engelmann spruce	Picea engelmanni Engelm.
Hemlock	Tsuga heterophylla (Raf.) Sargent.
Red fir	Pseudotsuga taxifolia (Lam.) Britton.
Balsam	Abies lasiocarpa (Hook.) Nutt.
Silver fir	Abies grandis Lindl.
Cedar	Thuja plicata Don.
Red cedar	Juniperus scopulorum Sargent.
Aspen	Populus tremuloides Michx.
Balsam	Populus balsamifera Linn.
Cottonwood	Populus trichocarpa Torr. & Gr.
White birch	Betula papyrifera Marsh.

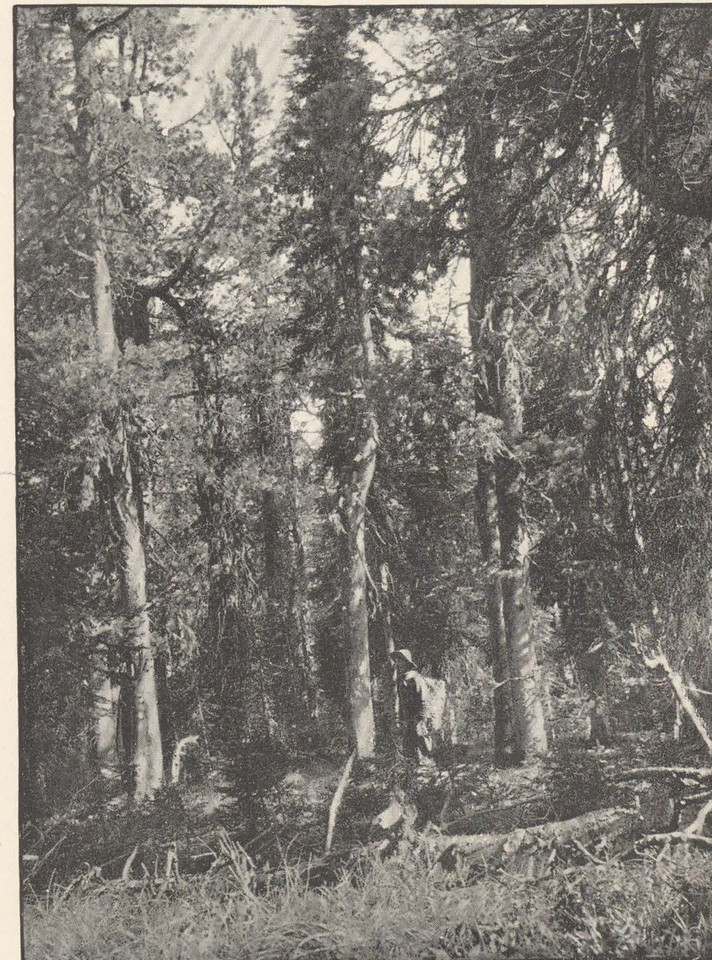
THE SHRUBS.

The following list of shrubs has been made with the kind assistance of Mr. F. V. Coville:

Laurel	Kalmia microphylla.
Birch	Betula occidentalis.
Dwarf birch	Betula glandulosa.
Spiræa	Spiræa lucida.
Oregon grape	Berberis repens.
Brittle brush	Menziesia glabella.
Five-finger	Potentilla fruticosa.
Silver bush	Elæagnus argentea.
Willow	Salix amygdaloides. Salix monticola (?) Salix vestita.
Dogwood	Cornus stolonifera.
Mountain ash	Sorbus sambucifolia.
Huckleberry	Vaccinium membranaceum.
Alder	Alnus sinuata. Alnus tenuifolia.
Maple	Acer glabrum.
Thorn	Cratægus douglasii.
Elder	Sambucus melanocarpa.
Highbush cranberry	Viburnum pauciflorum.
Squawberry	Lepargyræa canadensis.
Yew	Taxus brevifolia.
Juniper	Juniperus communis.
Creeping juniper	Juniperus sabina.
Red cedar	Juniperus scopulorum.
Snowberry	Symphoricarpos occidentalis.
Service berry	Amelanchier alnifolia.
Devil's club	Echinopanax horridus.
Thimble berry	Rubus parviflorus.
Red raspberry	Rubus strigosus.
Currant	Ribes viscosissimum. Ribes lacustre.
Gooseberry	Ribes saxosum.



A. HEAD OF INDEPENDENCE BASIN, EAST OF TOBACCO PLAINS, ABOVE INDEPENDENCE MINES.



B. NUT PINE (PINUS ALBICAULIS), WHITEFISH RIDGE, NORTHEAST OF WHITEFISH LAKE

DISTRIBUTION OF SPECIES.

For convenience in describing the habitat of species the reserve may be divided into three classes of land, viz: (1) Alpine; (2) mountain slopes; (3) lowlands.

There are but few sharply-drawn lines of distribution in the natural forest, and the species interlap over these broad lines according to exposure, moisture, and prevalence of fire.

THE ALPINE REGION.

This comprises the higher summits, basins, and slopes, generally above 6,000 feet. The species are Engelmann spruce, balsam, nut pine, and mountain larch. On the dry spurs leading up to the mountains, lodgepole pine, and on talus slopes, red fir, reach near the alpine region, while in damp, cold ravines balsam and Englemann spruce reach far below it. The hardiest tree of this region is the larch (*Larix lyallii*), but its distribution is not general. It was seen only within 15 miles of the Canadian boundary, and near glaciers or lingering snow. It mingles with the other alpine species, but is never densely crowded. In moist basins it ascends higher and shows more vigor than they.

Balsam (*Abies lasiocarpa*) is found throughout the region. At uppermost limits it is matted on the ground, seldom sending up a leader. In lower mountain regions it mingles with other species with habit like that of *Abies balsamea*. An intermediate form is found in the grassy mountain basins or parks having an elevation from 6,000 to 8,000 feet, with lower branches long and pliant and matted on the ground, while the upper are short and rigid. These grow singly or in small groups of remarkable beauty, the central tree of the group usually the largest.

Nut pine (*Pinus albicaulis*), limited to the high altitudes, is sometimes crowded in forests, but more frequently is isolated in grassy parks near lingering snow (Pl. LXXVIII, *B*) where the trunks are usually short, crooked, and defective, and the characteristic crown is more open and eccentric as the upper limit is neared.

Engelmann spruce (*Picea engelmanni*) has very nearly the same distribution as the balsam, but is rather less of an alpine tree, and extends farther into the bottoms and farther down the eastern foothills, even reaching out on the plains several miles, forming brush prairie with aspen and willow, at an elevation of about 5,000 feet. In deep, moist canyons, at about 5,000 feet, this is a large timber tree, rivaling the lowland larch.

THE MOUNTAIN SLOPES.

These are the middle grounds in which the species (excepting the mountain larch and the yellow pine) mingle, and according to exposure, moisture, and prevalence of fire, alternate in predominance (Pl.

LXXIX, *A*). The higher moist and northern slopes in this intermediate region are ruled by spruce and balsam, the latter usually subordinate. The long morainic ridges leading away from the mountain spurs are mostly usurped by lodgepole pine, while the sunny slopes, especially if rocky, are shared with and often ruled by red fir. As the Engelmann spruce and balsam follow the water courses they are met at an altitude of 5,000 to 6,000 feet by lowland larch, silver fir, hemlock, cedar, and white pine. These species are not definitely limited by altitude, but rather by degrees of moisture and exposure to winds. The silver fir is always well sheltered; the larch, while somewhat exposed to wind in low altitudes, yet seems to need shelter from the alpine storms and requires a subsoil through which it can reach constant water. Hemlock, white cedar, and white pine keep even closer to water, and thrive well enough to make timber trees only in the ravines of the Stillwater drainage and in the sheltered valley of the Flathead and its middle fork. The white pine was not seen east of the Continental Divide, and but few small specimens of white cedar and hemlock were seen in the valley above Upper St. Marys Lake. Lodgepole pine, Engelmann spruce, and red fir are the principal trees of the middle slopes.

THE LOWLANDS.

The principal timber tree of the valleys is larch, which is there a bench-land tree (Pl. LXXX, *B*). Red fir, spruce, and yellow pine follow. The spruce is most abundant on bottoms, and the yellow pine on dry benches and terraces (Pl. LXXX, *A*). Cottonwood, as usual, follows the stream banks, and the nomadic aspen seeks the borderland of forest and prairie.

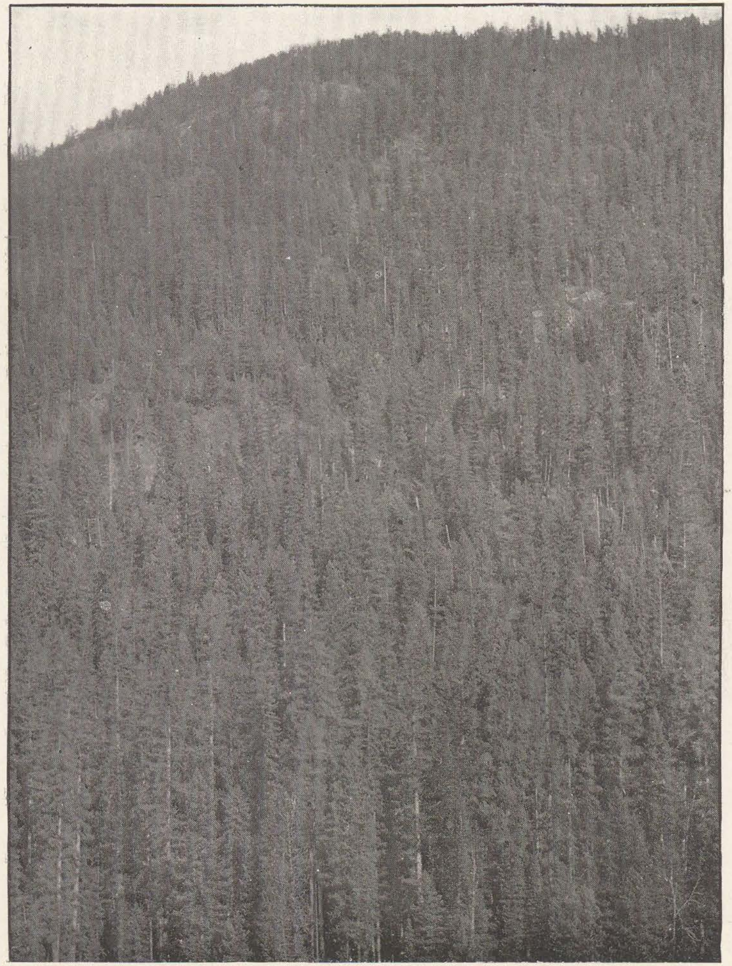
Red cedar (*Juniperus scopulorum*) occurs sparingly as a very small tree in the valley of the North Fork of Flathead River and on the eastern foothills bordering the plains.

DISTRIBUTION OF TIMBER.

THE LOWLANDS.

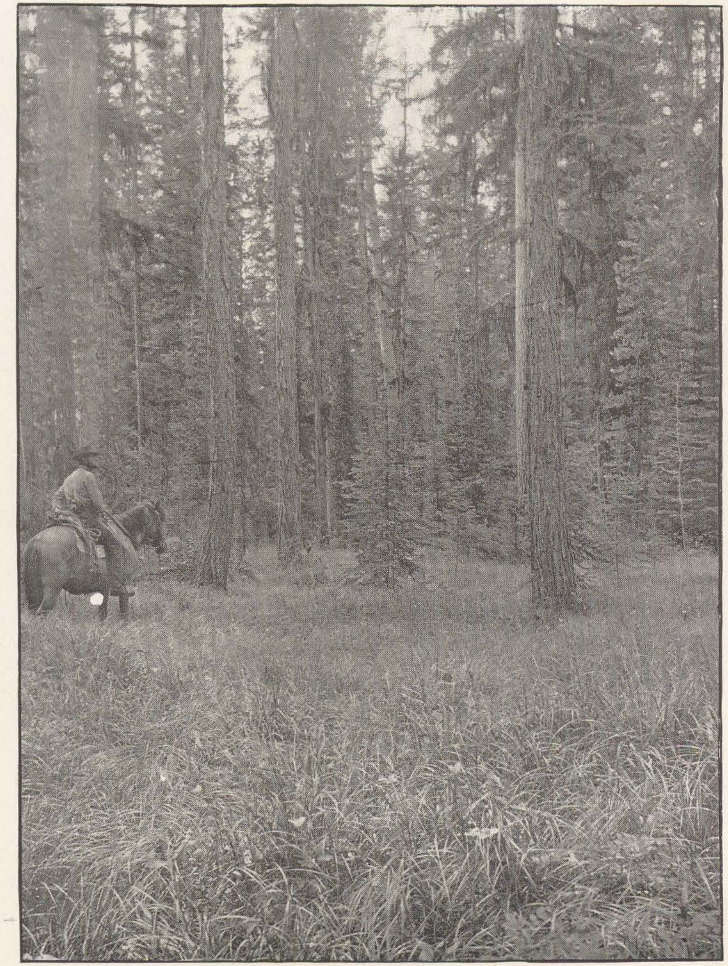
Larch, red fir, spruce, and yellow pine, comprising the greater part of the log timber, dot the bench lands and plains of the Tobacco, Stillwater, and Whitefish valleys, and also, growing more densely but smaller, with white pine, hemlock, and cedar, cover the valley from Flathead Gap to the head of McDonald Lake and the unburned portion of the Middle Fork of Flathead and its tributaries. These are both large tracts of continuous timber land, the former containing 145 square miles and about 225 million feet of log timber, the latter 70 square miles and about 100 million feet.

Small, isolated areas of white pine, larch, spruce, and cedar occur in the valleys of the western tributaries of the North Fork of Flathead



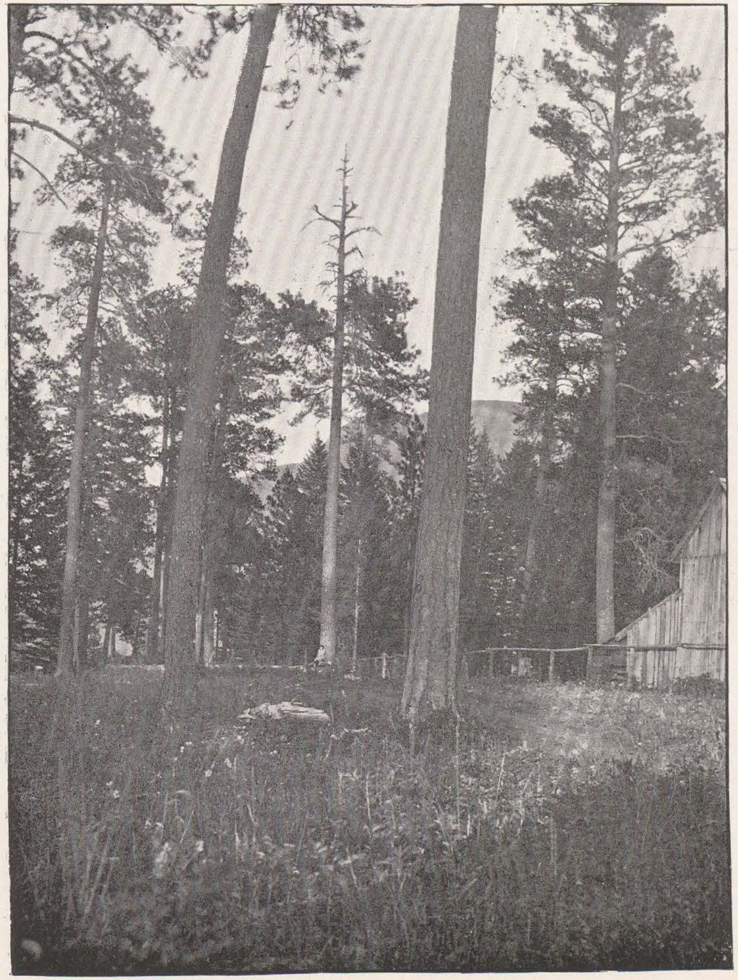
A. SLOPE BELOW MOUTH OF COAL CREEK, MIDDLE FORK OF FLATHEAD RIVER.

Red fir, larch, lodgepole pine, and balsam.

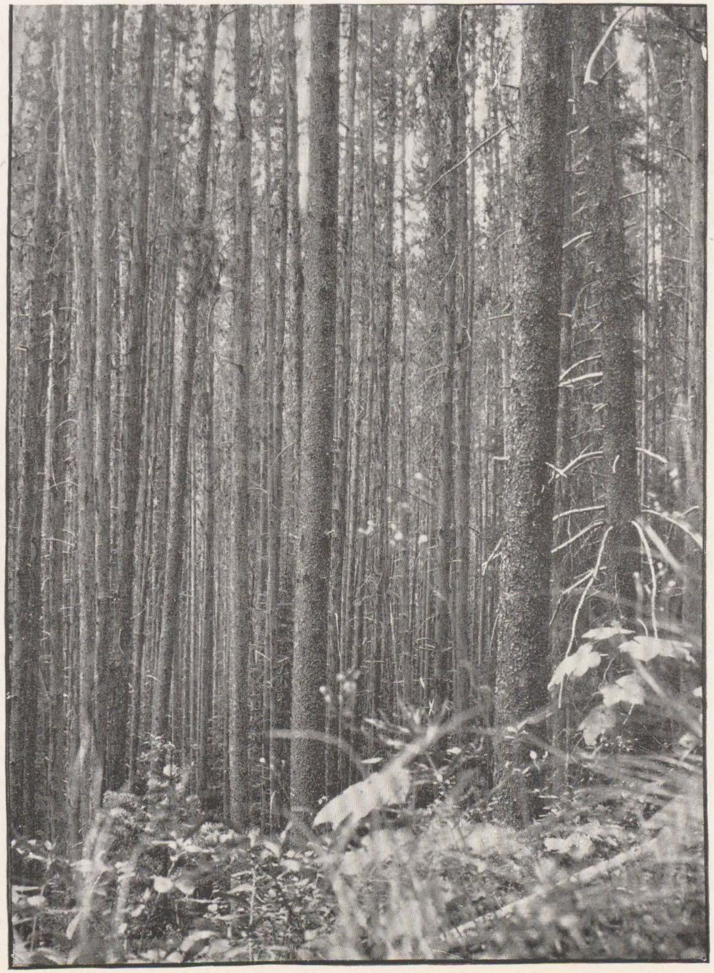


B. HALF-WOODED LAND ON FORTIN CREEK.

Seedlings of larch and red fir among pine grass.



A. YELLOW PINE (PINUS PONDEROSA) ON BENCH LAND, 1 MILE EAST OF COLUMBIA FALLS.



B. HEAVY STAND OF LODGEPOLE PINE (PINUS MURRAYANA) ON YAKINIKAK CREEK.

Trees 6 to 12 inches in diameter.

River, and south of Logging Creek is a small area of yellow pine surrounded by larch, spruce, and red fir. Elsewhere in the valley of the North Fork the timber is principally scattered larch that has survived the frequent fires.

East of the mountains log timber is limited to the deep and sheltered canyons, where spruce, red fir, and lodgepole pine, though small and knotty, are especially valuable because near the treeless plains.

THE MOUNTAIN SLOPES.

The spruce, lodgepole pine, and red fir covering the slopes, while often large enough for log timber west of the mountains, are eastward seldom large enough to saw, and at present have no market value on the stump. The Whitefish Range and the higher slopes of the valley of the North Fork of Flathead River have some 238 million feet. There is little elsewhere on such land.

THE ALPINE REGION.

While some trees are large enough for the mill, they are so few and so inaccessible they must wait local demand such as mining operations might create before they can be used. The few trees fit for the saw in these high altitudes are in sheltered places, usually confined to the gulches.

ESTIMATES.

It is hoped that no one reading this report will think it possible to estimate accurately the amount of timber on the 4,000 square miles of mountain forest, difficult of access, covered during the four months' field work devoted to this reserve. About 56 square miles could have been thoroughly examined in that time, and an estimate within 10 per cent of the actual cut could have been made. It is hoped that the present estimate, covering about 36 square miles a day, will approach within 50 per cent of the actual amount. It is believed the estimates given are "safe" ones and that all variations will prove in excess of the estimates. The region east of the Continental Divide was estimated closer than that west of it, not only because of the scarcity and greater value of timber there, but also because, as it lies in deep canyons, one must pass through it to see it at all. In contrast with these hidden canyons, large areas in the Whitefish Range and in the Stillwater Valley could be seen at once from the higher points. In such places generalizations were made, and details were used only when traveling, as a check, or to determine representative stock on certain characteristic lands.

The estimates given under the description of the several natural subdivisions are summarized on the next page.

Estimate of timber, Flathead Forest Reserve.

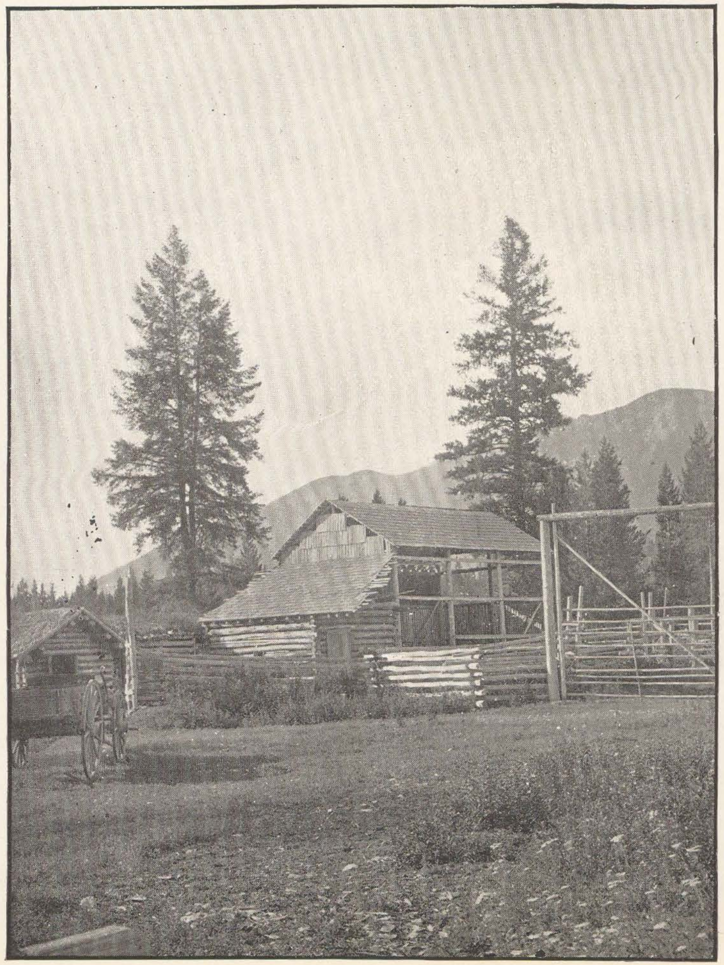
Locality.	Area.	Lumber.	Small wood.
	Sq. miles.	*Million feet B. M.*	*Cords.*
Columbia Flats and Stillwater Valley	75	125	300, 000
Edna and Fortin creeks	70	115	230, 000
Akanoho or Grave Creek	10	16	100, 000
Whitefish Range	550	238	1, 000, 000
Yakinikak Creek	80	10	26, 000
North Fork of Flathead (lower benches)	100	15	30, 000
Eastern tributaries of the North Fork of Flathead River	300	95	500, 000
McDonald Creek	12	28	75, 000
Flat Top	50	....	60, 000
Kootna Creek	95	4	10, 000
Belly River	20	10	18, 000
Lees Creek	30	3	50, 000
Kennedy creeks	35	....	10, 000
Swift Current Creek	50	25	400, 000
Boulder Creek	18	3	50, 000
St. Marys River	120	16	60, 000
Divide and Red Eagle creeks	20	6	65, 000
Cut Bank Creek	14	1	70, 000
South Fork Cut Bank Creek	3	....	10, 000
Two Medicine Creek	17	10	50, 000
Middle Fork and Elk creeks	8	6	90, 000
Summit Creek	75	(45 M.)	24, 000
Middle Fork of Flathead River	190	125	400, 000
Total	1, 942	851	3, 628, 000

The remaining 218 square miles have no trees large enough for use.

These estimates, in feet, B. M., are intended to include all material that would make a log 8 inches in diameter at the small end and 16 feet long, although present custom west of the mountains is that a log must be 12 inches in diameter at the small end and sound.

Under the present custom the amount of log timber now having a stumpage value would be about 300 million feet, distributed as follows:

	Million feet.
On Stillwater and Whitefish	100
Edna and Fortin	50
North Fork of Flathead	25
McDonald Lake and Creek	25
Middle Fork of Flathead	100



A. BARN OF DAVID STRYKER ON SEC. 36, T. 34 N., R. 25 W.

B. BOGUS HOMESTEAD, HEAD OF LONG PRAIRIE, VALLEY OF NORTH FORK OF FLATHEAD RIVER

To give some idea of the amount of smaller wood material, cords were used, the estimate being made according to the custom in the Eastern States, and including all sound and straight material over 4 inches in diameter.

OCCUPANCY.

On the Tobacco Plains road within the reserve five occupied houses were seen, and four of these had gardens and fields. David Stryker, on sec. 36, T. 34 N., R. 25 W., had about 80 acres under cultivation (Pl. LXXXI, *A*). Several prospectors' cabins on Deep Creek, and C. F. Pemberton's on Akanoho, are occupied during part of the year. In the valley of the North Fork of Flathead River some thirty unoccupied cabins were seen (Pl.XXXI, *B*). Many of these were in a tumble-down condition. Four or five of them would be habitable with some repairs. At the Coal Banks on Coal Creek are several substantial buildings, occupied at times by prospectors. On Camas Creek two houses were found in good repair. Four prospectors' cabins were seen on the McDonald Creek drainage above the lake, one of them occupied. There is a cabin on the South Fork of Kennedy Creek, and several are on Swift Current and Boulder creeks (Pl. LXXXII, *A*). Henry R. Norris, by allotment to his Indian wife Rachel and their children, is holding 280 acres just below Upper St. Marys Lake. St. Marys Village, composed of about twenty log buildings, is entirely on the reserve. In the valley of the Middle Fork of Flathead River and on Mud Creek are three or four cabins occupied by trappers. Near the mouth of Harrison Creek Mr. Daniel Dooty is living. Mr. Dooty is one of the forest rangers for the reserve. About the head of McDonald Lake are four or more buildings used as hotels for tourists in summer, and at the foot of the lake are as many more used for the same purpose. A neat steam launch makes daily trips across the lake, meeting a stage from Belton on the railroad. At Summit Lake, north of Columbia Falls, are two hunting cabins. At the head of Whitefish Creek is a prospector's cabin. In none of these places does agriculture alone support a family (Pl. LXXXII, *B*).

AGRICULTURE.

As yet the possibilities of agriculture on the lands included within the reserve are mostly conjectural; adjacent lands on Tobacco Plains and in the Stillwater Valley have been tried, and have proved productive, but the variations of temperature and moisture between the different locations are so very great that each needs trial before definite statements can be made of their capabilities, except, perhaps, in the line of producing grasses and hay. On natural prairies or meadows producing abundant natural forage, one may feel assured that cattle and horses would do well provided the lands are accessible and not too long covered by snow. Timothy has been generally introduced in small quantities along the trails by horses passing over them, and everywhere on the moist lands it grows luxuriantly. Our horses noticeably preferred the natural grasses, especially after frost.

The Upper Stillwater Valley is now partly occupied by ranchers whose farm labors are supplemented by boarding travelers. Along the Tobacco Plains road is the only cultivated farm land within the reserve, and here vegetables and hay are almost the only crops. The portion of the Whitefish Valley within the reserve, all wooded and probably more liable to frosts, has no certain agricultural value at present. The valley of the North Fork of Flathead is plainly valuable for grazing and hay and probably for grain, but it is said to be liable to deep snows in winter. (It was free from snow the 1st of November, though the surrounding mountains were covered.) This valley would have been entered by actual settlers before this but for its difficulty of access. A poor trail from Belton and Tobacco Plains, and a very bad one from Columbia Falls, do not afford means of bringing in or taking out stock or produce. A wagon road from Belton to Camas Creek, 15 miles long, through moderately rough land, heavily wooded, would open the valley to settlement. Some 50 square miles near the river would then prove of value for ranching.

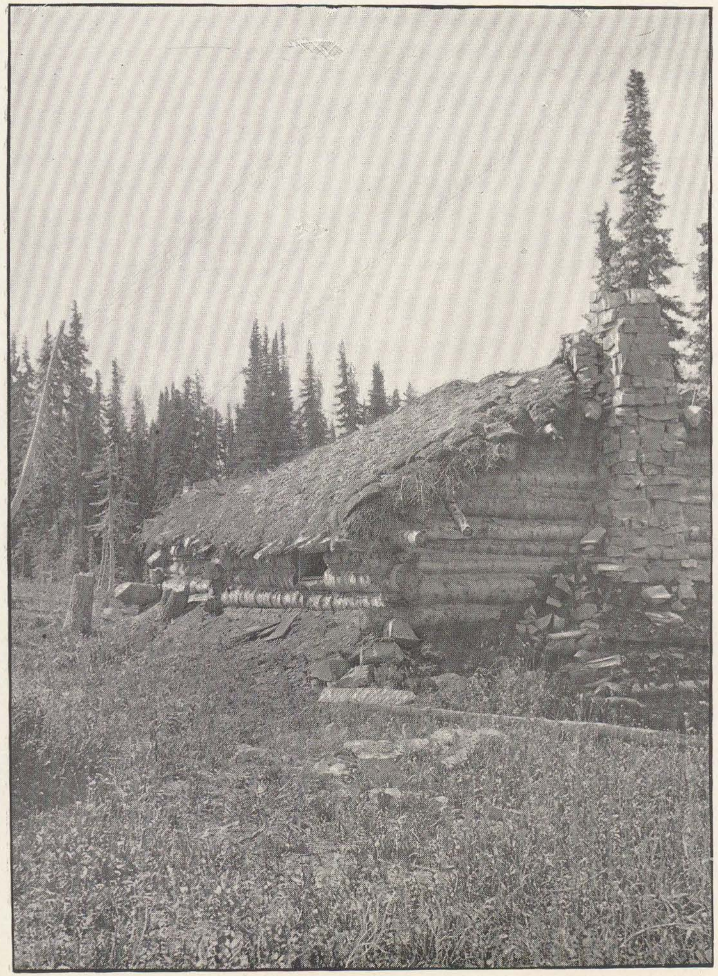
The Middle Fork of Flathead River and its eastern tributaries have land that would grow hay, but, excepting perhaps 1,000 acres in the whole valley, it is all so densely wooded that the cost of clearing would be more than the cleared land would be worth for general farm use.

The narrow valleys east of the Continental Divide, excepting the North Fork of Kennedy Creek, Boulder Creek, Divide Creek, and the Middle Fork of Two Medicine Creek, would afford favorable locations for growing hay and feeding a limited amount of stock.

Except in the valley of the North Fork of Flathead River there is no agricultural land that should be opened to settlement if this reserve is to be protected from fire, for none of these valleys would support an agricultural population, but all would furnish good locations for forest rangers who by some farming on such lands could occupy their time when not employed on the reserve.

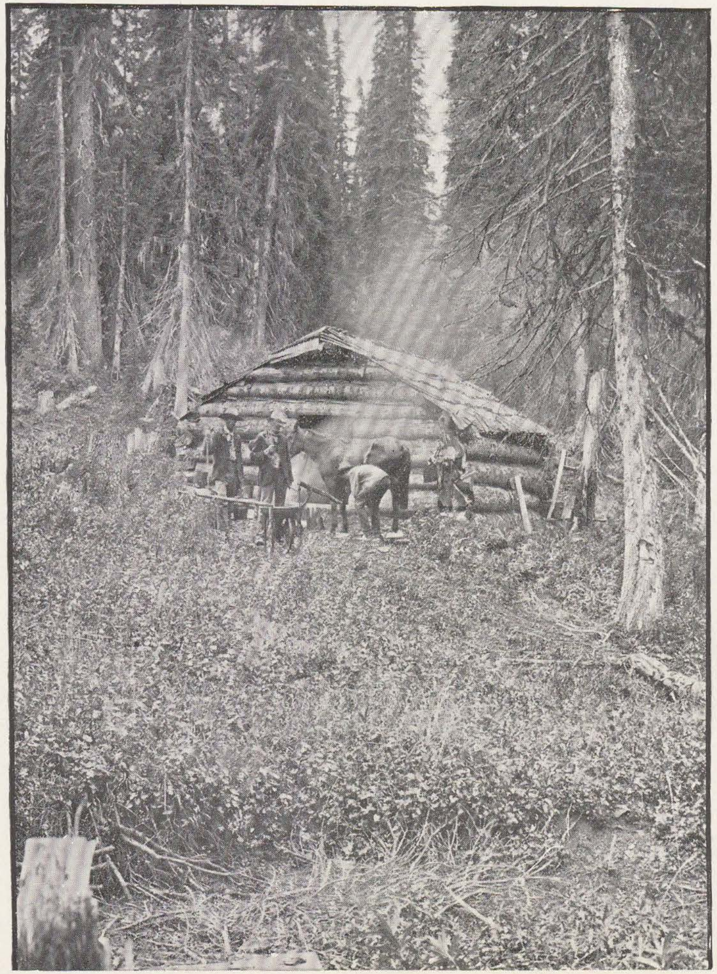
MINING.

On the entire reserve there are no mines shipping ore. About fifty prospects were noticed, on which assessment work and development were being done (Pl. LXXXIII, *A*). Most of the ores are of either copper pyrites or gray copper in nearly vertical veins, cutting limestones and quartzites. Lignite coal crops out in many places in the valley of the North Fork of Flathead River, and it is said that hard coal and petroleum have also been found in this valley.



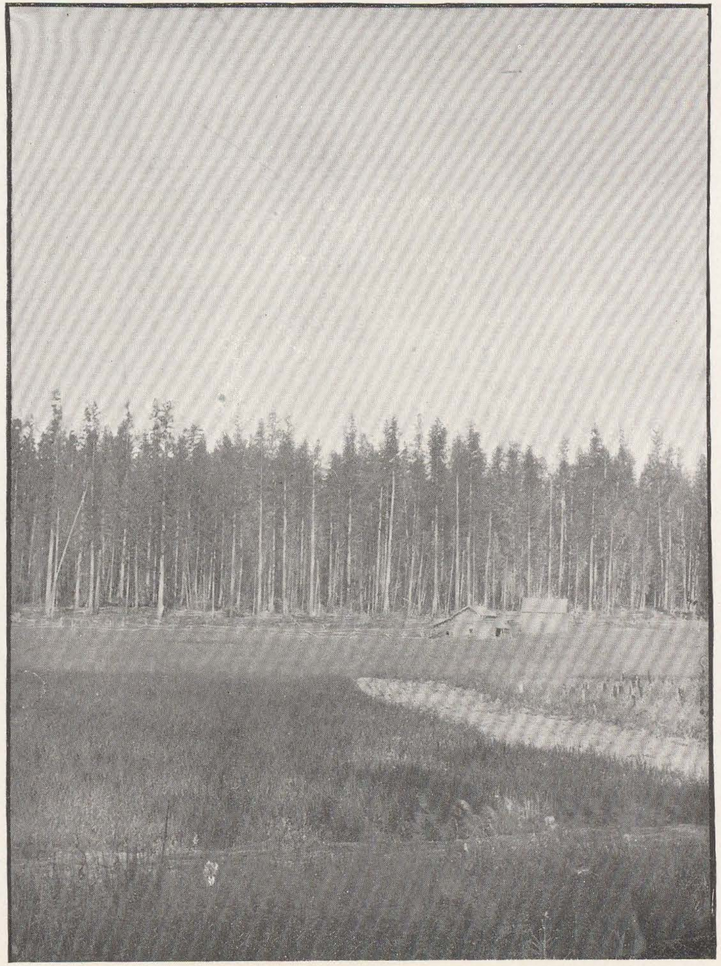
A. PROSPECTOR'S CABIN, 1 MILE WEST OF SWIFT CURRENT PASS.

B. HOMESTEAD, COAL BANK TRAIL, NORTHEAST OF COLUMBIA FALLS.



A PROSPECTOR'S CABIN, COLLINS CREEK.

Balsam (Abies lasiocarpa) and spruce (Picea engelmanni).



B. HOMESTEAD ON NATURAL MEADOW, SURROUNDED BY LARCH (LARIX OCCIDENTALIS), VALLEY OF WHITEFISH CREEK.

Limestone occurs in large quantity. Some of the lower beds are subcrystalline.

Green schist, gray and white limestone, buff dolomites, red quartzites (often shaly), and dark amygdaloids constitute the great part of the mountain ranges, while tilted Cretaceous beds occupy the valley of the North Fork of Flathead and the lower portions of the valleys east of the Continental Divide.

DETAILED DESCRIPTION OF VALLEYS.

COLUMBIA FLATS AND THE STILLWATER VALLEY.

Topography.—Between the Stillwater River and the mountains eastward, and bounded on the south by a line west from Columbia Falls, lies a gently sloping area of about 275 square miles, 75 of which lie within the reserve and 200 outside. The river is bordered by a narrow bottom, with bluffs seldom over 100 feet high. Above the bluffs the land rises quite gently and uniformly toward the mountains, this gentle slope merging into rolling areas of gravel and bowlder clay, and these into hills determined by underlying rock, which grade into the mountain slopes.

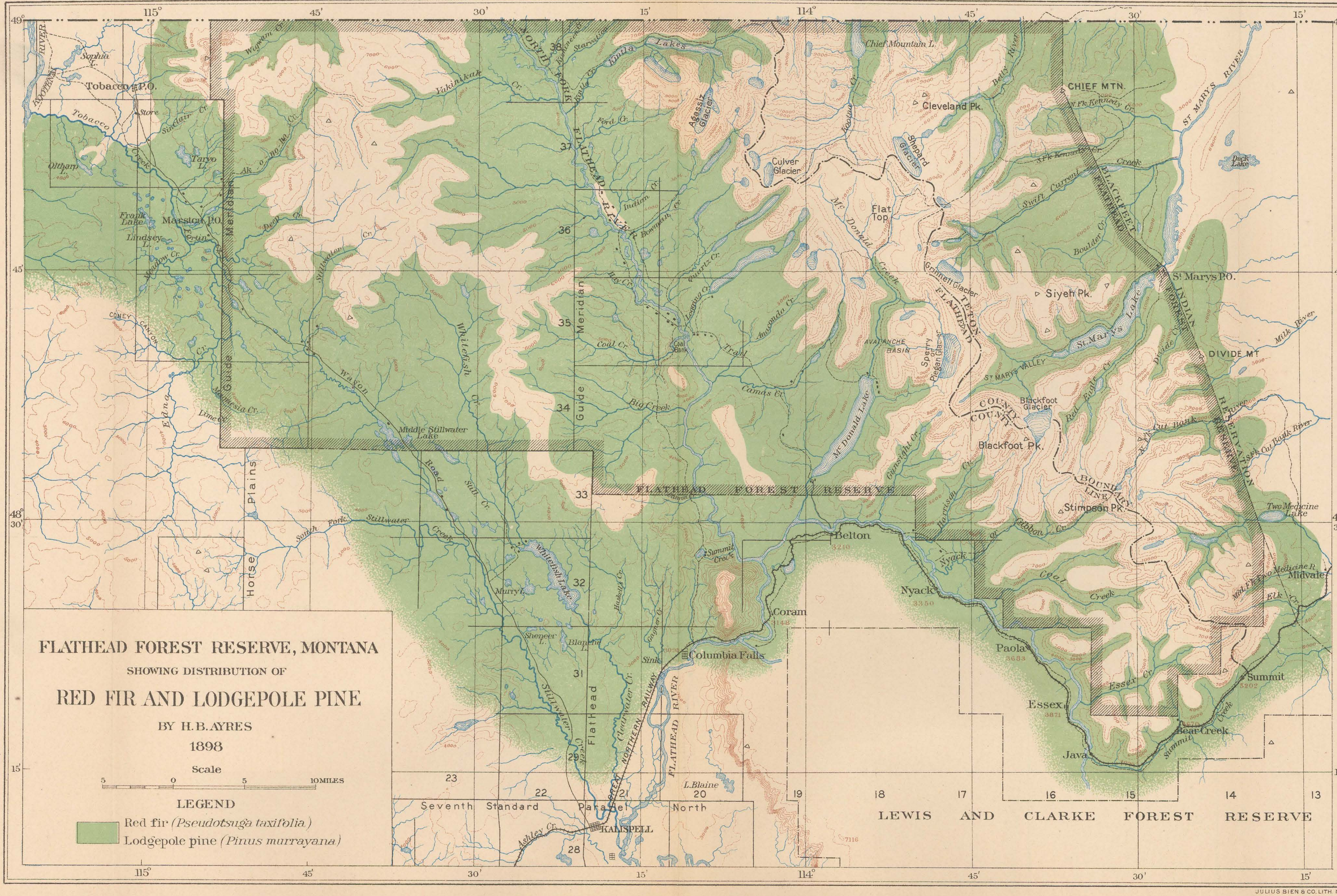
Soil.—In the greater portion of this area of modified drift gravels are abundant, especially near the water courses, and heavy clays are rare. Nearing the northern or upper end of the valley gravel pre dominates, and siliceous schist crops out frequently in sharp bluffs along ridges parallel to the streams. In the lower portion of the valleys the soils are finer and darker and the subsoils are frequently deep gravels. Such areas are usually prairie.

Litter.—Of litter there is a medium amount. There is very little upon the sandy and gravelly pine land, but on the finer alluvial soils, and especially near the mountains, where moisture seems to be more abundant, there is so much litter as to make it difficult to take horses through. In general the amount of litter increases when the forest is densely crowded and free from fire, and the small trees killed by overcrowding fall and accumulate upon the surface.

Humus.—The humus varies with the soil and with the frequency of fire, ranging from very little or none on the most sandy and most frequently-burned lands, to several inches on tracts where the soil is loamy and well moistened.

Trees and timber.—This whole area, excepting small prairies and meadows, is timbered with larch, red fir, and lodgepole pine, with small quantities of other species in mixture; and, on the lower gravelly and sandy lands, with irregular patches of yellow pine. On the clayey lands larch is by far the leading tree in height and size, forming perhaps 75 per cent of the timber at present marketable, while Douglas spruce may form 15 per cent, yellow pine 5 per cent, and lodgepole pine 5 per cent.

East of the head waters of Whitefish River the larch and red fir, limited by the dry mountain slopes, follow the water courses to about 5,000 feet, while on the drier spurs lodgepole pine is almost the only tree seen until an altitude of nearly 6,000 feet is reached, where balsam and nut pine appear, holding under them occasional patches of snow even as late as the middle of July. The mountain slopes are, at best, sparsely wooded, and on the dry ridges, which form the eastern side of the Whitefish Valley, fires have supplemented the injuries by snow and wind, leaving, north of Whitefish Lake, along the narrow summit, only small areas of green woods. The largest trees of the valley are larch. One of these, cut on the edge of Long Prairie, where the altitude is about 3,500 feet, measured 181 feet high, had a diameter of 36 inches on the stump, and scaled 3,000 feet B. M. This tree had 379 annual rings on the stump. Both on the dry gravels and the rocky ridges, near the foot of the mountains, lodgepole pine and small knotty red fir replace the more vigorous growth of larch and red fir on the finer alluvium and clays of the main valley. About the head waters of Stillwater River, above the canyon, near Stryker's ranch, on sec. 36, T. 34 N., R. 25 W., larch is found in moderate size well up the tributaries, but still confined to the moister land. Upon the mountain slopes, which bound the basins and gulches, the lighter green foliage of the larch may be seen following the water courses in a pointed strip that lies principally on the shaded side of the ridges, and, nearing its uppermost limits, is narrowed and confined to the bottoms of the gulches. The remainder of the surface, where not much broken by ledges or talus, is well covered by lodgepole pine and short, branchy red fir. Other species occurring in the upper valley near the water courses and on the very moist soils are: White spruce in some abundance, and frequently, where crowded, of size suitable for log timber; white cedar, more closely confined to moist land and far less abundant; white pine, rarely found here as a timber tree and only in moist and sheltered localities; hemlock, rarely found out of the mountains; silver fir (*Abies grandis*), scattered as a small or medium-sized tree on the damper portions of the upper valley among the spruce. None of this seen was suitable for log timber except on the pass leading from Columbia Falls toward the North Fork of the Flathead River, where it is associated with white pine and cedar. Ascending the mountains Douglas spruce continues, dwarfed and knotty, either isolated about rock ledges or rockslides or mingled with lodgepole pine on dry slopes until the alpine species are met at elevations varying, according to moisture and exposure, from 5,000 to 6,000 feet. Lodgepole pine continues much farther up and mingles with the nut pine and balsam and Engelmann spruce, even at an altitude of 7,000 feet.



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Estimates.—Within this region are, roughly estimated, some 422 million feet of log timber. Of this, some 300 million feet are on the main flat, 176 million feet are on partially timbered land bordering the main flat, while 15 million feet are on the mountain slopes. Of this timber, some 60 per cent is larch, 20 per cent red fir, 10 per cent yellow pine, 7 per cent lodgepole pine, 2 per cent spruce, and 1 per cent white pine. About 125 million feet of this amount are within the reserve.

Young growth.—Young growth has been starting from time to time as the occasional fires have made conditions favorable. Trees of all ages are found. While the older ones are of fire-enduring species, such as larch, red fir, and yellow pine, the younger growth is a mixture of all species common to the lowlands of the region and these are of all sizes.

Underbrush.—Brush is not abundant, except along water courses and on the areas that have not fully recovered from the effect of fire. *Menziesia* is, perhaps, the most common shrub, and this, with huckleberry and *Shepherdia*, covers the drier lands with a growth more or less dense, while dogwood and willow line the water courses.

Fires and reproduction.—Very destructive fires have been rare in this region, although there is evidence that fires have frequently run over the land. Fire-killed areas, however, are found along the mountain slopes, where some of these areas are bristling with small dead trees. The fires that have run over the greater portion of the valley have been moderated by the abundant bear grass, which, remaining green throughout the season, retards fire. Fires have scorched and slightly injured butts of large trees, and, occasionally, blackened stubs are found. Here and there are areas of several acres on which small trees, up to 2 inches in diameter, have been killed by these light fires, but in the main valley no large areas were found where fire had killed many large trees, except in the upper portion of the Stillwater Valley and on the mountain slopes.

In competition with red fir the larch seems in many places to have acquired its ascendency by its more rapid growth in height; in other places, however, where in competition with lodgepole pine, by its ability to survive fire. Where the fires had been severe enough to kill all the original stock, as in the Upper Stillwater Valley, lodgepole pine and aspen restock the ground almost exclusively. After the light fires run through the woods, seedlings spring up wherever the fires have made suitable conditions by killing part of the old stock, letting in light, and removing the small plants from the soil. Much of the the land is imperfectly stocked because of the bear-grass, which prevents seedlings from starting. Other areas become well stocked soon after the fire, but many of the seedlings never make trees. Near the head of Whitefish Lake a small area that had been burned two years ago, leaving the ground about half shaded by surviving larch and killing nearly all surface vegetation, was well restocked with larch about 4 inches high, averaging 2 to 3 feet apart. Lodgepole pine follows the more severe fires quite freely, probably because its most abundant and accumulated seed, held in the cones for years, is liberated by the fire, and because the seedlings of this species endure much sun. Small areas of young lodgepole pine are found scattered about on timber land in the Upper Stillwater Valley. These are burned areas restocked. On one acre of such restocked land were found 2,640 trees, 2 to 7 inches in diameter, 35 years old, and 34 feet high.

Dead timber.—There is very little dead log timber standing in this valley and none was seen that had any market value. It is scattered here and there through the forest, and it is not only isolated and difficult of access, but worm-eaten and more or less decayed.

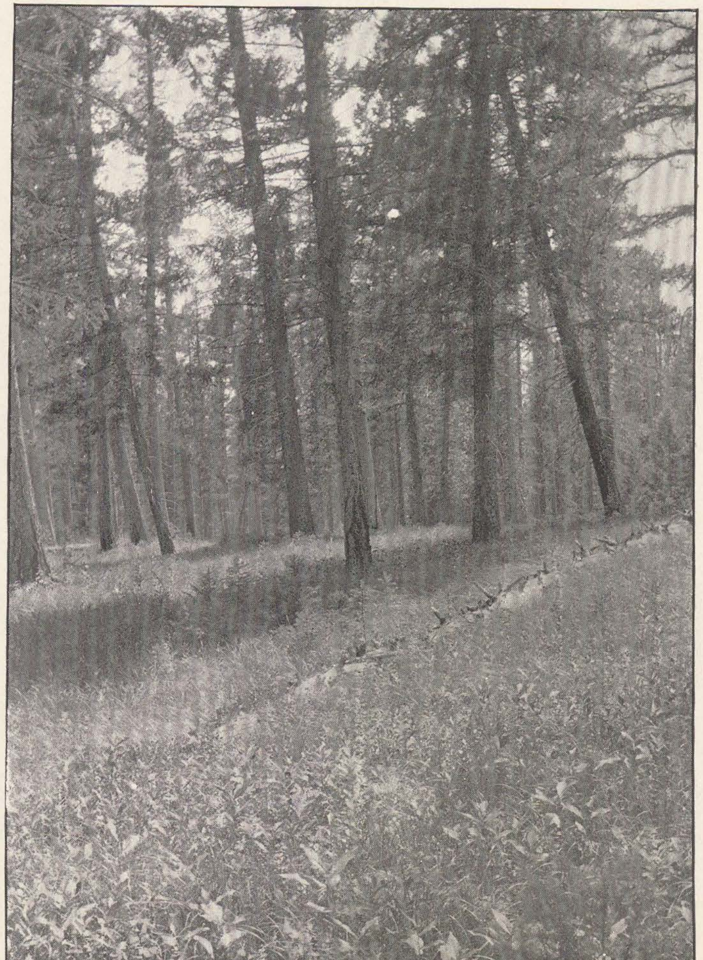
Cutting.—Some cutting has been done on the lower lands for the mills between Columbia Falls and Kalispell. Some logs have been cut about Whitefish Lake, but no cutting was found within the bounds of the reserve except for trails, roads, houses, fencing, and bridging.

Transportation.—Away from the railroad, Whitefish River and Stillwater River form the best means of transportation at present. Roads could be easily made throughout the tract, and the density of the stand of timber is very favorable for operations by means of logging railroads.

Demand.—Although lumber is being shipped from this valley by the lumbermen of Kalispell, Columbia Falls, and intermediate points, the present prices are low and can yield little profit. Some of the best timber (yellow pine) within 2 miles of Columbia Falls has recently sold for $1 per thousand feet on the stump, and sold from the mill, I am told, for $7 per thousand feet.

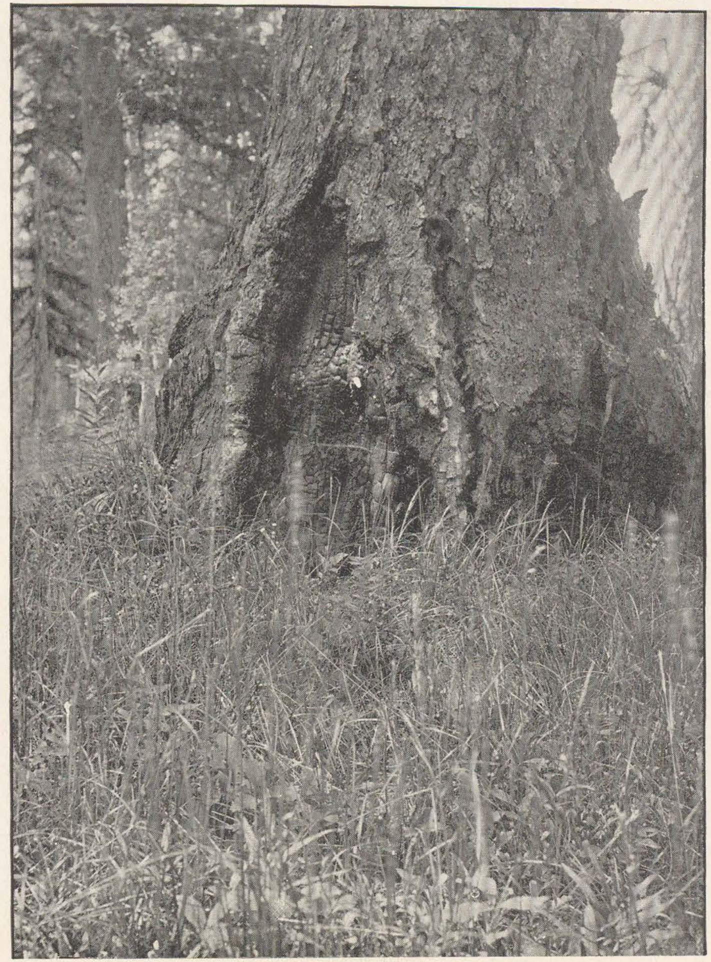
Agricultural land.—At least two-thirds of this area is land that would be suitable for agriculture when cleared and irrigated. But a small proportion, however, has a present agricultural value, most of it being so heavily wooded and there being so little market demand for the wood, that the cost of clearing would exceed the value of the cleared land. Exceptions are found on the most fertile portions, where irrigation is not necessary because of natural moisture in the subsoil. In fact, there are now within the area many settlers, each of whom has some land under cultivation, and near the railroad are some excellent farms. Even well toward the head of Stillwater River, as on sec. 36, T. 34 N., R. 25 W., some vegetables and abundant crops of hay are grown, although snow has been known to fall 8 inches deep in June, and frosts occur in midsummer. Vegetables, however, in this elevated region are often severely frosted without apparent injury.

Irrigation.—Very little of this land is now irrigated, but the greater



A. SPARSE SEEDLINGS UNDER LARCH (LARIX OCCIDENTALIS), LODGEPOLE PINE (PINUS MURRAYANA), AND RED FIR (PSEUDOTSUGA TAXIFOLIA).

One-half mile south of Sunday Creek, Edna Creek Valley.



B. BUTT OF LARCH REPEATEDLY SCORCHED BY LIGHT FIRES.

Bench land, Edna Creek Valley. Bark 6 inches thick.

portion of it is irrigable from the Stillwater and Whitefish rivers, and, at some expense, from the Flathead River, if the two smaller streams are not sufficient.

Water power.—Occasional water powers may be found on these two streams, sufficient to run sawmills or flour mills.

Mining.—No mines are shipping at present, and very few claims have been staked in the whole valley, and these, so far as learned, are along the mountains, most of them about the head of Stillwater and Whitefish rivers.

EDNA AND FORTIN CREEKS.

Topography.—This valley, comprising an area of about 187 square miles, some 70 square miles of which lie within the forest reserve, is broad in its lower or northern portion broad, with gentle slopes gradually ascending into the mountains. The elevation of the lower lands is about 3,000 feet, and that of the mountains bordering the valley, the higher of which lie east of the valley and north of the Stillwater road, is from 5,000 to 7,000 feet. The surface of the intermediate lands is characterized by elongated ridges of drift material.

Soil.—By far the greater portion of the valley has a clay soil very light in color, the gravel ridges being placed here and there about the mouths of tributary valleys. A chemical analysis would be hardly a fair test of the fertility of the soil in its natural condition, for most of the land is deficient in moisture. The creek bottoms, where moisture is plenty, are evidently productive, for they are so densely covered with brush and trees that it is very difficult to force a passage across them without cutting one's way. It seems probable that the whole valley would prove very fertile if irrigated.

Litter.—The general surface is remarkably free from litter, an occasional fallen tree offering little impediment to travel in any direction. Until some 20 years ago slight and frequent fires kept the ground clear, and most of the litter now found has accumulated since that time, except in the upper portion of the valley, where some recent burns have occurred.

Humus.—Humus is light except on the wet land. On the uplands there is very little vegetable material, either on top of or mingled with the soil. The frequent fires occurring until recently have given little chance for humus to accumulate. Recently quite a mulch has accumulated from the pine grass, which is now but imperfectly decayed. The upper portion of the valley, recently burned, is nearly bare except for fallen wood.

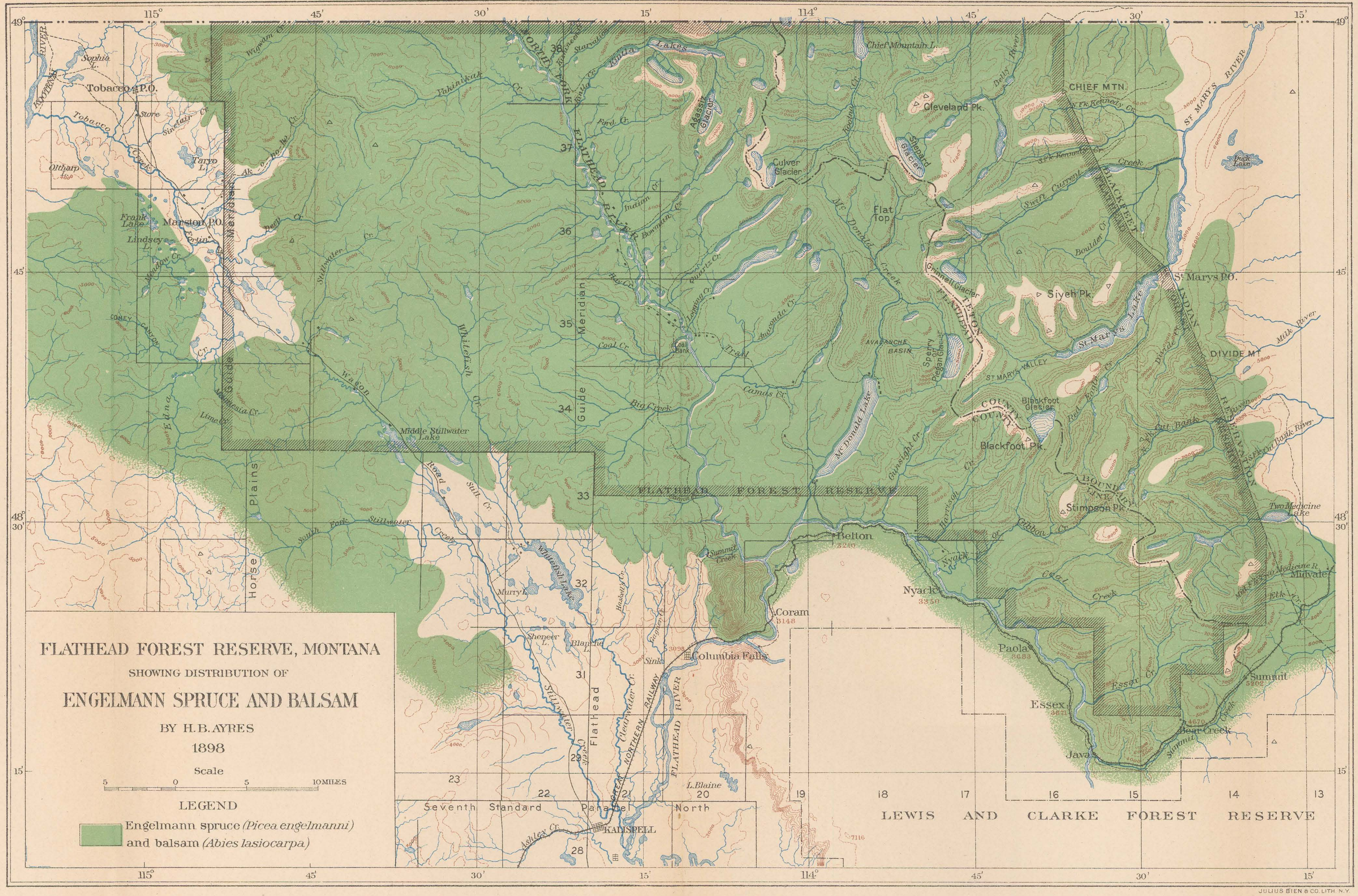
Trees and timber.—The timber in this valley is principally larch. In size also the larch is the leading tree, some of this species reaching 3 feet in diameter, being 60 feet to the first limb and having a total height of 160 feet. The red fir is here seldom over 100 feet high and 30 inches in diameter, with live limbs almost to the ground. An entirely clear log of it can seldom be found. The white spruce is also very much branched, affording no clear logs. It reaches 100 feet in height, and about 2 feet in diameter. It grows only along streams and water courses, or upon well-watered land. Yellow pine is found only on the driest land of the lower valley, where it is of the usual size and free from knots. Lodgepole pine is scattered throughout the forest—tall, slender, and straight; often clear 40 feet from the ground and reaching a total height of 100 feet and a diameter of 16 inches. The oldest trees noticed in the valley were about 250 years of age, and from this age down to 25 years there are successive stages or generations. These several gradations are due to fires, which have run here at intervals of several years, and following each fire new trees seem to have started. With this difference in age is a corresponding difference in size. The oldest trees are mature but seldom overripe. They are usually sound except sometimes at the butt, where they are injured and swollen by fire (Pl. LXXXV, *B*). Most of the trees are limby, but the limbs of the larch are small. Most of the knots of all species are sound.

Estimates.—The timber standing in this valley above Marston is roughly estimated at 384 million feet. Of this about 30 per cent lies within the reserve. As to species, 80 per cent of it is larch, 10 per cent red fir, 6 per cent lodgepole pine, 2 per cent yellow pine, and 2 per cent spruce.

Young growth.—The trees less than timber size are classed as young growth. Recurring fires, mentioned before, often left very favorable conditions for young trees to start by removing vegetation from the surface of the ground, while leaving many trees alive to furnish some shade and protection from wind. So we find, throughout most of the valley, thickets of young trees, mostly red fir and spruce, growing under larger trees (Pl. LXXXVII, *A*). The greater portion of this young growth does not exceed 20 feet in height, and most of it seems to have started about 25 years ago. This young stock is somewhat irregular in distribution, but if the older trees be cut with regard to a future growth, those remaining would furnish excellent material to cultivate.

Underbrush.—There is very little underbrush indeed. The stock of young trees just mentioned might be called brush, and the land might thus be called brushy, but shrubs as underbrush are seldom found except on wet lands.

Fires and reproduction.—The light fires which prevailed in the valley up to 20 or 25 years ago seem to have left very favorable conditions for reproduction, as evidenced by the young trees now growing (Pls. LXXXVII, *B* and LXXXIX, *A*). The upper portion of the valley, however, has suffered from more recent fires, and these


FLATHEAD FOREST RESERVE, MONTANA
SHOWING DISTRIBUTION OF
ENGELMANN SPRUCE AND BALSAM
BY H. B. AYRES
1898
Scale
5 0 5 10 MILES
LEGEND
Engelmann spruce (Picea engelmanni) and balsam (Abies lasiocarpa)
FLATHEAD FOREST RESERVE
LEWIS AND CLARKE FOREST RESERVE
Seventh Standard Parallel North
Tobacco P.O.
Marston P.O.
Kalispell
Columbia Falls
Coram
Belton
Nyack
Paola
Essex
Java
Bear Creek
Summit
Midvale
St Marys P.O.
Chief Mtn.
Cleveland Pk.
Siyeh Pk.
Blackfoot Pk.
Stimpson Pk.
Divide Mt
Two Medicine Lake
McDonald Lake
Whitefish Lake
Flathead River
St Marys River
Blackfeet Indian Reservation
Guide Meridian
Horse Plains
JULIUS BIEN & CO. LITH. N.Y.

fires have been so severe as to kill a great proportion of even the fire-resisting larch, red fir, and yellow pine, and, as is usual in such cases, the lodgepole pine has followed. This lodgepole pine has frequently been reburned, and different ages of the young stock are now seen growing among the dead trees. The greater portion of the valley has now such an accumulation from successive crops of pine grass and other herbaceous plants added to the fallen leaves and trees that, should a dry season occur, this tract would be in great danger of a destructive fire.

Dead timber.—There is but little dead timber in the valley. Some dead trees still stand in the burned region along the south line of T. 34 N., R. 25 W., but none of this is log timber. Farther south also, in T. 32 N., R. 26 W., and thence westward and northwestward, fires have swept over the hills, killing much of the small timber that was there. About half of this is fallen, half remains standing, but at present it has no market value, there being no demand for it.

Cutting.—There has been no log timber cut. Most of the cutting done has been for houses and in clearing land. Roads and trails have been cut here and there, and a few prospectors and trappers' camps have been built in the mountains. The area of the land cleared is about 50 acres.

Transportation.—The wagon road from Kalispell to Tobacco Plains traverses the lower portion of the valley. The stream is drivable at moderate expense into the Kootenai River. For extensive logging operations a logging railroad would be the most feasible means of transportation for this valley, as the grades are easy and the timber stands fairly dense.

Demand.—There is no local demand at present, and the timber has little or no market value on the stump.

Agricultural land.—Five houses with clearings were seen in the valley, selected in the locations most favorable for ranches, usually covering natural meadows and other land that does not need irrigation. The limits of agricultural land are to be determined principally by the limits of possible irrigation, and to map such limits a detailed survey would be necessary. Possibly 12 square miles of this valley may be irrigated profitably.

Irrigation.—Water is not abundant in the streams of the valley. There seems to be much underground drainage, and irrigation must be limited on this account. Several streams from the mountains reach the gravels of the valley and then disappear. These could be saved for irrigation, and the water of the main stream could all be utilized. On July 25 the main stream, where it joins Grave Creek, was about 25 feet wide, 2 feet deep, and quite rapid. No land has been cultivated in the valley except below the junction of the east with the south branches on the Kalispell road, where vegetables have been grown successfully and hay proves an abundant crop. Here the land is evidently fertile.

Mining.—No mines are shipping at present, but some claims are held in the mountains surrounding the valley.

TOBACCO CREEK AND TOBACCO PLAINS.

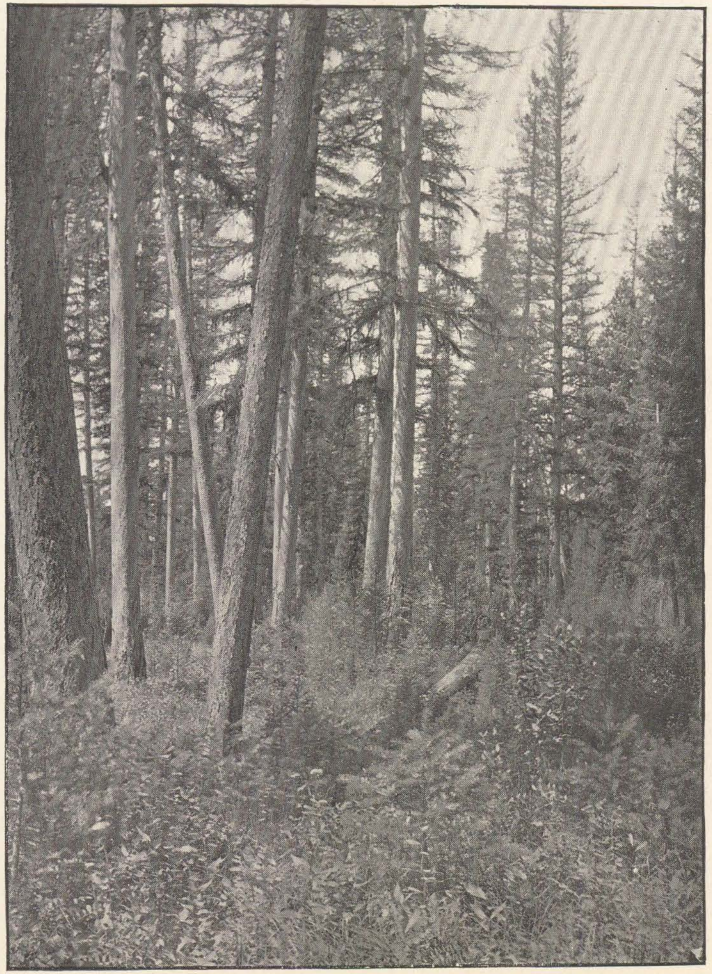
Topography.—This region, none of it within the reserve, is bounded by the Kootenai River on the west, the international line on the north, the mountains on the east, and Grave Creek below its canyon to its mouth, and a line thence westward to the Kootenai River on the south. It may be most readily described as a broad valley, about 12 miles wide, into which large glaciers have moved and rested until they melted. In the higher portions of the valley the surface is tumulose, with short hills and hollows. In the middle elevations are the long, gravelly ridges deposited by streams flowing through crevasses in glaciers, while in the lower valley are the gravels and sands separated from the drift by lake waters. Here in this lower portion is a more even surface, the plains proper. This glacial topography has been slightly modified in later times by the streams, which have brought débris from the mountains and left it near the mouths of the canyons, have cut through the ancient deposits, forming narrow bottoms, and, with the aid of beaver, occasional meadows along the water courses.

Soil.—The upper portion of the valley, that near Marston, contains quite a large proportion of clay soil, clay predominating except near streams, where gravels and bowlders brought down by the mountain torrents that succeeded the glaciers occupy the bottoms and the sand hills which occur sparingly above the high banks or bluffs of the streams. Even more than in the preceding valley, irrigation is needed here on the clay lands before the full value of the soil can be known, although where moisture is sufficient trees and other vegetation now grow well. The irrigated land of the gravelly plains produces heavy crops of hay, grain, and vegetables, proving that only water is needed to make good farm land; and, doubtless, the more clayey lands in the higher portions of the valley would prove at least equally fertile.

Litter.—Litter is very light. There is some débris from fires along the foot of the mountains, but elsewhere there is very little material other than fallen trees and old grass, of which there is but a light growth.

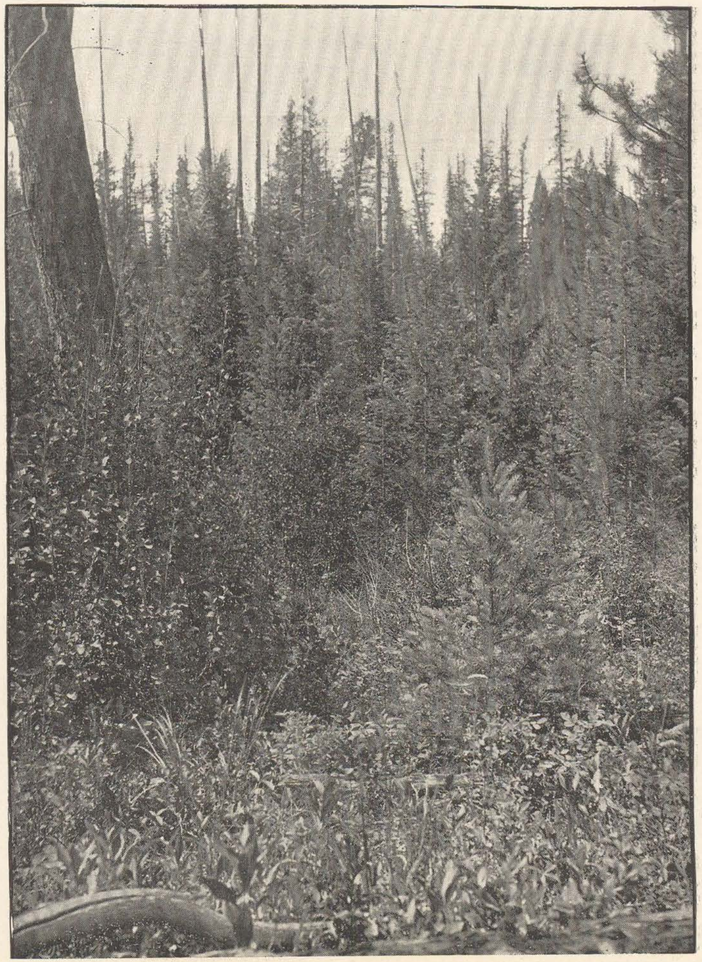
Humus.—Humus also is light except in the wet places. Fires, until recently prevailing, have kept such material from accumulating.

Trees and timber.—The trees growing here are, on the higher clay lands, larch and red fir; on the intermediate soils, yellow pine and short, knotty, red fir; while on the gravelly ridges and on the plains



A. LARCH (LARIX OCCIDENTALIS), WITH SCATTERED SEEDLINGS OF RED FIR (PSEUDOTSUGA TAXIFOLIA), WEST OF DIVIDE, STILLWATER ROAD.

Typical of a large area in this region.



B. OLD BURN ON FORTIN CREEK.

Restocked with same species: Yellow pine (Pinus ponderosa), red fir (Pseudotsuga taxifolia), lodgepole pine (Pinus murrayana), and aspen (Populus tremuloides).

below, where the subsoil is porous to a great depth, there are no trees. Few trees in the lower portion of the valley exceed 125 feet in height and 3 feet in diameter. The larch, where fairly crowded, has about one-third of the trunk clear, and is usually sound except at the butt. The red fir is short, seldom over 75 feet high, very much branched, and has a very short trunk with many knots. The yellow pine varies in length of clear trunk more than the other species; where crowded the trunks have sometimes 60 feet, or two-thirds of the total height, free from limbs, while where open grown a 16-foot clear log can rarely be taken from the butt. The butts of the yellow pine are frequently defective from the effects of both fire and wind.

Estimates.—Within this area are some 262,400,000 feet, B. M., of log timber. About 50 per cent of this is larch, 30 per cent yellow pine, 12 per cent red fir, 5 per cent lodgepole pine, and 3 per cent spruce.

Young growth.—Owing to the frequent fires there is but little young growth, apart from what may be called seedlings (to be noted under reproduction), excepting along the mountain foot, where about 4 square miles are found, covered in various degrees with saplings, the largest of which are suitable for fencing, and are now being cut by ranchmen on the plains. This young growth is mixed, consisting of red fir, larch, lodgepole pine, spruce, and aspen. Through it are scattered large trees, survivors of the fires.

Underbrush.—Very little underbush is found except on the bottom lands, along water courses, and on the mountain slopes.

Fires.—Even more than in the previous area, fires have, until recently, swept over the plains and crept through the woods, preventing a new growth and eating into the old stock. Since the valley has been settled fires seem to have been much less frequent, and, over much of the area, entirely wanting. The most evident damage by fires in recent times is seen on the mountain slopes about the head of Sinclair Creek. South of Independence Basin the mountain side has but a scant covering of brush, with here and there patches of young lodgepole pine and balsam. North of Independence Creek the mountain side is even more bare, and north of the international line a severe fire swept over a large area in the year 1896. It is to be regretted that these mountains are being bared, and so rapidly, especially as the supply of water for irrigating the plains is scant, and dense forests on these mountains would materially increase the supply by holding the snows late into the season.

Reproduction.—Throughout the upper valley, on the clay lands that do not become extremely dry, are thickets of red fir, with more or less larch, but on the driest hills, where gravelly or sandy, very few young seedlings are found, and these few are nearly all yellow pine. These are not evenly distributed, but are grouped; most of them under or near old trees of yellow pine. Again, hedge-like strips are seen along trails. The cause of this peculiar distribution may be that in such places the seeds have been covered with the dust stirred up by animals passing along the trails or stamping flies under the shade trees. It was at first thought that the groups under the old trees were there by reason of the shade, but some of the most thrifty seedlings were found on the south side of the old trees, where most fully exposed to the sun. Probably several conditions have joined together to produce this abundant new stock in such places. The tramping and stamping of animals has served to prepare the ground for the seed and even to press the seed into the earth. The settling dust has also served to cover the seeds. Seeds, too, fall most abundantly under or near the parent tree. Again, the fallen cones under the old trees serve as a mulch to cover the seed and to subdue the grass, and prevent it choking the seedlings (Pl. LXXXIX, *B*).

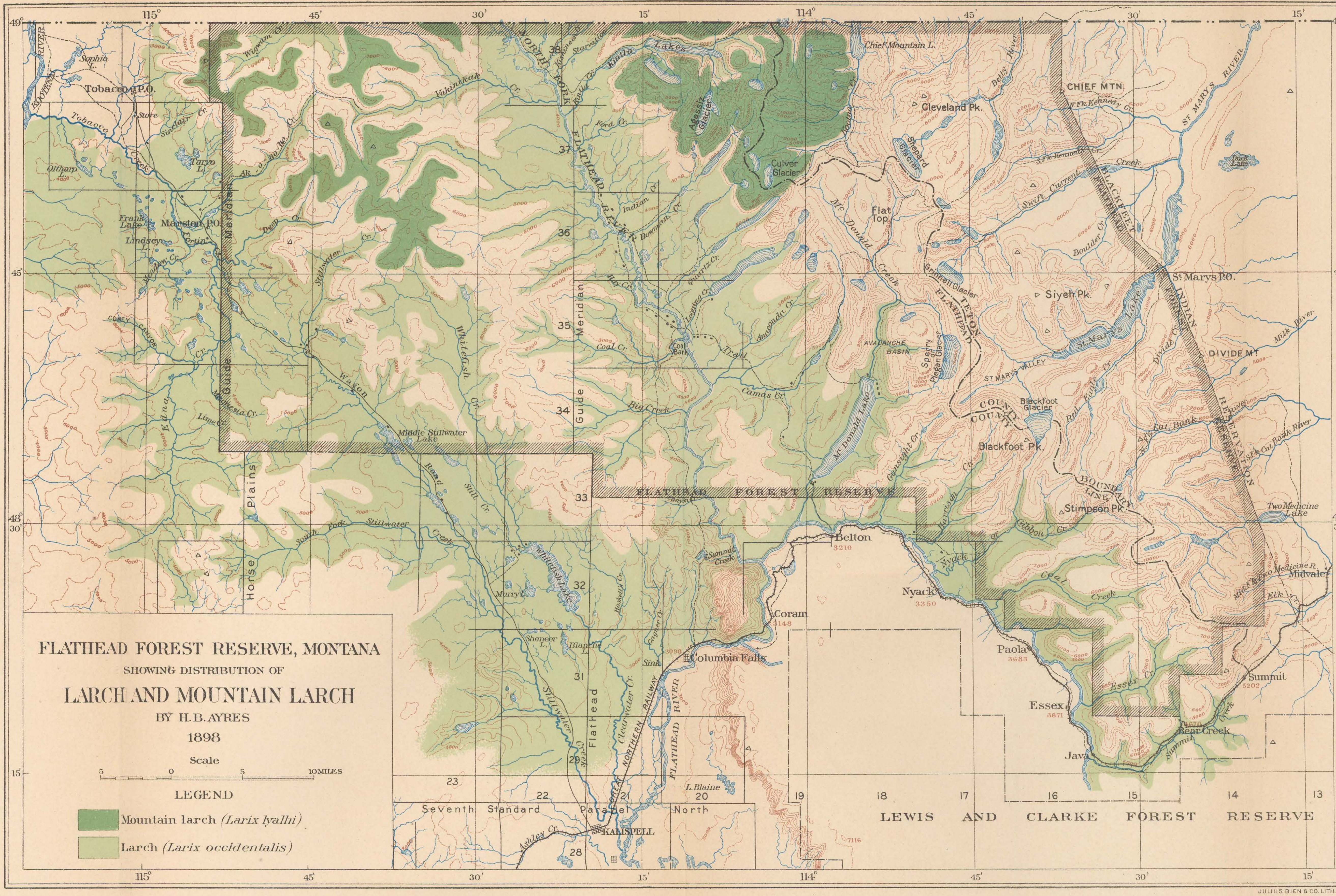
Dead timber.—There is no appreciable amount of dead timber, merely an occasional tree through the lower forest. On the mountain sides the remaining wood killed by fires is small and is now of no market value.

Cutting.—No cutting has been done except for local use. Two sawmills have been in operation on the plains; one on Sinclair Creek, half a mile above the wagon road, where several hundred thousand feet of lumber have been cut, most of it yellow pine. Much fence timber has been taken out, and the buildings of the ranchmen are made almost entirely of logs taken from the surrounding woods.

Transportation.—Tobacco Creek will be drivable after some expenditure for clearing the channel of driftwood and building the necessary dams. Owing to the peculiar conformation of the hills, logging would be easier than one might first think upon learning the rough topography of the region. Snow in winter is too unreliable here for hauling on sleds, but the surface offers no serious obstacle to logging by railroad.

Demand.—There has been much demand for fencing material for the numerous ranches on the plains, and the thick sapling undergrowth of red fir along the foot of the mountains has been drawn upon, using young trees from 6 to 10 inches in diameter. Sawed lumber is now in moderate demand for building, both in the village and on the ranches, and the extension of irrigation will require quite an amount of plank and other timber for flumes.

Agriculture.—But a small portion of the land that may be classed as agricultural in the valley is now cultivated, probably not over 2,000 acres out of a possible 36,000. Agriculture here has been stimulated by the excellent market afforded at Fort Steele during the building of the new line of railroad. The opening of that railroad will diminish the market, which now must be found principally along the Great



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Northern Railway, reached by steamer on the Kootenai River and by wagon at Kalispell.

Irrigation.—Irrigation seems necessary for most of the land in the valley, and is now fairly commenced. Many excellent fields of grass and some of grain were seen. Sinclair and Campbell creeks are being partly used, and a company has been formed to dam Taryo Lake and lead the water from it to the lower plains. Abundant water for the lower plains could be had from Tobacco Creek, but at more expense, and by depriving the upper valley of the portion it may some time require. Much water comes from the mountains directly east of the plains, a great portion of which sinks into the gravel. This might be economized considerably by fluming it over the most open soil. The flow of these streams has evidently been more steady before the dense forest growth was burned from the mountains. In climates where most snow falls at a temperature about the freezing point trees have a doubtful effect in holding snow, but in this cold, winter climate they help snow to accumulate and the shading of evergreen trees greatly retards the melting of snow in spring, as shown frequently under dense shading balsams and spruce, where in the middle of July a depth of as much as 5 feet of snow was found, while open areas near by were entirely bare.

Water power.—There is no considerable water power in the valley except on Tobacco River, where several mill sites may be found. The stream at the junction of Fortin and Grave creeks was, the last of August, about 100 feet wide and 2 feet deep, with quite a strong current. The smaller streams, such as Campbell and Sinclair creeks, would afford but little power.

Mining.—At present no ore is shipped from the valley, but several prospects in ores of copper, silver, lead, and gold are being quite extensively developed.

AKANOHO, OR GRAVE CREEK.

Topography.—This narrow valley, with steep but fairly-uniform mountainous sides, has a drainage area of some 35 square miles. The stream is everywhere rapid. Where it leaves the canyon it had, the first of August, a width of about 50 feet and a depth of about 2 feet. The mountains bordering the valley reach an altitude of some 7,000 feet, while the stream bed leaves the canyon at about 3,000 feet.

Soil.—The earth of the valley has been derived principally from green schist, and is a light-colored clay. There are no indications of special fertility, but trees and brush grow well wherever moisture is abundant. Throughout the valley there is so much broken rock that much of the drainage is underground, and many of the slopes are very dry.

Litter.—Even where unburned, the litter is not abundant. Humus is also light, seldom reaching a depth of more than 3 inches, and mingling but slightly with the earth except in alluvial spots, which are few and small.

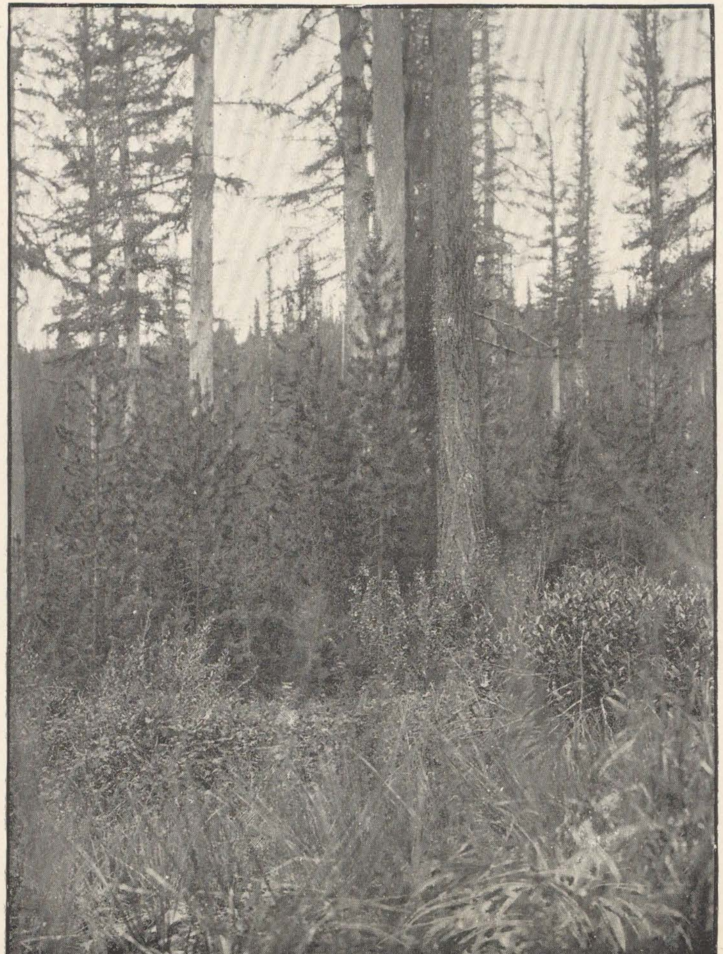
Trees and timber.—Larch, red fir, lodgepole pine, Engelmann spruce, and white pine are the principal trees here, and the larch easily leads them all in the lower altitudes. Below the canyon the valley forms part of, and is similar to, the Tobacco Creek Valley, with its larch, red fir, and occasional yellow pine. Within the canyon larch of timber size is abundant on the south side, covering the long mountain foot which reaches well out in the Tobacco Valley and continues up the Akanoho, although nearly pinched out by the burn of 1892, which swept the mountainous sides of the canyon for nearly 3 miles above its mouth. The larch here is not very large. It is commonly 100 feet high, and frequently 2 feet in diameter on the stump, and where fairly crowded is some 30 feet to the first limb. Red fir accompanies this tree, or parallels it rather, on the north side of the canyon and is short and knotty, seldom over 75 feet high, with hardly a clear log. The stump diameter is seldom over 30 inches. In the damper spots there are some white pine, white cedar, and Engelmann spruce, while lodgepole pine occupies the drier ground and crowds densely on the middle slopes, to mingle with the alpine fir and Engelmann spruce at an elevation of about 5,000 feet, finally yielding to these species altogether at about 6,000 feet.

Estimates.—There about 16 million feet of log timber in this valley, 50 per cent of this being larch, 15 per cent red fir, 20 per cent spruce, and 15 per cent lodgepole pine. None of it is large.

Young growth.—The greater portion of the whole forest may be classed as young growth, because most of the trees are too small for log timber. It is questionable whether this stock would ever make large log timber without cultivation, as it stands quite dense and the steep and rocky mountain slopes seem to be unfavorable for its best development.

Underbrush.—There is a medium amount of underbrush. That growing on the middle slopes is small, that north of the valley is composed largely of *Menziesia*, spiræa, mountain ash, and huckleberry. South of the stream are *Menziesia*, azalea, huckleberry, and maple. The bottoms of ravines are densely crowded with alder, willow, thimbleberry, and dogwood.

Fires.—The lower portion of the valley has been quite severely burned on both sides. The most recent severe fire was in 1892. This swept the mountainous sides of the canyon, and has left them studded with dead trees. Less dead material is left on the north side of the valley, which, being drier, was burned more severely. South of the stream the slope has been repeatedly burned, and young stock of



A. BURN OF TWENTY YEARS AGO ON WOLF CREEK TRAIL.

Larch (Larix occidentalis) surviving. Partially restocked with lodgepole pine (Pinus murrayana).

B. YELLOW PINE (PINUS PONDEROSA), WELL RESTOCKED UNDER PARENT TREES.

Crossing of Sinclair Creek, southeast edge of Tobacco Plains.

several generations now appears among the dead trees and stubs. Here, as elsewhere, the same species usually occupy the ground when the old stock is killed, yet it seems that lodgepole pine is more apt to follow fire on the dry mountain slopes than the other species.

Dead timber.—What timber is dead was killed sometime ago, and is now of no market value.

Cutting.—No cutting has been done except by prospectors, trappers, and others for their necessary cabins, fires, and trails.

Transportation.—The main stream is drivable in June, although very rapid and stony. It affords very few, if any, favorable chances for dams, and log driving would necessarily be limited to June, when the water is said to continue about 2 feet above its usual height during several weeks. It would not be very difficult to build a logging railroad, but there is hardly enough timber to warrant such an expense.

Demand.—There is practically no demand at present for timber of the quality found here. Even the better class of timber found in the lower valley goes begging, and the difficulty of access to the upper portion will make it slow in becoming marketable.

Agricultural land.—There is no agricultural land in the valley, except such small areas as might be used for garden spots.

Irrigation.—There being so little agricultural land, little water will ever be needed for irrigation in this valley, but all of it may be used in Tobacco Valley, below.

Water power.—There is abundant water power. The water could be used repeatedly, but the question of access to the valley will probably limit all manufacturing to the mouth of the canyon.

Mining.—No mines are shipping at present, but some promising prospects are held in the mountains, especially in the lower portion of the valley.

WHITEFISH RANGE.

Topography.—The mountainous region west of the North Fork of Flathead River and east of the Stillwater Valley and Tobacco Plains has an area of about 550 square miles. Several of the peaks reach an altitude of 8,000 feet. The gorges between are sharp, narrow, and nonagricultural. The views from the highest points reveal a succession of green wooded slopes, broken here and there by burned areas, ridges too high and snowy for thrifty trees, and occasional ledges of rock. The most rocky portion lies between Tobacco Plains and the head waters of Akanoho and Deep creeks. Numerous streams of the clearest water flow from this region in every direction, all tributary, however, to the Kootenai and the Flathead rivers. There is remarkable uniformity in the character and size of the principal streams and of the valleys through which they flow. Upon reaching the borders of the river valleys the streams, as a rule, diminish in size, and many of the smaller ones disappear altogether. Some maintain their flow during June, then go dry as the snow leaves the mountains.

Rock.—Green schists, red quartzites, and gray or buff limestones, with some metamorphic rocks, principally amygdaloid, dipping northeastward, continue through the range with frequent deep faultings.

Soil.—The soil seems fertile and, wherever abundant and well watered, produces a vigorous growth of vegetation.

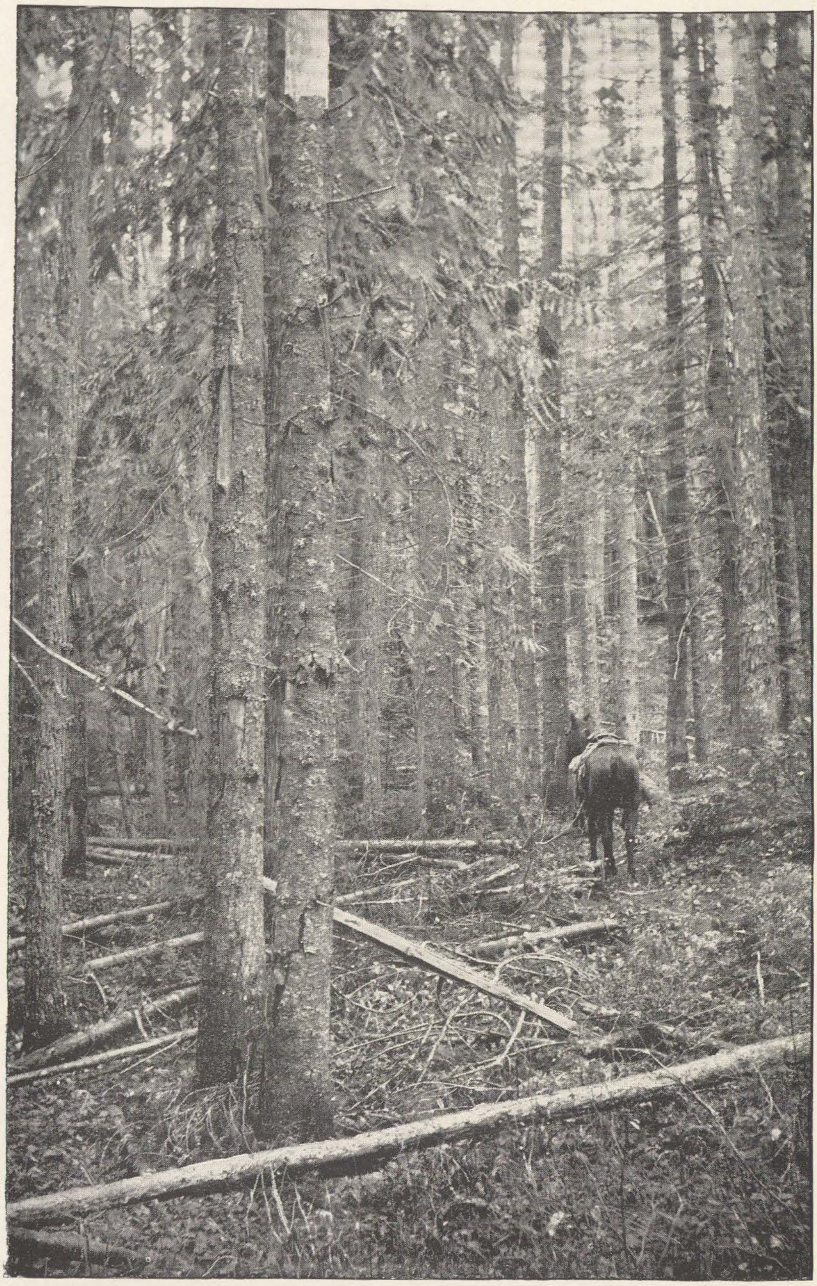
Litter.—Litter varies extremely from the open and often grassy mountain ridges to the deep network of fallen trees that encumber the old burns, or in moist ravines accumulate from overcrowding or old age.

Humus.—Humus also varies from nothing on the higher and steeper slopes and burns to a depth of 2 inches or more on moist areas.

Trees and timber.—The trees of this region are, as a rule, small, seldom exceeding 125 feet in height and 30 inches in diameter, except in the canyons, where the Engelmann spruce, the lowland larch, the red fir, and the white pine rival one another in size. The lodgepole pine is next, this tree frequently reaching 100 feet in height and 10 inches in diameter. The largest seen was 125 feet high and 14 inches in diameter. The lowland balsam or silver fir (*Abies grandis*) and the alpine balsam (*Abies lasiocarpa*) are seldom seen more than a foot in diameter and 75 feet high. The mountain or nut pine (*Pinus albicaulis*), common everywhere above 6,000 feet, has its usual scrubby habit, much branched, with a large trunk, and reaches its largest size here, being about 30 inches in diameter and 50 feet high, with a short and defective trunk.

The mountain larch (*Larix lyallii*), common on the most elevated peaks and seldom found below 6,000 feet, is a sturdy alpine tree, resisting the snows and snowslides better than any other species. It reaches a maximum size here of 24 inches in diameter and 80 feet in height. The largest trees are found about the heads of the basins, where snow lingers late into summer or in banks entirely through the season. Here it is the most hardy tree. On the most exposed summits, where the alpine balsam (*Abies lasiocarpa*) was unable to send up a leading stem, one of these larches 2 inches in diameter and 5 feet high showed 45 annual rings.

White pine (*Pinus monticola*) occurs in the mountain valleys, sometimes reaching a height of 150 feet and a diameter of 24 and even 30 inches on the stump. Along the trail from Columbia Falls to the coal banks in the valley of the North Fork of Flathead River most of the white pine was found. Here the trees were tall and crowded (Pl. XC). Several of the heaviest acres were selected and carefully estimated, and found to contain from 25,000 to 30,000 feet per acre. It is to be regretted that much of this white pine is dying. The dying trees were found infested with bark borers. Parts of the affected area had been slightly



DENSE WHITE PINE (PINUS MONTICOLA), LARCH (LARIX OCCIDENTALIS), AND CEDAR (THUJA PLICATA), NORTH OF COLUMBIA FALLS.

Undergrowth of balsam and cedar. White pine dying.

injured by fires escaping from hunting camps, but the trees were dying also beyond the areas burned. But few trees were dying this year, and on these the leaves were turning yellow. On November 3 about one-third of the leaves on the dying trees were yellow. The bark of these trees was found studded with the reddish-brown borings of the larvæ of the beetle which Mr. L. O. Howard has identified as *Dendroctonus terebrans*. On cutting into the bark and wood the larvæ and the beetles were found in great numbers in and under the bark only. The wood had not been penetrated. The sapwood was found to be thoroughly blued, indicating that this portion of the tree had been inactive or practically dead during the warm season. Mr. Howard states that this and allied species of beetles have been noted in the Northern States from New England to Oregon. It is doubtful whether these insects attack vigorous trees, but it seems probable that they attack and kill trees that are weakened from any cause, and that possibly where these beetles have bred in great numbers in trees injured by fire, they may attack and kill trees otherwise thrifty.

White cedar (*Thuja occidentalis*) was found but sparingly, not enough in any locality to be of commercial value (Pl. XCII). Occasional trees were found a foot, even more, in diameter, and 50 to 80 feet high, but much branched.

Of hemlock (*Tsuga heterophylla*) a few trees, usually small, are in the mountain canyons.

Engelmann spruce (*Picea engelmanni*) abounds both on the mountains and in the canyons. On the drier slopes it is small and knotty, but in the canyon bottoms it is frequently 3 or even 4 feet through and 100 to 150 feet high.

White spruce (*Picea alba*) is common in the valleys, especially near streams. Except where densely crowded, it is much branched and short, and suitable only for inferior lumber.

Cottonwood (*Populus trichocarpa*)—a small number—was scattered along the water courses, reaching a maximum diameter of about 28 inches and a height of about 70 feet. These are so isolated as hardly to be of commercial value.

Aspen (*Populus tremuloides*) is common on lands of medium moisture among lodgepole pine, frequently reaching a foot in diameter and 70 feet in height.

Red fir (*Pseudotsuga taxifolia*) is most abundant on rocky slopes with southern exposure, where it is short and much branched, suitable for mining timber, but not desirable in the lumber market. It is found also on bench lands in the lower portion of mountain valleys, where, when crowded, it often forms a trunk 30 inches in diameter and 30 feet to the first limb, with a total height of 100 feet. In such instances it is one of the most desirable timber trees in the region.

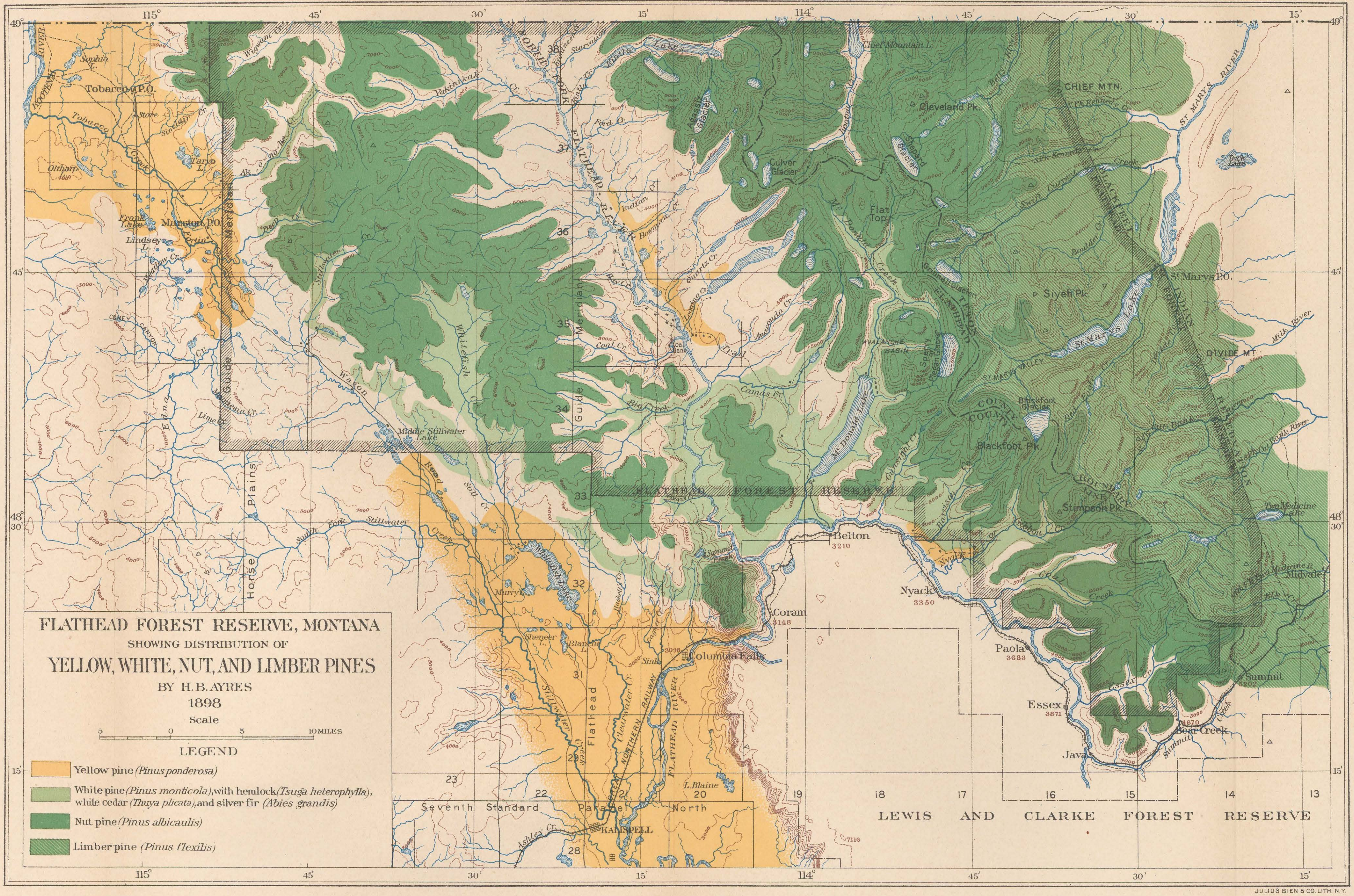
Very little timber in the mountains was found defective. Most of the trees large enough for log timber are on moist land, where there were no traces of fire. In such places the larger trees were found several hundred years old, but the greater areas are stocked with younger trees, seldom exceeding a hundred years, excepting larch and red fir, which, by means of their thick bark, have often been able to survive fire that has killed the other trees. The trunks of these are often swollen and defective at the butt from the injuries they have received from fire.

Estimates.—There is no large body of timber in this tract and none that is worth getting out in the present state of the market. Most of the timber of milling size is in narrow strips and isolated bunches, along narrow valleys or in canyon bottoms. The following estimates were made:

Estimates of timber, Whitefish Range.

Locality.	Area.	Quantity.
	Sq. miles	*Million ft. B. M.*
Stillwater drainage	80	11
Deep Creek	16	11
Elk Creek	48	15
South of Yakinikak Creek	82	16
Meadow Creek	14	8
Coal Creek	16	11
Big Creek	124	26
Canyon Creek	40	20
Other areas, principally between Canyon Creek and the Great Northern Railway	36	20
In higher altitudes, sparsely distributed, averaging less than 2,000 feet per acre (inferior timber)	100	100
Total	550	238

Young growth.—The unburned woods have very few young trees as undergrowth, except about the upper and the lower limits of the forest (Pl. CIV, *B*). These higher and lower altitudes have a mixed growth; trees of various ages and sizes and species growing together. On the middle slopes, where swept by severe fire within the past 50 years, lodgepole pine is found first reoccupying the ground, often to the exclusion of other species, but usually with a varying percentage of larch, red fir, and balsam; the larch on the lower slopes and the Englemann spruce in the higher ravines and other moist localities. As the prairies of the river valleys are approached, young growth often appears mixed with log timber. There the too thoroughly drained soil has been unfavorable to the starting of young trees, pre-



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venting immediate and complete restocking, and unoccupied places have been left to be filled in by repeated trials with whatever stock nature has been able to start there with her broadcast sowing. Land stocked in this way is usually left with a good stand of young growth after the mature timber trees are cut.

Underbrush.—Among the dense growth of lodgepole pine very little underbrush occurs, but almost everywhere else there is a great deal. It is most difficult to penetrate along water courses where alder, vine maple, willow, spiræa, dogwood, thorn, mountain ash, devil's club, thimbleberry, currant, gooseberry, and many coarse herbaceous plants combine to make a passage impossible without cutting. Next to these in density are the northern slopes, where *Menziesia* and huckleberry, matted over the surface under spruce and balsam, hinder the climber by entangling his feet more than they aid him by affording an uncertain hand-hold. The waxbush, growing in dry and more open localities, is more difficult to pass, but usually grows in patches that may often be avoided. Juniper and yew are common, as are also huckleberry, rose, service berry, chokecherry, and snowberry.

Fires and reproduction.—Fires have been most abundant along the lines of greatest travel. East of Tobacco Plains, and the valley above it, fires have escaped and swept up the mountains, covering something over 10 square miles. East of Whitefish Creek, above the lake, about 8 square miles have been burned over; north of Yakinikak about 8 square miles, and on Coal Creek and northward some 20 square miles have been burned. All these burns have been severe, killing nearly all the trees in their way. Areas where light fires have run and not killed the trees, have not been outlined on the map. Following these fires the reproduction, while considerably varied, has, as a rule, been imperfect. The species following the fire have been usually lodgepole pine and balsam, with but a small proportion of spruce, white pine, cedar, and other trees considered valuable for timber. The number of seedlings on the burned land varies greatly. On the higher altitudes seldom more than 100 seedlings per acre are found, and on the slopes where the restocking is best are seldom more than 500 trees per acre. Most of the areas swept by fire in this region have been burned within the last twenty-five years (Pl. XCIII).

Dead timber.—Dead timber is common on these burns, but is so small in size and amount and so much scattered that it is commercially of no value. Dead trees are most noticeable as an obstruction to travel, whether away from or on the trails, for wherever fires have run fallen trees make traveling very difficult for many years afterwards.

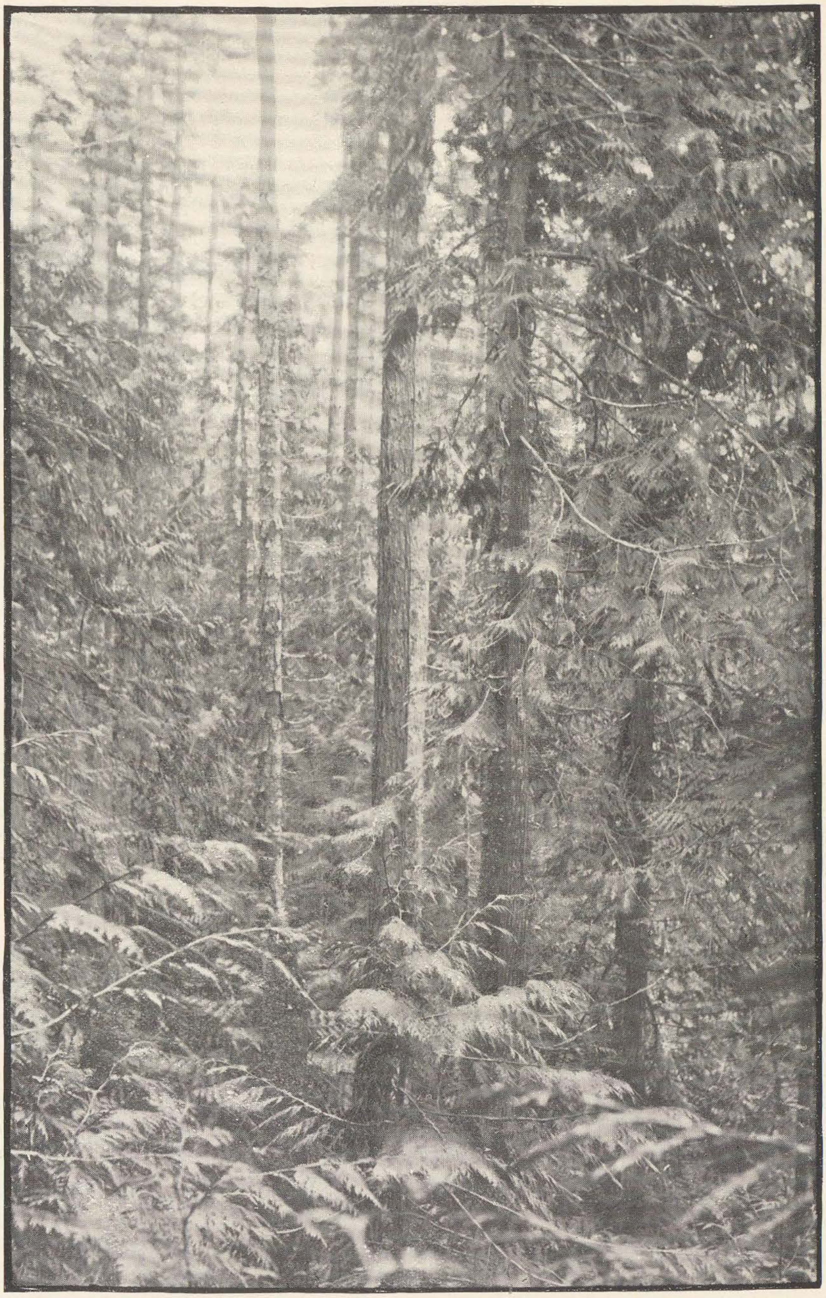
Cutting.—Except some ties cut by a squatter on unsurveyed land on the Coal Bank trail no cutting has been done for the market and but little timber has been cut for cabins and mining operations (Pl. XCIV, *A*).

Transportation.—There are no roads within the region. Driving logs in the streams would be difficult because of the steady and rapid fall, the numerous and shifting bowlders, the broad and shallow currents, and the absence of lakes or suitable places for storing water. Flumes could be used for transporting logs, or electric railways operated by water power would probably be found practical, both for taking out log timber and furnishing access to the mineral resources of the region.

Demand.—Local demand at present is nothing, and the only demand for shipping is from the region east of the mountains. In mining at present the little timber needed for cabins and cribbing is inappreciable.

Agricultural land.—Within the mountains there is practically no arable land. Some of the hardier vegetables could be grown. Grass and hay would in places grow well, but the small areas where this would be possible are so isolated that practically they would suffice only for the convenience of travelers or miners.

Irrigation.—At present water from the Whitefish Range is in demand on Tobacco Plains. The streams that enter the plains from the east are short and head in mountains that have been burned over. They flow plentifully during the spring while the snow is melting, then diminish during the summer. The importance of having the sources of streams needed for irrigation kept wooded should be appreciated, especially in this northern latitude and cold climate, for here, in addition to the retarding of water flow, the woods greatly retard the melting of deep snows that accumulate on these mountains during the winter. This effect was plainly seen on all these mountains where there were shady evergreen woods near openings, which afforded a contrast. July 15, on the mountains northeast of Whitefish Lake, snow was found under the dense shade of the fir trees, while in the burned openings near by there was no snow except in drifts. Even in this climate the earliest snows of autumn fall at a mild temperature, and often when the trees are warmer than the exposed grassy areas. At such times the trees will promote the melting of snow, but this should not lead to the conclusion that their influence is the same during the whole winter as it is in the warmer regions, or where the temperature does not reach much below freezing. It should be remembered that the same influences which tend to keep snow and water in wagon roads in wooded portions of the valleys tend also to hold snow and water on the wooded portion of the mountains, and just as the road dries up when the shade and shelter of woods are cut away from it, so will the mountain streams dry up when the shading and sheltering forests are burned off. All possible water flowing from these mountains toward Tobacco Plains will some time be needed for irrigation. Much of that flowing southward is needed now about Columbia Falls, Kalispell, and in the Stillwater Valley. These fertile valleys will probably need all the water these mountains in their best condition can furnish to make them productive to their fullest capacity.



CEDAR (THUJA PLICATA), SLOPE OF RAVINE, CANYON CREEK.

LODGEPOLE PINE (PINUS MURRAYANA) KILLED BY FIRE, AND LAND DENSELY RESTOCKED BY SAME SPECIES.

Near Summit Station.

Water power.—None of the abundant water power is now used. Akanoho, Deep, Stillwater, Whitefish, Yakinikak, Red Meadow, Coal, and Big creeks are each capable of driving mills, each furnishing where they leave the mountains about the 1st of August streams some 50 feet wide and 2 feet deep, with a fall of about 20 feet per mile.

Mining.—No mines are shipping ore at present, though a number of prospects are being developed along the western mountains between Stillwater lakes and the international line, with fair prospects of copper, lead, and gold.

YAKINIKAK VALLEY.

This valley is so nearly the counterpart of Akanoho that the description of one will fit the other, except as to minor features, the principal of which is the timber. Lodgepole pine rules in Yakinikak. Very little else is found below an elevation of 5,000 feet, above which balsam and Engelmann spruce predominate. The Engelmann spruce is also scattered all along the bottom of the canyon, and larch reaches about halfway up the valley from the North Fork of Flathead River. Some very short and knotty red fir appears on southern exposures, but lodgepole pine forms about 90 per cent of all the tree growth, although but half of the log timber. Lodgepole pine nearly everywhere in this valley is as dense as it can stand, and the inferior trees of it are being killed by overcrowding. About 3 miles east of the divide the narrow bottom is crowded with trees some 20 feet apart, 6 to 10 inches on the stump, and 70 to 100 feet high. This was some of the most heavily wooded. The lightest stock was young growth north of the stream below the canyon, on land severely burned about the year 1868. One of the largest trees of this young stock was 7 inches in diameter on the stump and 38 feet high. Higher, on the mountain sides, where dry, part of this stock was 2 to 4 inches in diameter, 15 to 26 feet high, and 1,600 trees per acre. At an altitude of 5,000 feet and over, on southern exposures, where fire had killed balsam and spruce, they were succeeded by lodgepole pine. On northern exposures in the lower canyon, spruce, larch, and balsam are found opposite the exclusive lodgepole pine on southern exposures across the valley. Some 10 million feet of larch, red fir, lodgepole pine, and spruce are estimated in this valley. The volume of water, the fall, the water power, and the amount of agricultural land are very much the same here as in Akanoho. No mining prospects were seen.

THE EASTERN TRIBUTARIES OF THE NORTH FORK OF THE FLATHEAD RIVER.

The long, parallel ridges gradually descending southwestward from the high mountains of the Continental Divide to the North Fork of Flathead River are morainic, slightly modified by later waters. They are remarkably uniform, and the description of the Kishineen Valley would need but slight modification to apply to the whole tract from the international line to Camas Creek and from the Flathead bottom to the pyramidal peaks on the eastern horizon, comprising an area of some 300 square miles.

Starvation, Ford, Indian, Bowman, and Quartz creeks, for this reason, are simply alluded to as similar to Kishineen, and Kintla and Logging creeks are given a special description only in the points which differ from that valley. The ridges between all these streams coming from the northeast are covered with lodgepole pine, among which are occasional larch, survivors of the repeated fires. Near the mountains, and especially upon their lower slopes, fires have been so severe that very few trees are left, and the whole western side of the high mountain range, as seen from a distance, appears brown and barren. A close examination of the steep mountain slopes, however, finds brush of various sorts half covering the ground, with some lodgepole pine and balsam, about one-fourth of a stock, springing up among the brush, and the dead and partly-fallen trees.

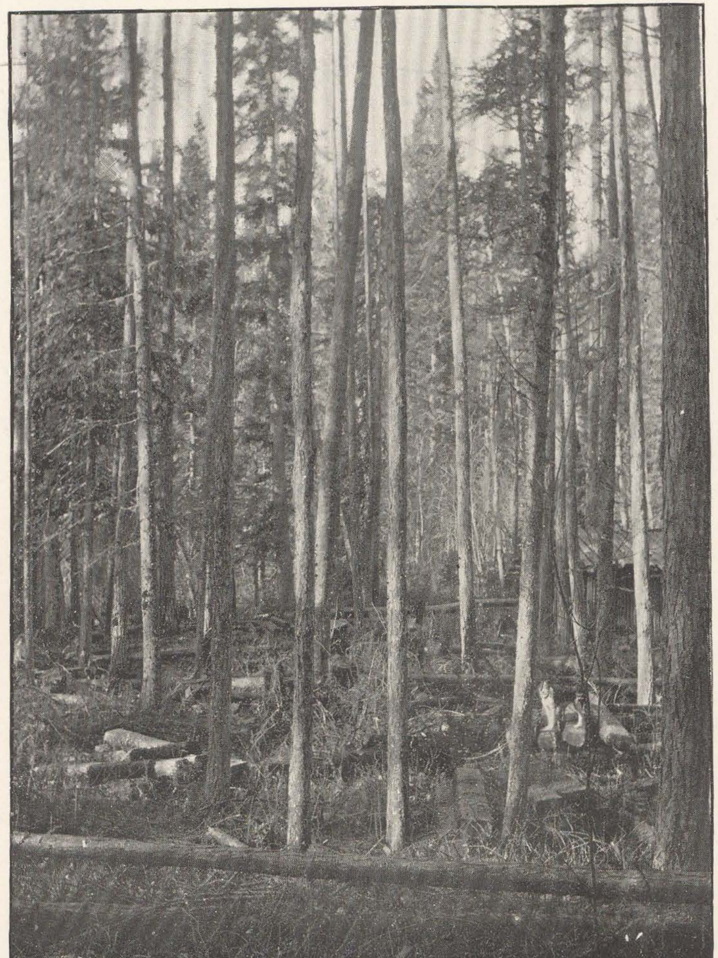
There are the following amounts of log timber, in irregular patches and groups, on the creeks and lakes named:

	Feet B.M.
Kishineen Creek	5,000,000
Starvation Creek	4,000,000
Kintla Lakes	17,000,000
Kintla Creek below the lakes	1,000,000
Ford Creek	10,000,000
Indian Creek	2,000,000
Bowman Creek	5,000,000
Quartz Creek	4,000,000
Logging Creek	22,000,000
Anaconda Creek	2,000,000
Camas Creek	23,000,000
Total	95,000,000

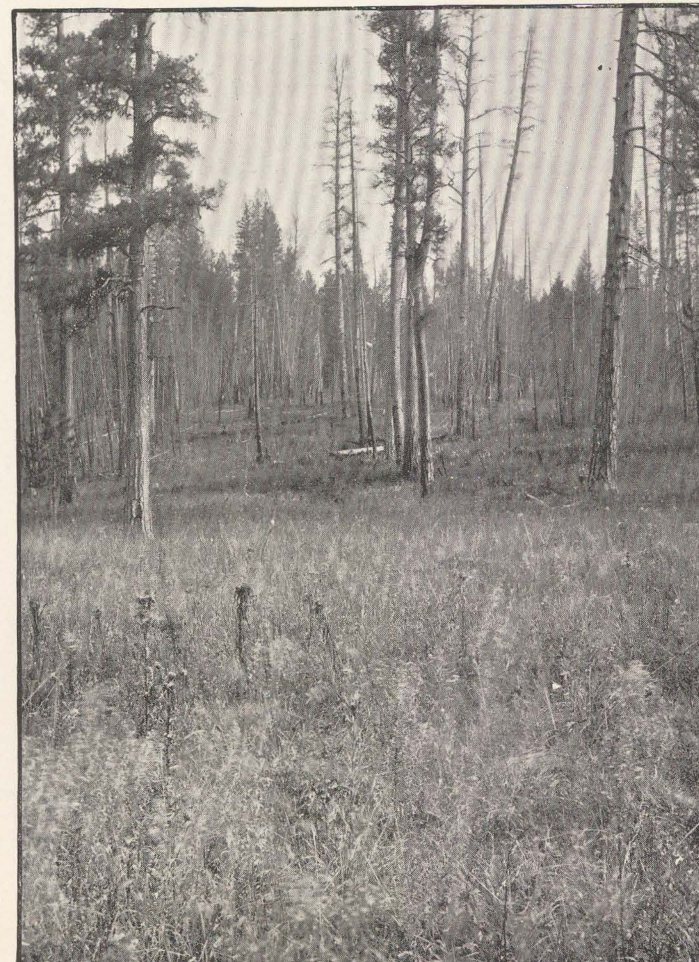
Of this 80 per cent is larch, 5 per cent is red fir, 5 per cent is pine, mostly lodgepole, and 10 per cent is spruce. Although this timber, if in a compact body, could be put into the river with no great difficulty, it is so much scattered and is of such inferior quality that very little of it has a present value on the stump.

KISHINEEN VALLEY.

Topography.—This valley heads far in the mountains north of the international line. After leaving the mountains it continues southwestward between two uniformly diminishing morainic spurs to within a quarter of a mile of the Flathead River, where the drift from the mountains has been modified by the main river current. Along the Kishineen the glacial débris has been somewhat terraced by modern water,



A. TIE CUTTING BY SQUATTERS. RED FIR AND LARCH, NORTH OF COLUMBIA FALLS.



B. YELLOW PINE HALF KILLED BY FIRE, NEAR LOGGING CREEK, NORTH FORK OF FLATHEAD RIVER.

and an irregular bottom, never more than one-fourth mile wide, has been formed. Most of this bottom is stony and dry. Only detached areas of a few acres each are suitable for cultivation, probably not more than 500 acres in the whole valley. The slopes of the valley above its bluffs are fairly uniform, especially south of the stream, and could be irrigated by tapping the stream about where it leaves the mountains. This point, however, is in British territory.

Soil.—The soil is gravelly and stony, and the subsoil, though principally glacial till, consists in places of deep beds of gravel.

Litter.—Frequent fires have consumed most of the débris, and so little remains upon the ground that horses may be taken in any direction quite freely.

Humus.—Humus is light. On most of the area less than 2 inches has formed during the thirty years that have passed since the last fire.

Trees and timber.—The very few trees suitable for milling here are the scattered larch that have survived the fires which seem to have been frequent and severe up to some thirty years ago. These larch vary from 10 inches to 2 feet in diameter and 70 to 125 feet in height, with about one-third of the trunk clear. Most of them stand upon the ridges. Probably they were left there because on that unfavorable soil less vegetation accumulated to feed fire, and when fire occurred it was not hot enough to kill them. There are hardly 5 million feet of log timber in the Kishineen Valley.

Young growth.—All the growth, excepting the surviving larch just mentioned, is young or too small for log timber. In this young stock trees of all ages up to 30 years are found. Nearly all of these are lodgepole pine, but on the moister subsoil there is a sprinkling of larch among the pine. It is noticeable that on shaded ground larch is more apt to spring up than the pine. With few exceptions there is now a fine stand of lodgepole pine and larch over the entire valley.

Underbrush.—There is very little undergrowth anywhere; on most of the land there is none.

Fires and reproduction.—The last severe fire, which occurred about thirty years ago, has been followed by a stock of lodgepole pine of medium density, which has been generally thickening since by seedlings continuously springing up between the older trees. Among these seedlings there is quite a sprinkling of larch; probably 5 per cent of the whole stock is larch. It is noticeable that there is more larch on the moister areas than on the very dry, gravelly ridges. There is also more springing up in the shade of the pine than in the exposed sunny areas. The larch promises to soon overtop the pine. The stand is about 300 trees of both species per acre.

Dead timber.—There is no dead timber of value.

Cutting.—No timber has been cut in this valley.

Agricultural land.—Agricultural land will be limited by the water that can be brought upon it, by the amount of stone in the soil, and by the steepness of the surface slopes.

Irrigation.—Probably none of the land in the valley can be cultivated without irrigation. Possibly 500 acres could be irrigated at moderate expense within the valley bottom. Outside of this bottom long ditches would be necessary for irrigation. Altogether about 5,000 acres could be irrigated.

Water power.—Abundant water power could be obtained by damming the stream, along which there are many favorable places for reservoirs.

Mining.—No evidence of mining or prospecting claims was seen in the valley.

KINTLA LAKES AND MOUNTAINS.

Topography.—This extremely rugged mountain region has been deeply cut and broken by great faultings, and cut by subsequent erosion. In the largest and most continuous of the deep valleys lie the Kintla Lakes and their tributaries. These two lakes are each 7 to 8 miles long and hardly a mile wide at the widest point. The upper end of the lower lake lies in the mountains, but its lower portion extends out between the foothills to within 3 miles of the Flathead River. Between the lower lake and the upper is a rocky valley some 3 miles long and a mile wide. Several tributaries from the glaciers in the high mountains to the south enter the stream between the two lakes. The upper lake has along its northern side a moderate slope of earth and talus reaching to the bare mountain wall a quarter of a mile away. South of this lake the mountain walls rise abruptly, culminating in Kintla Peak, one of the boldest and most difficult of access in the range. Above the upper lake several inlets from glaciers coming together have formed an area of about 5,000 acres of fairly level land. From this bottom the tributary valleys rise abruptly. The southern inlet heads in a glacier about 3 miles long, the foot of which is about 3 miles from the lake. The eastern inlet has a less rapid descent, except near its source, which is in a small glacier about 3 miles east of the head of the lake. Soon after leaving this glacier the stream falls into a deep valley some 4 miles long. The northern tributary has a very moderate fall through the last 2 miles of its course, but above is almost one continuous cascade from the high mountain ridge on and north of the British line. The peculiar conformation of these mountains may be best explained by describing the rocks of which they are formed. From Tobacco Plains eastward to the eastern foothills of the Rocky Mountains are strata of green schist, gray and buff limestone, and red quartzite, with occasionally dark metamorphic rocks, both crystalline and amygdaloid. West of Kintla Lakes these have a uniformly northeastward dip, with great faults bearing northwest and southeast, outlining the frequent valleys, the largest of which is that of the North Fork of Flathead River. Here at the head of Kintla Lakes, however, the strata become horizontal, and east of this point they have a southwesterly dip. Where the dip is slight such firm rock forms very steep and high walls. Some of them rise to a height of probably 5,000 feet above the lake with scarcely one-third of their height covered by talus. Some of these peaks, especially the northeastern ones, are rounded on the summit, presenting a much less serrated profile than the peaks bordering the Flathead Valley. Several of them are characterized by sharp points in their centers rapidly broadening to shoulders, below which the walls are almost perpendicular.

Soil.—About the head of the upper lake the luxuriant vegetation indicates a fertile soil, as might be expected from the amount of limestone contributing to it. Wherever soil is present, and even on the rocks far up the craggy mountain sides and close to the glaciers, and above them, trees and other vegetation grow with unusual vigor.

Litter.—On the unburned areas litter is abundant, the condition approaching that in the Cascade Mountains. The moss is often a foot deep in the lower tributary valleys above the lake.

Humus.—Humus is also deep on the unburned portions which extend up the mountain sides to timber line.

Trees and timber.—While lodgepole pine is found prevailing over the northern portion of the valley of the North Fork of the Flathead River, it yields gradually, as one moves up the Lower Kintla Lake, to larch and red fir. This change is first noticeable on the south side of the lake, where larch and red fir of timber size and quality are soon found near the lake, while lodgepole pine still predominates on the higher slopes. About half-way up the lake this same change occurs on the north side. At the head of the lake the timber diminishes, and on the north side yields to brush and stunted trees, while on the south it continues well through the gorge and even (somewhat interruptedly) to the foot of the upper lake. The narrow mountain foot along the north shore of the upper lake was well timbered with larch, red fir, and spruce until the fire of 1894. On the south side, east of Kintla Peak, is unburned Engelmann spruce and red fir, a crescent-shaped body of timber which is widest and heaviest along the southeastern inlet of the lake. Here the Engelmann spruce is frequently 30 inches in diameter and 60 feet to the first live limb. The red fir rivals it closely. Along both the northern and eastern tributaries timber exists in moderate quantity and medium quality. The flat north of the eastern extremity of the lake is covered by a mixed growth of spruce and balsam, with some larch and red fir on the higher portions. The mountain slopes are best wooded on northern exposures, producing timber suitable for mining purposes well up to timber line, where the mountain larch (*Larix lyallii*) reaches a diameter of 30 inches and a height of 80 feet. This larch is here more vigorous than in any other locality seen, and is here the hardiest tree in the high altitudes. It resists breaking and bending by snow better than any other, and, so far as could be judged by the appearance of pieces cut from the wood, it is the most valuable timber here for mining purposes.

Estimates.—There are about 9 square miles of timbered land about Kintla Lakes, and on this area some 17 million feet of larch, red fir, and spruce are standing alive and thrifty, and some 10 million feet of larch and red fir stand dead on the north shore of the upper lake.

Young growth.—Should the log timber now standing be removed, there would be left a forest of smaller trees ready to grow into timber. Much of this would be inferior as to species, for the timber species would be less predominant in the remaining stock, but everywhere the stand would be fairly good, with red fir and spruce enough for a good second crop, if favored by judicious thinning.

Underbrush.—In the mountain valleys, below the upper basins common near timber line, brush grows with great vigor. *Menziesia* is the principal species, and there are no large areas of other species. It is most abundant under scattered spruce and balsam on northern slopes. Huckleberry, spiræa, mountain ash, mountain alder, maple, devil's club, thimbleberry, yew, juniper, waxbush, squawberry, and service berry occur here also, scattered and mixed with young trees or under large ones.

Fires and reproduction.—In the year 1894 a severe fire, that seems to have escaped the control of some careless camper between the two lakes, swept the north shore of the upper lake and the south shore until stopped by the rocky spur of Kintla Peak. North of the lake this fire was very severe, killing all the trees, of which 10 million feet B. M. now stand dead. South of the lake the fire was less destructive, owing to a lighter stock and more rocks. Reproduction seems free and abundant on the north shore of the lake, and larch and red fir are already appearing under the dead trees in ample quantity for a new growth of timber.

Dead timber.—The 10 million feet standing dead, killed by the fire of 1894, on the north shore of the upper lake, is still suitable for milling. Some of it was cut for making a raft, and it was found sound and free from worm-holes.

Cutting.—No cutting has been done except for camping purposes.

Transportation.—Kintla Creek and the North Fork of Flathead River are both drivable.

Demand.—This timber has no market value at present. It is too remote. There is no local demand.

Agricultural land.—Agricultural land is found only in such small quantities as might be used for vegetable gardens, or small areas of meadow.

Irrigation.—The two lakes, each with a surface area of about 5 square miles, afford excellent reservoirs to insure a steady supply of water. The abundance of irrigable lands in Flathead Valley below could, perhaps, use all the water from these lakes. The outlet, where forded, near the North Fork of Flathead River, August 13, was 80 feet wide, 2½ feet deep, and quite rapid.

Water power.—Excellent water powers are here below each lake.

Mining.—Some prospecting has been done in the valley, but no mines are producing at present.

KINTLA CREEK, BELOW KINTLA LAKES.

Kintla Creek, below the lower lake, August 13, was about 75 feet wide, 2½ feet deep, and rapid. It cuts through the foothills and flows between moraines extending beyond the foothills without forming any considerable bottom. North of the creek and the nearest moraine is a wet meadow or slough nearly a mile long, and around this are about a thousand acres of moderately-sloping, fertile land. The remainder of the valley consists of morainic ridges with occasional areas of steep circular hills and hollows. Here and there are small areas that might be cultivated with profit, if there were a local demand for the crops. Otherwise, this valley is so like that of Kishineen that it seems unnecessary to describe it in detail.

LOGGING CREEK.

This valley varies little from the others north of it. Below the lake it is narrow and terraced. The lower portion of it is well timbered and mixed throughout with larch and red fir, while Engelmann spruce is found in the damper portions. Two miles below the lake lodgepole pine begins to prevail, and occupies nearly all the land toward the mountains, except the steeper slopes toward the lake which are somewhat timbered south of the lake with mixed larch, spruce, and lodgepole pine, and north of it with lodgepole pine and red fir. A few trees of yellow pine were seen north of the lake.

CAMAS CREEK.

Topography.—The portion of this valley that lies within the mountains is narrow and stony, with precipitous sides—an old glacier bed. Out of the mountains the slopes of the valley are easy, and the flat bottom is from half a mile to a mile wide.

Soil.—The soil is clay, with a fine grit about the consistency of molding sand, or a trifle more clayey. It seems to have been formed of sediments from glacial waters. The bottom is nearly all too wet for cultivation without drainage, and much of it is covered with a deep, dark vegetable accumulation.

Litter.—Litter is abundant on the spruce land, between the two lower lakes and south of the creek under the hills, but north of the creek, for some 8 miles above the river there is very little, as repeated fires have consumed most of it.

Humus.—Humus is also light on this burned area, but in the spruce swamps often reaches a foot or more in depth. On the creek bottom also humus is frequently deep.

Trees and timber.—Larch and spruce, with occasional red fir, constitute the timber. Other trees are small and to be classed as young growth. Larch prevails south of the creek on northern exposures, where some has survived the former fires, and where the new growth of this species is overtopping the lodgepole pine among which it started. In size it varies greatly, from a few inches in diameter for the young growth to some 20 inches for the older stock. As this tree usually grows tall, overtopping the surrounding stock, the upper portion of the trunk is quite limby, but the limbs and knots are small. Seldom more than 30 feet of the trunks are clear.

The Engelmann spruce on naturally subirrigated land forms large and valuable timber. One tree grown on the border of woods and on the bank of a stream was found to be 25 inches in diameter on the stump, 150 feet high, and 182 years old. The clear trunk of this tree was 18 feet long. Within the dense woods between the two lakes there is some very good timber 20 to 30 inches in diameter and about 40 feet to first limb. Among these spruce are some white pine, cedar, and even hemlock and silver fir.

Estimates.—There are, approximately, 9 square miles of timbered land in the valley, and this would yield some 23 million feet, 50 per cent being larch, 30 per cent Engelmann spruce, 10 per cent red fir, 5 per cent lodgepole pine, and the remainder white pine, cedar, and balsam.

Young growth.—The young growth is not abundant or promising except south of the creek on northern exposures. North of the creek, where fires have run more frequently, the lodgepole pine has come in slowly and sparsely, with many blank spaces that are being filled in as occasion favors the rooting of the most vigorous seedlings to water through the unfavorable subsoil. White pine is seen occasionally among the other seedlings, about one white pine to every 2 acres. Engelmann spruce appears also among the lodgepole pine, but it has not developed as rapidly, except in damp areas.

Underbrush.—Underbrush is not abundant. Scattered among the lodgepole pine are service berry and *Ceanothus*, and under the spruce are *Menziesia*, dogwood, huckleberry, devil's club, and thimbleberry.

Fires and reproduction.—Excepting the body of spruce timber below the upper lake, on the wet land about the lower lake, and on several strips at the foot of the hills south of the creek, the valley has been burned so repeatedly and severely that very little dead material has been left and very little humus is found on the surface of the dryer portions. In this condition the soil in the valley seems unfavorable to the starting of seedlings, and the burned areas are restocked very slowly. In fact, some 400 acres of the valley is now prairie or meadow, on which trees seem unable to start. On the burned areas there is so much clay in the soil that much water runs off without sinking into it. Thus only in most favorable times and places can a new growth find conditions suitable for starting. On the larch land, south of the creek, reproduction is somewhat easier, and here some of the slighter burns have been followed by a dense new stock.

Dead timber.—Dead trees and stubs are scattered here and there over nearly all the valley, but none of these have any commercial value.

Cutting.—No cutting has been done, except for building cabins and for camp fires and trails.

Transportation.—The stream can be made drivable at moderate expense by damming the lakes, clearing the banks of brush, and clearing the bed of the lower portion from bowlders. Logs would float from its mouth to the mill at Columbia Falls with little attention.

Demand.—There is no demand for local use. Columbia Falls is the nearest market for logs, and present prices there would hardly pay for getting out log timber.

Agricultural land.—Agriculture has not been tried, but the growth of grasses and other vegetation, where well watered, as on the creek bottom, warrant classing this land (some 10 square miles of it) between the mountains and Flathead River as favorable for ranching, and possibly valuable for wheat, oats, and the hardier vegetables. That portion lying within the mountains is nonagricultural.

Irrigation.—Irrigation is possible and easy in the whole valley. The lakes above furnish some 3 square miles of storage surface, and the slopes of the valley are most favorable for leading water.

Waterpower.—In connection with the reservoirs afforded by the lakes, the lower portion of the stream would furnish excellent water power. At the ford on the Belton trail, on August 29, the stream was about 50 feet wide and 1½ feet deep, with a moderate current.

Mining.—There are no mining operations in the valley at present.

THE NORTH FORK OF FLATHEAD RIVER.

Topography.—Between the ends of the parallel mountain spurs of the Whitefish Range on the west and those of the Continental Divide on the northeast the valley proper has been formed, with sides terraced to a height of some 200 feet, and a flat bottom grooved by the sinuous river and its straight and rapid tributaries. About 28 miles southeast from the international boundary the river turns from southeast to southwest and enters a canyon cut through part of the Whitefish Range, while the valley continues southeastward past the canyon and up Camas Creek. Excepting the ridges about McDonald Lake, the valley continues southeastward to and beyond Nilthwhatque, or McDonald Lake, but under this present heading only the continuous lowland from the international line to Camas Creek ford is considered. This valley is about 32 miles long, with an extreme width of 4 miles—an approximate area of 100 square miles. The river near the boundary is more rapid and more rocky, and changes in the bed are less frequent than toward the canyon, where the valley has more distinctly the appearance of a lake basin, with more alluvium and higher and more sharply-outlined terraces. The lower bottom is subject to floods and is frequently broken by channels of overflow.

Soil.—Clays are rarely found on the surface. They are exposed here and there in the river banks, especially in the "cut banks." A few clayey areas are found also near the hills. About 90 per cent of the soil is porous. Probably half of the 90 per cent is loam, while in the remaining 45 per cent gravel and sand predominate.

Litter.—Only the 10 square miles of moist woodlands have any considerable amount of litter, and these have not, as a rule, a great amount. Travel through them is difficult, but live brush forms the principal obstruction.

Humus.—Humus is usually light except on the moist woodlands and adjacent low prairies and about the mouth of ravines discharging upon bench lands, where the soil is sometimes darkened by humus to a depth of 2 feet or more.

Trees and timber.—Irregular patches of cottonwood, aspen, spruce, and lodgepole pine comprise most of the tree growth on the bottom land. East of the mouth of Logging Creek, however, is a small body of yellow pine, and in the same vicinity is red fir in considerable quantity, mixed with spruce and larch. There may be, altogether, 15 million feet of inferior timber in the valley. The yellow pine is mature, but most of the other timber is of medium age, knotty, and short bodied. One of the best wooded areas on the lowland had 200 trees per acre, 8 to 14 inches in diameter, and 70 to 100 feet high. The best stand of yellow pine was on terraced bench land, and a small area of it would yield 10,000 feet to the acre. The best mixed growth on upland was found about a fourth of a mile south of Logging Creek ford, where on one acre were 30 larch, averaging 20 inches in diameter and 140 feet high; 100 red fir, 8 to 12 inches by 90 feet; 70 spruce, 8 to 12 inches by 90 feet, and 2 yellow pine, 24 inches by 100 feet.

Young growth.—Were the log timber cut there would remain, except on the yellow-pine land, a fair stock of timber species. This stock would be of various ages, as a rule, for the seeding seems to have occurred at various times, as circumstances were suitable for the seedlings to grow. The most severely-burned areas, however, which are on the driest land and usually bordering prairie, have young growth of little else than lodgepole pine.

Underbrush.—On the bottoms are frequent areas of very dense willow, dogwood, and alder, but the uplands are fairly free from brush.

Fires and reproduction.—Evidence of severe and repeated fires is abundant. Actual prairie making has been accomplished. Throughout the valley burns are found varying in destructiveness according to the intensity of the fires, which have ranged from slight, creeping surface fires to those that have swept through the tree tops, and even fires that have rendered the land barren. North of Yakinikak the fire of 1893, that seems to have started from a camping place along this stream, ran to and beyond the British line, killing very nearly all the forest on the slope west of the Flathead River. This land is now fairly restocked with lodgepole pine, with some larch and spruce. Such restocking is rather exceptional in the valley, however. Elsewhere the reproduction has been imperfect and slow. The old burn, extending some 3 miles north of Coal Creek, is practically in the same condition as when crossed in the year 1883. A few unburned stumps, a very few isolated lodgepole-pine and spruce seedlings, and a few stools of grass and weeds give this land a desert-like appearance. The general opinion of men who have noticed this tract is that it has been burned so severely and so repeatedly that it will no longer grow vegetation. The whole valley seems unfavorable to forest reproduction and growth, probably owing to the prevalence of gravelly subsoils.

Dead timber.—The largest area of dead timber in condition for use is between Yakinikak and the British line, where are some 75,000 cords suitable for fuel, house logs, or fencing. It is now too far from market to be of any value. Throughout the valley are small areas of dead wood and some isolated dead trees, but none of present market value.

Cutting.—On secs. 21 and 22, T. 34 N., R. 20 W., a man named Chilson, about eight years ago, cut under contract with the Columbia Falls Mill Company (Messrs. Peterson and Olson) several hundred thousand feet of yellow pine. Part of this was landed and left in Logging Creek Slough; the remainder now lies rotting on the skids in the woods (Pl. XCIV, *B*). About 450 logs, scaling about 96,000 feet, were seen on skids. Throughout the valley many trails have been cut, over thirty cabins have been built, and a small amount of timber has been used in the coal banks on Coal Creek. No timber has been taken from the valley to market.

Transportation.—The river is drivable, and most of it is navigable; otherwise, horse trails are the only means of travel used at present.

Demand.—Log timber is marketable at Columbia Falls, but prices are very low. Only the best of the log timber could be marketed there with profit. There is no local demand at present.

Agricultural land.—The bottom lands vary as to soil from fine sediments with a rank growth of vegetation to almost barren gravels, and about 75 per cent of the 14 square miles of their area is arable. The lower benches are the most valuable for agriculture. They are free from floods, fairly uniform in surface, often stony, but with the greater areas arable. Most of this land has a porous subsoil, and irrigation would be necessary. It is usually fertile, as shown by a vigorous growth of vegetation wherever there is sufficient natural moisture. Most of it is prairie, and is irrigable. This sort of land is irregularly distributed and has an area of about 30 square miles. Other benches, higher, smaller, and less valuable, form an area of about 14 square miles, completing a total of about 58 square miles of agricultural land in the valley. About 12 square miles of this are now prairie; about 5 square miles that would make good hay land when cleared are now covered with willow, dogwood, and other brush; about 10 square miles are covered with lowland trees, such as cottonwood, aspen, and spruce, and the remaining 30 square miles are wooded with lodgepole pine, having a small proportion of other species in mixture.

Irrigation.—The land most favorable for irrigation is on the terraces or benches. These reach into the valleys of the tributary creeks and afford favorable ground for ditches. Extensive irrigation of the lower bottoms will be questionable, owing to overflows. Many of the slopes are too steep for agriculture. There are about 50 square miles of irrigable land in the valley.

Water power.—The most available source of water power is in the tributary creeks, especially those from the east. Most of these flow through lakes which would afford excellent reservoirs. The supply of water is abundant and on the lake streams fairly uniform.

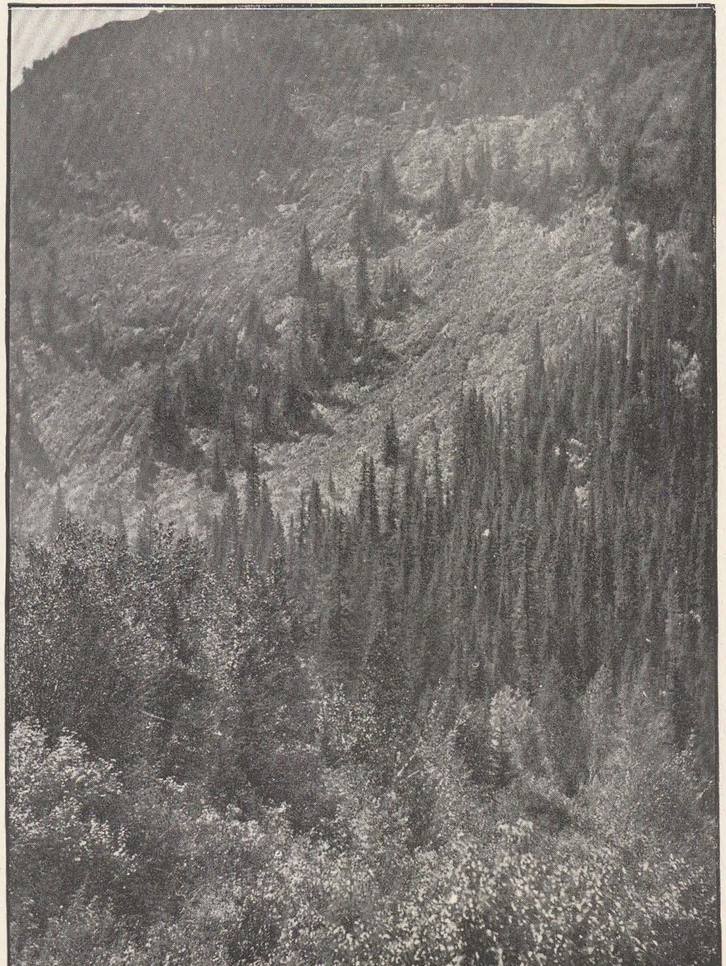
Mining.—No mining claims were found in the valley except those entered for coal. Lignite coal occurs in some quantity, and has been quite extensively developed. Petroleum is reported from the northern part of the valley.

Occupancy.—Many squatter and homestead claims have been taken and many cabins have been built. About thirty were seen, but only two of these were occupied; one at the coal banks on Coal Creek, and one on Bowman Creek. Two on Camas Creek were kept in repair and seemed to be occupied during a part of the year.

McDONALD CREEK.

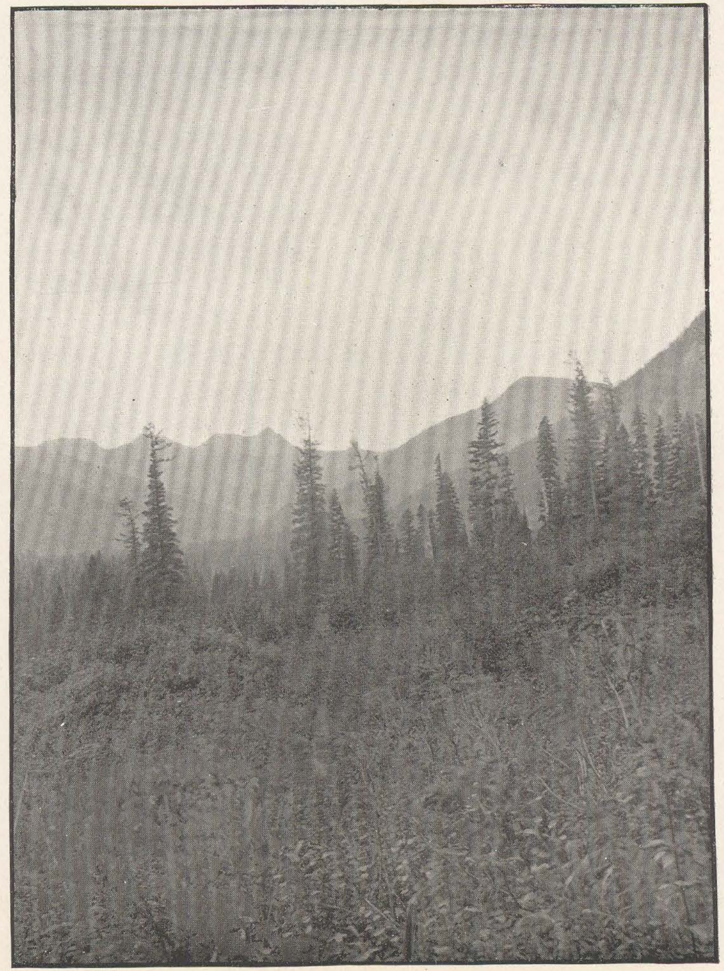
Topography.—The lower portion of this valley is narrow, with high and precipitous mountain sides and moderately-sloping bottom about a mile wide, excepting at the narrows about a mile above Avalanche Creek, where the rocks crowd to the stream. Above Trapper Creek the mountain slopes are less precipitous and the valley widens. The slopes become longer and more uniform, an exception being found in Flat Top Mountain between the main forks of the stream. This mountain has precipitous sides.

The scenery of this valley is of the grandest. The dizzy heights of the mountains about the lower valley, the very attractive and rest-



A. MOUNTAIN SIDE, McDONALD CREEK.

Balsam (Abies lasiocarpa), spruce (Picea engelmanni), and nut pine (Pinus albicaulis).



B. SOURCES OF McDONALD CREEK, LOOKING NORTHWEST.

Large white pine (Pinus monticola), with Engelmann spruce (Picea engelmanni) and balsam (Abies lasiocarpa).

ful park region on Flat Top Mountain and in Granite Basin, and the grand views from the mountains bordering these elevated parks, with the numerous glaciers and the cascading waters from them, are well worthy of being visited by tourists, a few of whom have already attempted the pilgrimage.

Soil.—The soil is yellow in color and seems very fertile. The trees are luxuriant, often large, and a vigorous vegetation prevails.

Litter.—The litter is abundant. Many young trees are being killed by overcrowding. These are falling and forming litter upon the surface. There is but little of such material, however, on the upper portion of the slopes, which, being sparsely wooded and being covered with bear grass, afford scant opportunity for such accumulation.

Humus.—In the lower portion of the valley humus is often 4 inches deep. This depth diminishes gradually upstream and very rapidly up the mountain sides, there being little or no humus above an elevation of 6,000 feet, except in small, moist basins that occur here and there along the foot of the higher ridges.

Trees and timber.—The first 4 miles above the lake are found densely crowded with trees of hemlock, larch, cedar, and white pine. On one-sixteenth of an acre, about 1 mile from the lake, were found 8 larch, 10 to 24 inches in diameter, 90 to 120 feet high; 29 hemlock, 6 to 11 inches in diameter and 70 to 90 feet high; 2 white pine, 10 inches in diameter and 100 feet high; and 3 cedar, 8 to 10 inches in diameter and 75 feet high. A few cedar and yew were on the ground as an undergrowth. The surface was otherwise free from vegetation excepting some mosses. The humus here was 2 inches deep, the soil a yellow loam about the consistency of molding sand, i. e., half clay, half sand.

Along the stream above this point the trees are larger, 2 feet being the common size on the stump below the narrows, above which, near Trapper Creek, white pine 40 inches in diameter was frequently seen, beautiful and vigorous, reaching a height of 150 feet. One of these trees was estimated to contain 4,000 feet B. M. Hemlock and cedar also reach a diameter of 36 inches and a height of 100 feet; silver fir (*Abies grandis*) becomes large enough for log timber, and Engelmann spruce maintains its usual vigor—where sufficiently crowded containing excellent timber. Outside of the valley bottom there is but little log timber, the slopes being covered with scrubby red fir, Engelmann spruce, and hemlock until an altitude of some 5,000 feet is reached, when the alpine species prevail. Above Trapper Creek the timber is quite irregular in distribution. There is a continuous strip along the stream, but the strip is very uneven, being narrowed in places by slides, widened elsewhere to continue well up the mountain slopes, and in such instances the forest grades into the alpine species of the higher elevations.

Estimates.—The 12 square miles along the bottom of the valley below Trapper Creek will average about 4,000 feet per acre. Above this point the distribution is so irregular that no attempt to average the yield was made. The estimate for the whole valley is 28 million feet, 30 per cent of this being hemlock, 30 per cent Engelmann spruce, 20 per cent white pine, 10 per cent cedar, and 10 per cent cottonwood and balsam.

Young growth.—The young growth in this valley does not present any marked characteristics. Seedlings have started from time to time, and now trees of all ages are found, usually as a mixed growth.

Underbrush.—Underbrush is usually very dense. There seems to be more moisture in this valley than in most others in this region. The conditions are more favorable to the growth of brush. The higher slopes, however, at elevations above 6,000 feet are as usual almost free from brush.

Fires and reproduction.—There have been no recent fires in this valley to injure any considerable area, except north of the lake on the spur between this valley and Camas Creek. The end of the mountain here was severely burned several years ago and is now about half covered with brush, with a very few seedling trees. This applies to an area of about 6 square miles. As stated under young growth, occasional small seedlings are found throughout the valley, but the vigorous growth of the brush and other vegetation near the surface seldom gives them an opportunity to start.

Dead timber.—Of dead timber there is very little; here and there a tree killed by overcrowding or by old age, but no wide areas killed by fire. There is no deadwood of market value.

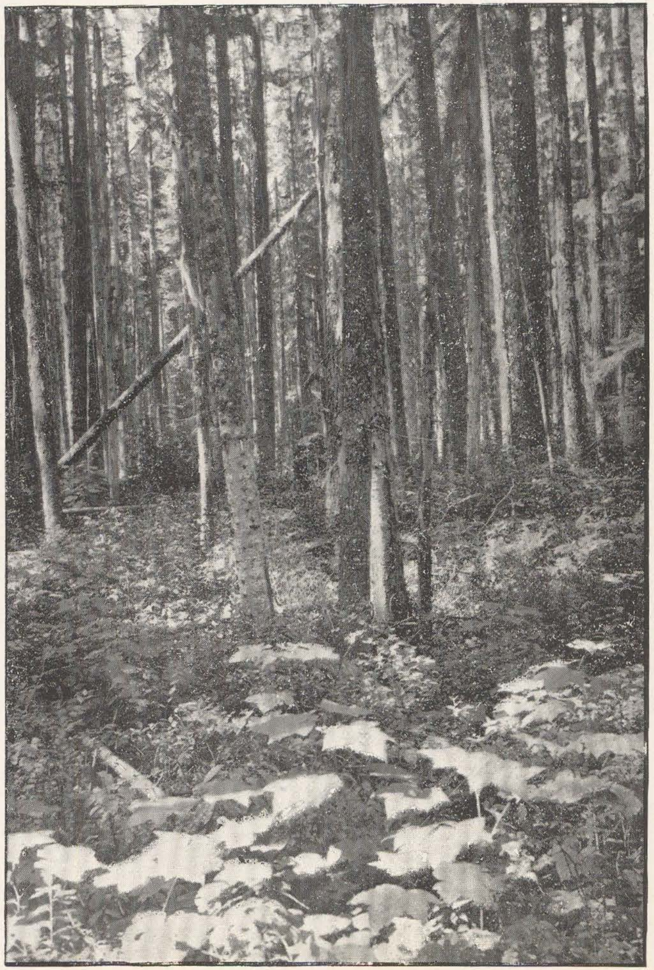
Cutting.—No cutting has been done except for trails and camps.

Transportation.—The stream would be drivable only at great expense. It is very rapid and rocky. The grade of the valley, however, is not steep and a logging railroad could be built at moderate cost.

Demand.—At present such timber, remote as this is, would probably have no market value on the stump. After getting the logs out of this valley they would have to be taken across McDonald Lake and down the river to Columbia Falls to find a present market, where logs are now bought for about $3 a thousand. For mining purposes or other local use there is no demand at present.

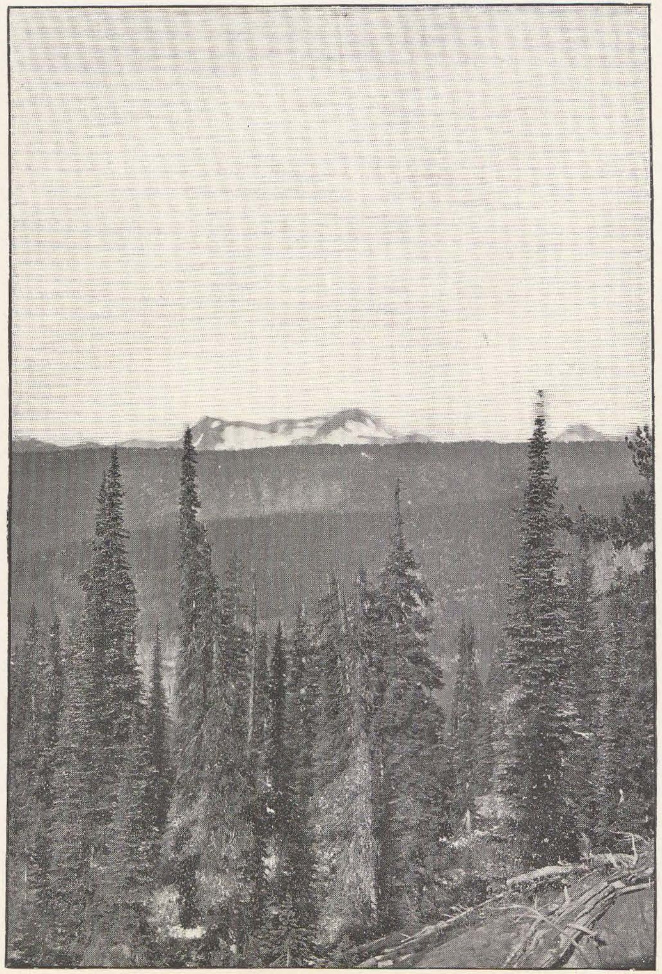
Agricultural land.—None of this land has a present agricultural value, but sometime small areas may be in demand for growing vegetables or hay. Small portions of the narrow bottom are fertile enough, but the cost of clearing would be great and the liability to frosts constant. None of this land is cultivated at present.

Irrigation.—None of this land is irrigated. There is abundant water to irrigate all the land that is arable.



A. FOREST ON McDONALD CREEK 1 MILE ABOVE TRAPPER CREEK.

White pine (Pinus monticola), with Engelmann spruce (Picea engelmanni) and balsam (Abies lasiocarpa).



B. VULTURE PEAK, LOOKING OVER FLAT TOP FROM HEAD OF COLLINS CREEK.

Balsam (Abies lasiocarpa), spruce (Picea engelmanni), and nut pine (Pinus albicaulis).

Water power.—Water power is abundant. At 6 miles from the lake this stream was, on September 2, 150 feet wide, nearly 1 foot deep, and moderately rapid.

Mining.—No mines are shipping at present, but some claims are held about the head waters of the stream.

THE FLAT TOP REGION.

Topography.—This region, an alpine valley, covering the Continental Divide, is bounded by very high and sharp mountains. The rocks and their stratification explain the topography. Limestones, quartzites, and greenstones, with some metamorphic injections and overflows, are synclinal along the Continental Divide, forming a great basin with sharp, jagged rim. From this basin flow Quartz, Logging, McDonald, and Kootna creeks. The three former drain into Flathead River, the latter into the Saskatchewan. McDonald Creek carries the most water, Kootna is next in size, and Quartz Creek is the smallest. Logging and Quartz creeks, however, merely cut through the western rim, while McDonald and Kootna creeks, interlapping, drain the greater portion of the basin. Deep and sharp canyons are frequent about the rim. Flat Top Mountain occupies the greater area of this tract, and on it is the divide between McDonald and Kootna creeks. This mountain is fairly smooth. After once getting up the wall, which, cut by ravines and canyons, bounds it on all sides except on the northeast, where it joins the higher mountains, horses can travel freely all over it. Its elevation was not determined, but, by rough estimates, it is thought to be about 8,000 feet. The surrounding mountains seem to run some 2,000 to 3,000 feet higher (Pls. XCVI, *B* and XCVII, *A*).

Soil.—The soil seems fertile, and wherever sufficiently watered and unencumbered by snow yields a vigorous vegetation. About one-third of this area has no soil, being bare rock, gravel, and talus, with slight accumulation of humus, and the remaining two-thirds is yellow loam, about the consistency of molding sand.

Litter.—The principal accumulations of litter are in the valleys or canyon bottoms, where the trees killed by overcrowding or old age fall and frequently render access very difficult. Occasionally, but rarely, on the higher slopes fire has run years ago, and the killed trees, more durable here than in lower altitudes, continue falling as the roots slowly decay; but the growth being sparse in these higher altitudes, no great amount of débris is found outside of the canyons. The basins about the head of the streams are open and grassy, and the middle altitudes, Flat Top especially, are scantily wooded, grassy, and almost entirely free from litter.

Humus.—In the canyon bottoms sometimes a foot of humus is found in moist places, and, varying according to drainage and altitude, grades from this depth to little or nothing in the higher mountains.

Trees and timber.—Except in the valley of McDonald Creek the trees are usually knotty, though sound, and seldom exceed 24 inches on the stump. Very few defective or crooked trees are found here, and most of these are young and thrifty, but short and much branched. Some 10 million feet of spruce and balsam would cover all the timber. About 80 per cent of this is spruce. There are about 250,000 cords of material not suitable for log timber (Pl. XCVII, *B*).

Young growth.—But a small proportion of the tree growth being large enough for log timber, the greater portion must be classed as young growth, although much of it is old. Most of this material is balsam and spruce, very much branched and knotty.

Underbrush.—There is very little underbrush, except on the lower slopes and in the canyons. The middle slopes have a scant growth of huckleberry, while on the lower slopes *Menziesia* is often very dense. On the frequent slides leading into the canyon are occasional thickets of alder and willow that are almost impassable without an ax. Devil's club, thimbleberry, currant, and gooseberry form a less dense growth on the drier portions of the slides.

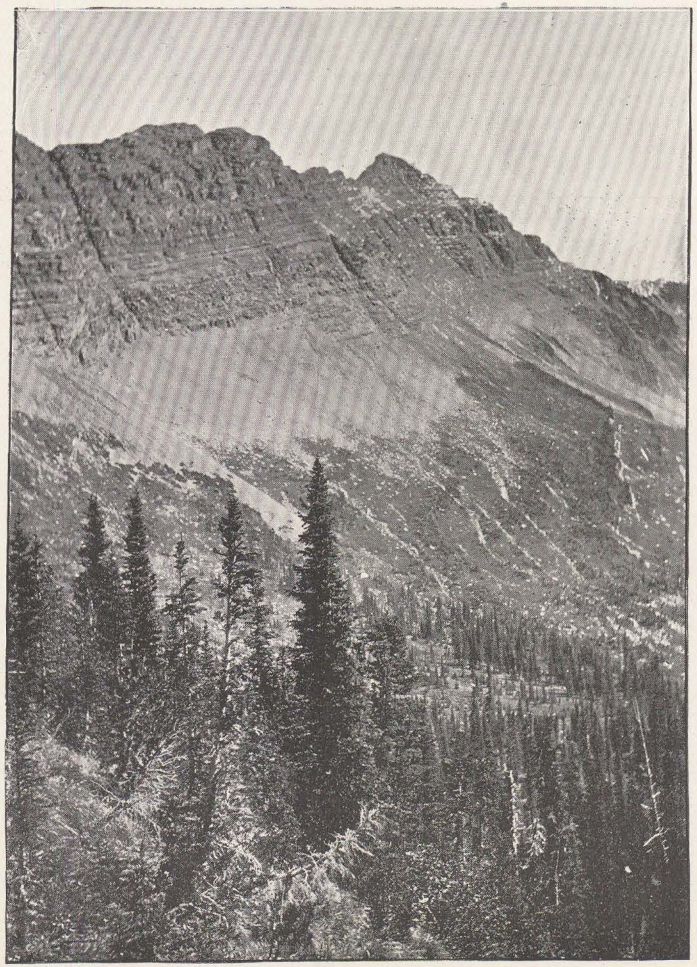
Fires and reproduction.—Very few recent burns have occurred, and few very young trees were seen. Some 400 acres were burned over on Flat Top in 1894, and on this area is a scant growth of young seedlings, not sufficient for a dense stand, but enough to make a stock similar to that burned, about 10 to 15 trees to the acre. On the unburned area the spaces between the larger trees are occupied by either grasses or "bear-grass," on which seedlings are unable to start. The scarcity of seed this year was notable. In this region not a cone was found in the high altitudes. It is therefore inferred that seasons in which no seed is matured frequently pass, and this fact, in connection with the severity of the climate and the unfavorable surface conditions, probably accounts for the sparseness of the forest in this region.

Dead timber.—Very few dead trees were seen except on the burn mentioned. Even dry wood for camp use is not abundant. The amount is not appreciable, except on the burn, where 100,000 feet of inferior log timber could be cut now, and about 2,000 cords of other material.

Cutting.—No cutting has been done except for cabins, camp fires, and trails.

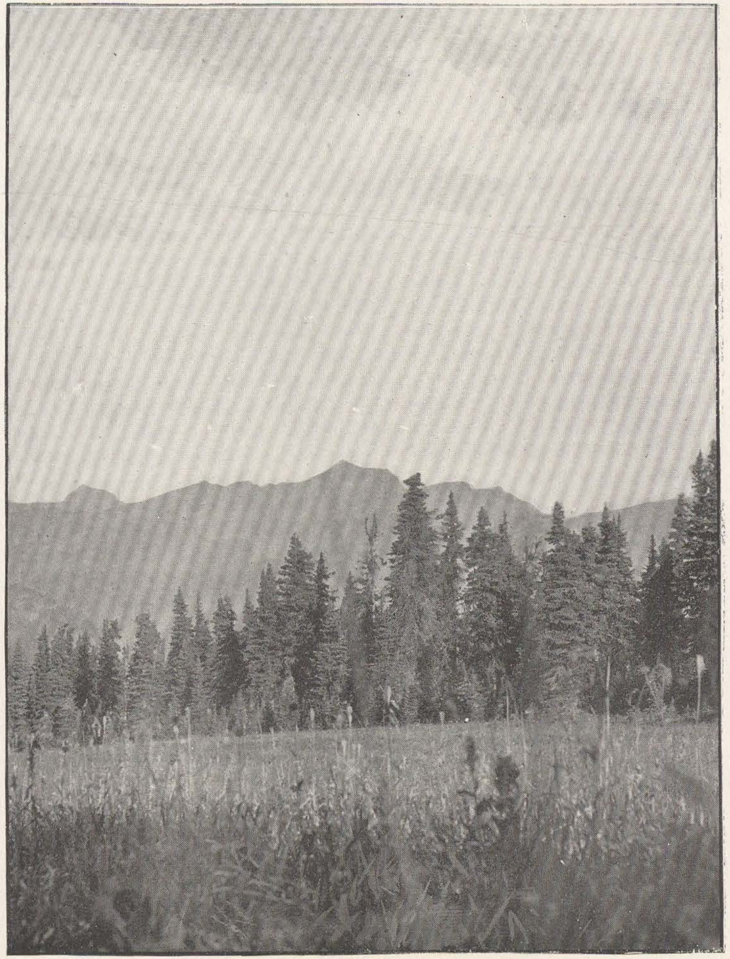
Transportation.—There are no facilities at present for transportation, and there is not timber enough to warrant the making of roads, except perhaps along McDonald Creek. Horse trails are the only means of travel at present.

Demand.—There is no demand at present. The numerous mining prospects of the vicinity have, as yet, used very little wood for props and cribbing.



A. CONTINENTAL DIVIDE EAST OF GRANITE BASIN, McDONALD CREEK DRAINAGE.

Balsam (Abies lasiocarpa) and spruce (Picea engelmanni).



B. VULTURE PEAK, FROM GRASSY OPENING ON FLAT TOP.

Balsam (Abies lasiocarpa) and spruce (Picea engelmanni) in foreground.

Agricultural land.—There is no agricultural land in the Flat Top region.

Irrigation and water power.—The water from this basin would hardly be needed for irrigation until it reached the Flathead Valley, and this is very remote. Water power in this area is limited to small streams.

Mining.—None of the many mining claims are shipping ore at present.

KOOTNA CREEK.

Topography.—This very mountainous drainage area covers about 95 square miles, and of this not over 5 square miles is bottom land. The very high mountains are cut by canyons, frequently 4,000 or 5,000 feet deep. Glaciers abound in the higher basins and pour into the narrow canyon bottoms their waters and the débris brought down by them, the latter frequently shifting the courses of the streams. Many of the very sharply-serrated summits are inaccessible. Many can be reached only by difficult climbing and long detours. The waters, heading principally in glaciers to the westward and increasing by minor drainage from lateral basins and gulches, collect in the narrow Kootna Valley, flow northward and form the beautiful Chief Mountain Lake, which, reaching across the international boundary, drains into the Saskatchewan. On September 13 the main inlet of the lake was 100 feet wide, 1½ feet deep, and fairly rapid.

Soil.—Derived principally from limestones, green schists, and red quartzites, much of the soil seems, both chemically and physically, of the best, and in the main valley above the lake, wherever moisture is suitable, vegetation is vigorous.

Litter.—On most of the higher mountains the rocks are bare. In the higher basins, where snow lingers late in the summer, the scanty vegetation of grass, low shrubs, and dwarfed trees does not accumulate much litter. The brushy middle slopes on the mountain sides, with patches and strips of forest, have their old and dead trees and occasional fire-swept areas and snowslides, where the fallen wood is considerable. In the valley bottom the trail was rendered very difficult of passage by fallen trees.

Humus.—Among these steep mountains the humus is never constant over any considerable area. A foot was the greatest depth noticed, and this was at the mouths of small ravines, where the growth of vegetation was most favored.

Trees and timber.—Engelmann spruce forms almost the only log timber here. A few trees of balsam are fit for sawing, and near the head of the lake there is a little red fir and lodgepole pine. The largest spruce are some 30 inches in diameter and 100 feet high, with scarcely more than a length of log timber free from limbs. The red fir is very knotty and short, seldom over 70 feet high, with no clear timber.

Roughly estimated, there are some 4,560,000 feet of log timber on this drainage, 90 per cent of which is spruce.

Young growth.—The trees not large enough for log timber are spruce and balsam, except in the lower valley, where red fir and lodgepole pine appear. The small trees of spruce and balsam promise to be of little value, being so slightly crowded that the limbs grow too freely. The red fir in the lower valley is very short and knotty, and the lodgepole pine will not make much log timber unless thinned.

Underbrush.—On the lower mountain slopes *Menziesia*, alder, willow, mountain ash, huckleberry, thimbleberry, and devil's club are very dense and difficult to pass through, although occasional openings occur on the drier portions. Toward the lake, on the lodgepole-pine land, where the subsoil is gravelly, the land is too thoroughly drained for a heavy growth of brush. Frequent grassy intervals occur along the bottom, probably developed by fires.

Fires and reproduction.—Evidence of old fires is frequent. No recent burns were seen except within a mile of the head of the lake, but most of the land about the lake was burned over. One fire had occurred in 1897, another in 1894, and another in 1889. These seem to have been set by careless campers visiting the lake to fish. A very extensive burn has swept the north end of the mountain east of the lake. These fires, though usually severe, have varied much in different localities; that of 1889 was very severe, and part of the area then burned was burned over again in 1894. Where most severely burned young lodgepole pine is coming in abundantly; where less severely burned and some of the shading trees have been left, spruce is coming in, with some balsam. Here, as elsewhere, the very severe fires tended to stock the ground with lodgepole pine.

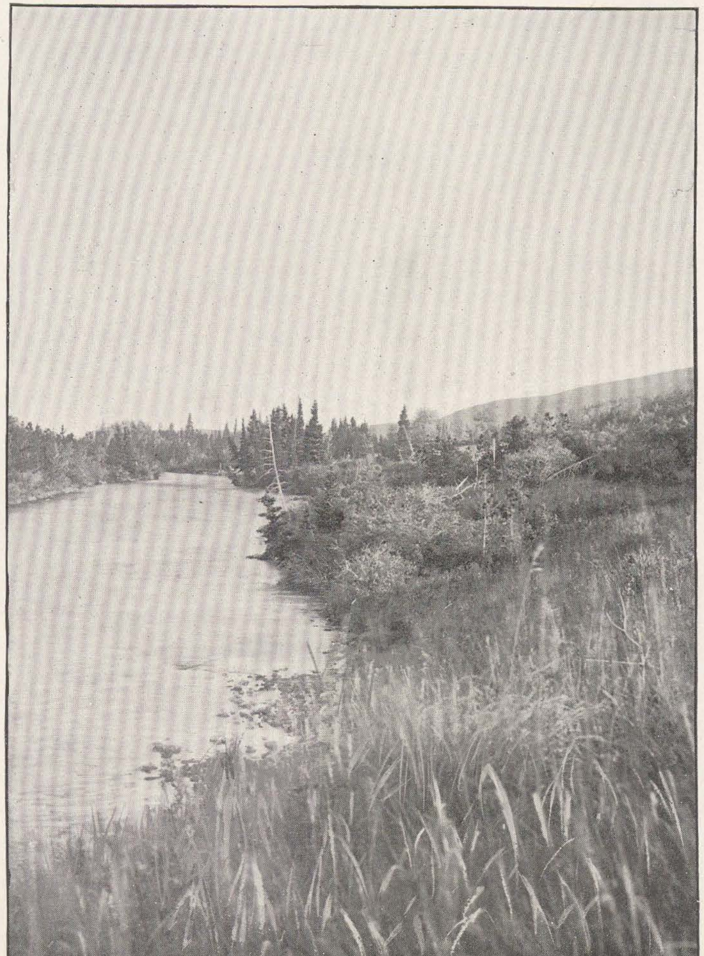
Dead timber.—Very little log timber is standing dead, and probably none of it has a stumpage value. There are, however, large quantities of fuel and some logs that could be used for house building; probably 30,000 cords are standing about the lake on the Montana side of the boundary.

Cutting.—Two cabins have been built in the valley. No other cutting was noticed except for camping and trail making.

Transportation.—The stream and lake afford excellent transportation for logs, as the stream is drivable, and logs can easily be floated on the lake.

Demand.—The only possible market at present is on the Canadian side. Rough sawed lumber at the foot of the lakes would bring $12 to $16 per M. from the settlers on the prairie below, in Alberta. There is at present no demand for mining timber.

Agricultural land.—About 4 or 5 square miles of the valley are more or less agricultural; that is, hay and some vegetables could be grown, but farming for the general market would be unprofitable. The best



A. BELLY RIVER (LOOKING NORTH), 2 MILES SOUTH OF BRITISH LINE.

Aspen, spruce, lodgepole pine, balsam, and willow.

B. EAST SIDE OF BELLY RIVER VALLEY, 1 MILE SOUTH OF BOUNDARY.

Burn partially restocked by lodgepole pine.

agricultural use of this valley at present would be for growing hay for wintering stock ranging on the adjoining plains.

Irrigation.—No water is used for irrigation south of the international line and little will ever be needed. There is ample supply for all the land that can be cultivated.

Water power.—There is ample water power for large industries at the head of the lake.

Mining.—None of the mining properties in the drainage are shipping ore at present.

BELLY RIVER.

Topography.—This valley (Pl. XCVIII, *A*) lies east and north of the most rugged mountains of the range. From large glaciers in this range flow the three principal tributaries of the river, passing through several lakes in recently glaciated canyons. The south and middle forks join about 6 miles south of the international line, while the north fork joins the main stream about 3 miles north of the line. The valley below the junction of the middle and the south forks is terraced by benches, the highest of which are some 200 feet above the river. The bottom lands gradually widen northward from one-eighth of a mile at the junction to about a mile on the international line. On September 15 the south fork was 50 feet wide and a foot and a half deep at its mouth, with a moderate current, and the stream near the international line was about 100 feet wide, 2 feet deep, and rapid. Away from the valley bottoms the mountain slopes are at first steep and rocky, then very steep and difficult, often impossible to climb.

Soil.—Clay abounds in the bluffs and appears occasionally in the valley bottom, but gravels usually predominate in the bottoms, and in most localities there is evidence of a deep, gravelly subsoil. The vegetation does not grow with remarkable vigor except in few places, where there are well-moistened, alluvial deposits. Irrigation might make it productive, however.

Litter.—Very little dead material is lying in the valley south of the British line except on the upper slopes, where lodgepole pine killed by fires twenty-five to forty years ago is lying netted among the new growth that has started since.

Humus.—Humus is light, owing to frequent fires and scant moisture.

Trees and timber.—Along the ridge east of the river and on the drier portions of the mountain slopes and benches west of it the trees are nearly all lodgepole pine, 3 to 6 inches in diameter, 10 to 30 feet high, and 20 to 30 years old. On the summit of the ridge east of the river a few older trees have escaped fire. In one tract (the largest) are some 60 acres, with trees 30 to 50 feet high and 6 to 10 inches in diameter. Along the mountains west of the river the largest timber lies above the benches and along the mountain foot. The benches have been burned and restocked with lodgepole pine about the same time the ridge east of the river was burned and partially restocked. About the lakes, both on the middle and south forks, is some spruce. These trees are from 10 to 26 inches in diameter, 70 to 90 feet high, and contain very little clear lumber. There are about 20 million feet of log timber in the valley; 60 per cent of it is spruce, 30 per cent pine, and 10 per cent balsam.

Young growth.—The smaller trees in the lower valley are principally of lodgepole pine. Most of these are about 25 years old. Where this stock has not fully occupied the ground, seedlings have been coming in from time to time since the main stock started, and these are of various ages, some of them only 2 years old. On the mountains are many small trees of spruce and balsam. Outside of the canyon bottoms there is little or no log timber, and all of the growth may be classed as young stock.

Underbrush.—The lower portion of the valley is brush prairie, the brush being willow, aspen, balm, and alder. On the upper slopes there is no brush below the mountains, where the usual *Menziesia*, alder, and willow densely cover the slopes.

Fires and reproduction.—Until within 25 years fires have been frequent and severe in the valley north of the mountains, sweeping the benches and the ridge east of the valley nearly bare. These have been partially restocked; but many grassy areas now exist which were once covered with trees (Pl. XCVIII, *B*). The most recent fires have been limited to the canyons in the mountains where, about 4 years ago, the lower mountain slope, near Ahern Pass, was swept by a fire that killed most of the forest between the two upper lakes. More recent fires have occurred north of the Canadian line, especially on the bluffs along the north fork of the river. Although much of the burned land has been restocked with lodgepole pine, even this usurping tree is here inclined to yield to grass. Many knolls where pine once stood are now grassy, and the lower benches and bottom lands of the valley have been reduced to brush prairie by fire, where, without fire, even this dry subsoil would support a forest.

Dead timber.—There is practically no dead log timber in the valley. There are some 15,000 cords of small material on the south fork, about and above the lake, but it is not worth getting out.

Cutting.—No cutting was noticed except for trails. A man from Alberta, looking for timber to cut and float down to mill, was met on the American side. This incident may be taken as an indication that cutting may be done soon.

Transportation.—This valley is easily accessible from the Canadian side. Wagons can now be driven to the international line, and little expense would make a road to the junction of the south and middle forks. In fact, a road well to the heads of these valleys would not be very expensive. The stream is easily drivable below the forks.

Access to this valley is, however, very difficult except through Canadian territory. The only trail now existing lies through Ahern Pass, and this is dangerous for horses.

Demand.—The settlements on the Canadian side of the boundary want lumber, and are paying $14 per M at the mill for inferior rough boards. A portable mill on the Canadian side has been cutting spruce and lodgepole pine for several years, and ready sale has been made there. At present there is no demand for mining timber.

Agricultural land.—The agricultural land is limited. The exact amount that may be cultivated with profit can be determined only by experiment. Hay can be grown over about 4 square miles in the valley, and half of this area is now stocked with coarse wild grasses that would make hay were the groups of willows growing there cleared out. Much of the bottom is stony, and the sides of the valley are steep. Except for this, irrigation would not be difficult. The valley is best adapted to grazing. The drier and rougher portion would make a good range, and on the best land hay and some grain could be grown for winter use.

Irrigation.—There is abundant water for the irrigable agricultural land in the valley and much to spare for the plains below.

Water power.—There are several very favorable locations for water power.

Mining.—There is no mining at present.

LEES CREEK.

Topography.—Several small streams contribute to form this creek. These head in the bold, rocky spur of which Chief Mountain is the end, and in the ridge which bears north from this spur is the head of the main stream. In their lower course these streams cut through Cretaceous rocks, causing topography approaching that of the plains.

Soil.—In this valley the transition is made from the soil found in the mountains to that of the plains. The higher slopes have the loam formed from limestone, schists, and quartzites, while the lower portions have the clays and fine silts common on the plains, except near the streams, where the soft rocks are bare and the bottoms are filled with gravels.

Litter.—Fire-killed trees often form a network difficult for horses to pass through, but much of the surface has been so severely and repeatedly burned as to leave much open ground, and by some study of route from the hilltops most of the valley is found accessible to horses without cutting.

Humus.—Owing to frequent burnings, humus is light except on occasional springy spots and sloughs.

Trees and timber.—As a rule trees are short. Few are over 70 feet high, and these are in ravines. Owing to freaks of fires, several different ages stand grouped in the same forest. No trees over 200 years old have been noticed. By far the greater area is covered with stock from 30 to 40 years old and too small for the saw. The saw timber is in the older groups that escaped fire. Even that is short and knotty and seldom over 16 inches in diameter on the stump. This region seems too much exposed for vigorous tree growth, being intermediate between the sheltered mountain canyons, where trees do well, and the exposed plains, on the borders of which the timber species are often found dwarfed to mere brush. In this area are some 3 million feet of log timber, 70 per cent of which is spruce and 30 per cent lodgepole pine. There are also some 50,000 cords of small wood in this valley, about 20 per cent of which lies within the reserve, the remainder being on the Indian reservation.

Young growth.—The greater proportion of trees are not over 40 years old, and these, though of some use for fuel, are more valuable for fence poles. As this young growth usually stands very dense, much of it could be cut out for fencing and leave the stock in better growing condition than it now is. Except where recently burned, there are few trees springing up. Once grassed, the seedlings seldom start (Pl. XCIX, *A*).

Underbrush.—Underbrush is small and scattered. Willows form dense clumps in wet ground, and aspen is often matted on the hills when free from the shelter of the pines; but the greater portion of the pine land is free from underbrush.

Fires.—Fires have frequently run in here from the prairie east, and have encroached greatly upon the forest, as the abundant fire-killed trees and charred snags on the brush prairie along the foothills indicate. Close about the mountains lodgepole pine has usually been able to reoccupy the ground after a burn, and the mountain sides are patched with thickets of young pine, often 40,000 trees to the acre; but on the lower slopes clumps of willow and dwarfed aspen form a brush prairie which replaces the old scrubby forest, of which a few scraggy dead trees remain as monuments.

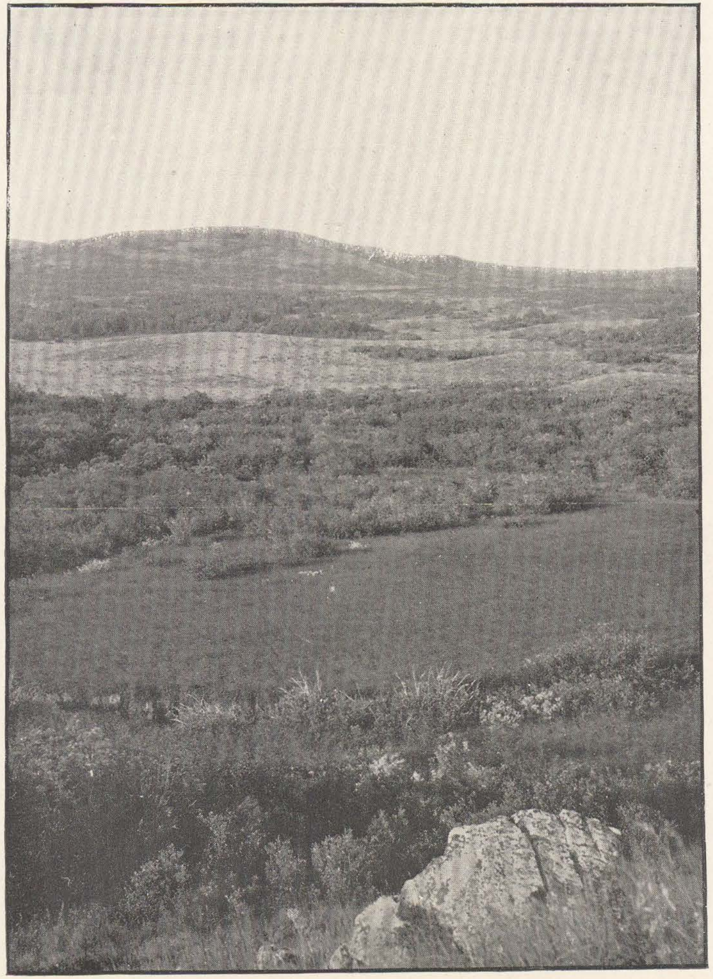
Dead timber.—There is no dead log timber of market value, but the deadwood could be used for fuel were the plains eastward settled thickly enough to create a demand.

Cutting.—There has been very little cutting done except for camping. A few poles were taken out some years ago for house logs.

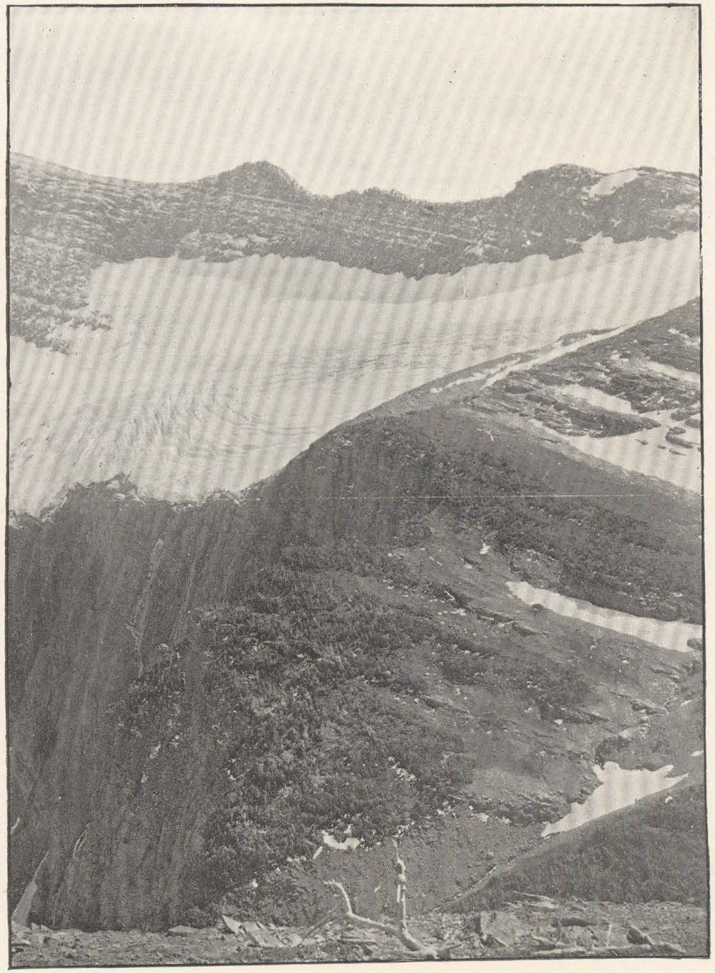
Transportation.—Wagon roads would not be difficult to make. The streams are too small to be drivable.

Demand.—House logs and fuel are being cut on the Canadian side and hauled long distances to the plains northeastward. Rough lumber sawed at a portable mill near Lees Creek brings $14 to $16 per M at the mill.

Agricultural land.—This land has little or no value for agriculture.



A. BRUSH PRAIRIE ON FOOTHILLS EAST OF CHIEF MOUNTAIN.



B. GLACIER SOUTH OF SWIFT CURRENT PASS, AT HEAD OF SWIFT CURRENT RIVER.

By the aid of irrigation small areas would grow hay and some of the hardier vegetables, but such tracts are few and small (Pl. XCIX, *A*).

Mining.—There are no mining operations at present.

KENNEDY CREEKS.

Topography.—The two forks of this stream, heading in the bare, rocky ridges southwest of Chief Mountain, are separated by the spur which terminates in Robertson Peak, on the eastern boundary of the reserve. A few miles east of this peak they join each other in the foothills, and on the border of the plains the creek joins the St. Marys River. These valleys within the reserve are very uniform; they may be described as very narrow bottom land between bare summits, large areas of talus and steep earthy slopes.

Soil.—Both valleys having been glaciated, their soils are derived from bowlder clay, gravels, and later disintegrations. The soil is scant and light colored, probably rich in plant food, but physically unfavorable to agriculture.

Litter.—Litter is scant, having been frequently burned off, except far in the mountains, where more moist, and where there are some accumulations.

Humus.—Humus is accordingly light, except in the few small hollows.

Trees and timber.—The irregular patches of lodgepole pine, Engelmann spruce, and balsam, subjected to fires from the prairies east and snowslides from the mountains, are able to produce but little timber. No marketable log timber was seen. There are probably 10,000 cords of wood in each valley.

Fires and reproduction.—Characteristic of the forest along its borders are the several areas burned at various times, each of which has trees of about one age and height. Restocking has followed fires quite freely near the mountains, while away from them, on the foothills once densely wooded, as shown by burned stubs and stumps, only scattered seedlings are growing. An inquiry as to the cause is excited by this condition. It seems probable that greater moisture and more shelter exists close to the mountains and favors the growth of seedlings there. This region was seen only in late September and October; at that time the frequent storms from the west covered the mountains with snow, wrapped their lower spurs and veiled their canyons with eddying mists, while the foothills and plains eastward remained dry and often free from clouds.

Dead timber.—There is no dead log timber of value, but there are several thousand cords of fuel in the two valleys, probably 1,000 on the North Fork and 2,000 on the South Fork.

Cutting.—No cutting has been done except for camping purposes.

Demand.—Each of these valleys is isolated from other accessible lands on the reserve, and excepting a possible demand from the Indian reservation or from miners in the mountains, neither of which have commenced, there is little prospect of a market for lumber or fuel here.

Agricultural land.—There is little promise of any of this land proving profitable for agriculture, except on a very small scale. On the South Fork some of the lower land could be irrigated and cultivated. One stock ranch might be successful there; some hay and vegetables—probably some grain—could be grown. There is good grazing on the adjacent hills.

Mining.—The region has been prospected and several claims are held in the mountains, but none of the properties are shipping at present.

SWIFT CURRENT VALLEY.

Topography.—The lower portion of this valley, having an elevation of about 5,000 feet, is separated from Kennedy and Boulder creeks by drift ridges some 800 feet higher, while the sources of all these streams are in the main range of the Rocky Mountains, the peaks of which, according to determinations made by Mr. A. H. Thompson, are 9,000 to 11,000 feet high.. For about 4 miles above the junction of this stream with Boulder Creek the drift ridges which bound the valley crowd closely together and confine the stream to a narrow gorge, through which it flows rapidly and straight without forming a bottom. Upstream the first bottom land is found forming bays along the second lake, and above this lake there is bottom land 1 to 2 miles wide. This width continues to near the falls at the foot of the third lake, above which high and precipitous mountains crowd close to the stream (Pl. XCIX, *B*).

Soil.—Derived from rock containing much lime, the soil seems rich in plant food, and wherever moisture is sufficient there is vigorous vegetation.

Litter.—On slopes toward the south fires have run so much that most of the litter is burned off; on slopes toward the north, which are mostly wooded, the usual amount of fallen and deadwood is found in slow decay.

Humus.—Most of the bottom-land soil is dark, even black, and the many small, moist areas on the slopes also have a deep, dark loam; but, as a rule, the steeper slopes have little humus and scanty soil; the higher portions of the mountains are entirely bare rock.

Trees and timber.—The forest is confined to the canyons along the tributaries before they leave the mountains, as above the falls at McDermott Lake, the valleys of Grinnell, Cataract, and Canyon creeks, and to the northern slope of the ridge between Swift Current and Boulder creeks. The distribution of the several species varies with the drainage and exposure. Down the valley the benchlands and higher gravelly ridges, with deep porous subsoil, have little else than lodgepole pine, which on most favorable ground reaches a maximum diameter of 10 inches and a height of 90 feet. Near the valley bottom, especially along the water courses and also toward the mountains, above the gravel deposits, spruce grows well, forming occasional areas worth logging. The trees are knotty almost to the ground, but usually sound. The largest are seldom over 24 inches in diameter and 90 feet high. On the higher ground, toward the mountains, the spruce gradually yields to balsam, and the balsam occasionally reaches a foot in diameter on the stump and 70 feet in height, but it usually bears branches all the way to the ground. The limber pine (*Pinus flexilis*) occurs frequently, especially on the summits of ridges and foothills. The nut pine (*Pinus albicaulis*) is scattered on some of the higher slopes toward the mountains. The log timber standing on the drainage is estimated at 25 million feet, 80 per cent of which is spruce, 15 per cent lodgepole pine, and 5 per cent balsam and red fir. There are also some 400,000 cords of other wood material, some 80 per cent of which is suitable for fencing.

Young growth.—Except for the smaller trees growing among the log timber, which is estimated above in cords, young growth is not abundant. The very severe burn along the northern side of the valley, instead of being restocked with lodgepole pine, as usual, has a growth of grass, aspen, and willow, with but few pines and spruces. The aspen, while vigorous, is short and very much branched and moderately sturdy in its appearance.

Underbrush.—Most of the brush is on the old burns, which are irregularly patched with aspen, willow, and alder. Where wooded, there is little underbrush. Light growths of *Menziesia* and huckleberry are under the lodgepole pine. A heavier growth is under spruce and balsam. On the lower mountain slopes with northern exposure, especially on snowslides, is a dense tangle of alder, bent downhill and ascending about 8 or 10 feet high. Higher up the mountain side the brush gradually yields to the climate. On the higher slopes there is little but juniper, and a few species forming trees elsewhere, but here reduced to brush.

Fires and reproduction.—On the north side of the valley fires have swept off nearly all trees, and but little restocking has occurred; but south of the valley fires have been less frequent and less severe and the restocking has been fairly good. Large areas here have escaped fire many years. On the areas once burned a scant growth of lodgepole pine is found, fairly uniform in age and size, but spruce and balsam seem to have been seeded at various times, as shown by the difference in size of the trees. Much of the spruce land has escaped the fire that burned the lodgepole pine adjoining it. Accordingly, the spruce varies greatly in age and size. Some trees are dead and fallen from old age; others have barely started above the ground. Toward the summit of the ridge south of Swift Current Creek is clay land that becomes very dry in autumn. On this the trees are short, dwarfed, and crooked. They seem to have been imperfectly matured in autumn, and, being soft, have been easily bent by the snows. The prevailing aspen on the lower slopes of the foothills is seldom over 20 feet high, and seems to be prevented from growing larger by the fires that frequently sweep in from the plains.

Dead timber.—The fires have been so often repeated and so severe on the lands that have been burned at all that there is little deadwood left. At the foot of the mountain, between Swift Current and Kennedy creeks, there may be 5,000 cords suitable for fuel, but elsewhere there is little more than is desirable for camping purposes.

Cutting.—There has been no cutting except for camping and for prospectors' cabins.

Transportation.—The river is drivable from the falls at the foot of McDermott Lake. A good trail leads up the river and a wagon road is now being cut out to mining prospects on the upper streams.

Demand.—There is no demand for timber at present. Local demand will depend largely upon the success of the mining operations and the occupation of the agricultural lands on the plains eastward.

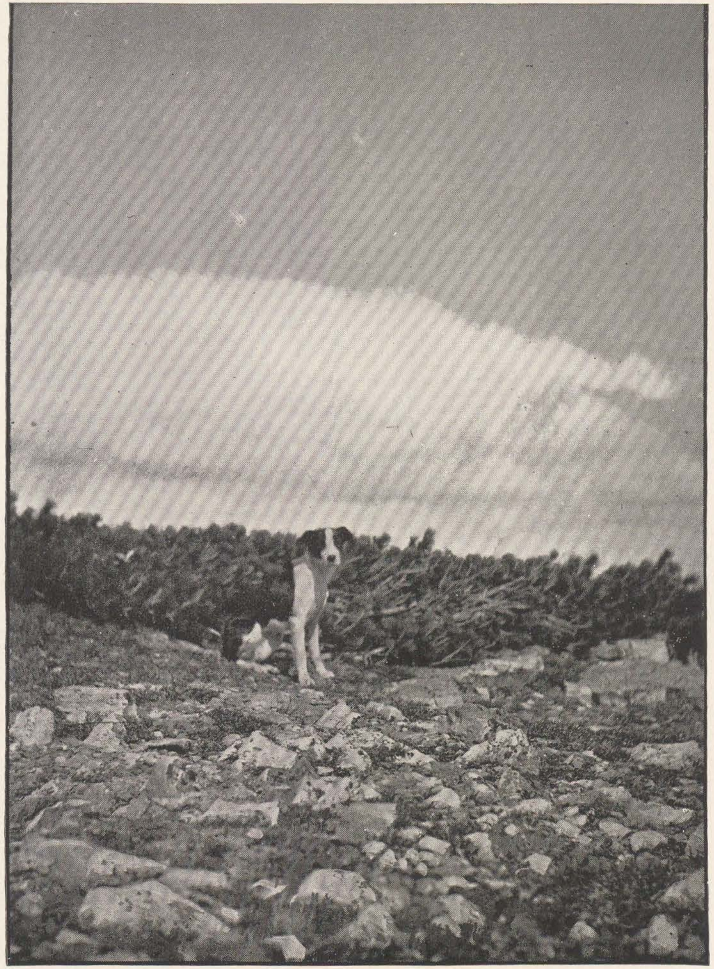
Irrigation.—No water is now used for irrigation. Some 6 square miles of the valley is irrigable, and for this land there is ample supply.

Agricultural land.—Along the river, above the lakes, are some 6 square miles of land that may prove agricultural with some improvement. Several ranches could be started at once, but most of this land is of no value without irrigation.

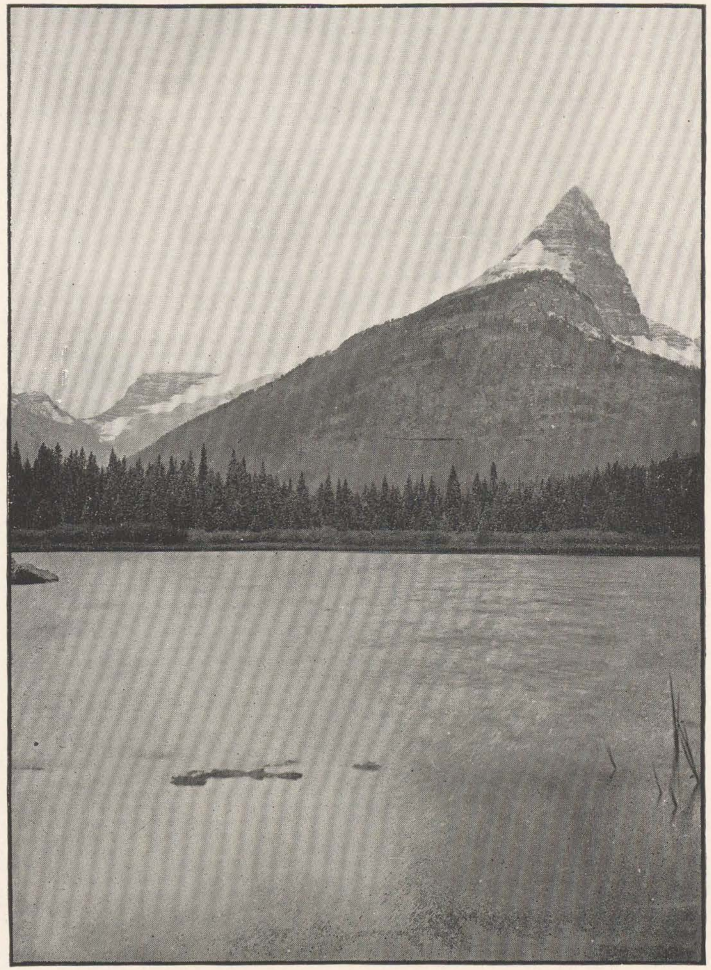
Mining.—Many claims have been located in this valley and development is now going on. No mines are shipping ore as yet.

BOULDER CREEK.

This might be described with Swift Current Valley, from which it is separated only by a low ridge. It has little or no bottom land, its slopes are steep, and the elevation is nearly 1,000 feet higher than that of Swift Current Valley. It is mostly wooded, but the forest extends only a little way up the slopes of Flat Top, which limits the valley on the south. Three million feet of log timber and 150,000 cords of other wood are estimated to be here. The log timber is knotty and inferior. About 50 per cent of the other material is suitable for fencing and for house logs; the remainder could be used only for fuel. There is no agricultural land in this valley. Several mineral properties are being developed.



A. LIMBER PINE (PINUS FLEXILIS) AT AN ALTITUDE OF 9,000 FEET, FLAT TOP MOUNTAIN.



B. HEAD OF ST. MARYS VALLEY. GUNSIGHT PASS ON LEFT; MOUNT REYNOLDS ON RIGHT.

ST. MARYS VALLEY.

Topography.—St. Marys Valley is about 20 miles long, has an average width of 2 miles, and is walled in by very high and steep mountains, which are bare and rocky except on their lower slopes (Pl. C, *A* and *B*). Heading in glaciers, the water descends by cascades to the main valley, which begins about 17 miles west of the reserve line. From this point the waters flow rapidly to the upper lake through an alluvial bottom about 1 mile wide, the slopes of which are wooded up to the talus on the mountain sides.

Soil.—There is much dark, alluvial soil throughout the valley, and even on the slopes above the bottoms, where not burned and not too dry or too much exposed to wind, vegetation is luxuriant. Much limestone and slate occur in the mountain rocks, from which this soil has been derived. While there are some gravel benches, they are not a prominent feature of the valley. Most of the gravel seems to have been carried out of it and deposited below the mouth of Red Eagle Valley.

Litter.—But little litter is found below the narrows of the lake. Up to this point it has been thoroughly burned off. South of the lake, although fairly stocked with trees, the gravelly ridge below the mountain spur is so dry as to be unfavorable for the accumulation of litter. Above the narrows fallen trees, though not very abundant, obstruct travel considerably.

Humus.—Humus is abundant, except on the higher portions of the burned areas. A deep, dark loam has been formed along the north shore of the lake.

Trees and timber.—Beside Red Eagle and Divide creeks some 20 square miles are wooded in St. Marys Valley. The trees are of all ages up to 200 years, all heights up to 125 feet, and all diameters up to 36 inches. Lodgepole pine, most abundant on the dry bench lands and slopes, reaches a maximum diameter of about 14 inches and a height of 100 feet. Engelmann spruce, on moist lower slopes, reaches 3 feet in diameter and 125 feet in height. One cut was 168 years old, 18 inches in diameter, 100 feet high, and contained 68 lineal feet of log timber, which scaled 336 feet B. M. Red fir occurs on the dry southward slopes, where it reaches 14 inches in diameter and 70 feet in height. Balsam (*Abies lasiocarpa*) on moist upper slopes reaches 24 inches in diameter and 74 feet in height, forming some timber large enough to saw. The nut pine (*Pinus albicaulis*) is found on the mountains sometimes 16 inches in diameter and 40 feet high. The limber pine (*Pinus flexilis*) on the foothills reaches 20 inches in diameter and 30 feet high. Aspen where well protected reaches 20 inches in diameter and 80 feet high. Balm of Gilead, along water courses, reaches 24 inches in diameter and 80 feet in height. Cottonwood (*Populus trichocarpa*) occurs about the foot of the lake, and, rarely, on the stream above it, sometimes 30 inches in diameter. Hemlock and white cedar were seen above the upper lake—only a few small trees of each. About 18 million feet B. M. of log timber are estimated in the valley, 60 per cent of this being spruce, 30 per cent lodgepole pine, and 10 per cent red fir, aspen, and balm.

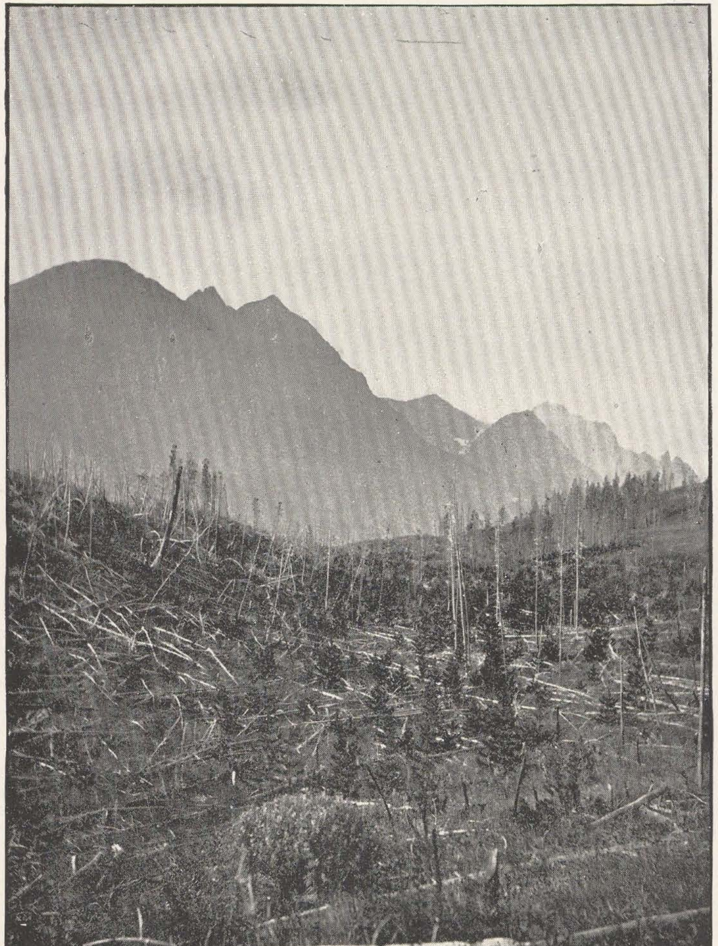
Young growth.—Much of the young growth promises to make better log timber than the trees which are now large, because it has been so much crowded and shaded by the larger trees as to prevent the growth of branch wood. As usual in a spruce forest, the stocking has occurred slowly and trees of varying ages are found. On the lodgepole-pine lands south of the lake the trees also vary in age, because the dry gravel ridges have been unfavorable, and but few trees have been able to start at all. Most of the trees, being too small for log timber, might be classed as young growth, for they will grow into log timber when the larger trees are cut away.

Underbrush.—*Menziesia* and huckleberry form the principal underbrush, varying with moisture and density of trees. In the openings are willows on the bottom, while alder, buck brush, and mountain ash on the lower mountain slopes make travel difficult and retard or prevent the stocking of these openings with trees.

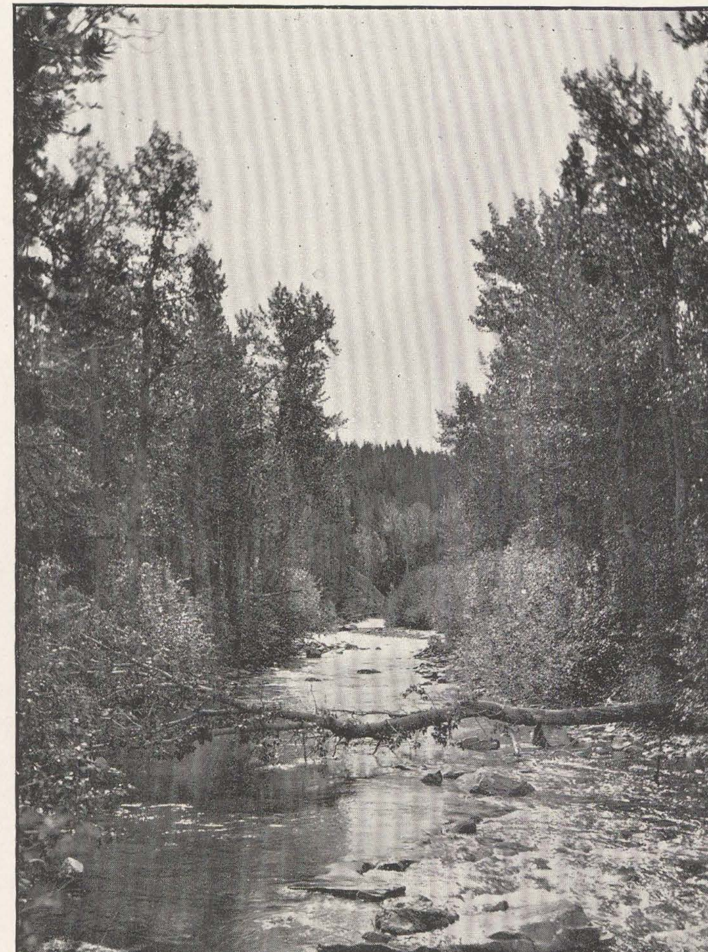
Fires and reproduction.—The fire of 1885, starting from an Indian camp on Roes Creek, with a strong wind from the southwest, swept the whole wooded side of the ridge to the foot of Lower St. Marys Lake, covering an area of about 10 square miles in a few hours. Most of the trees were killed, only a few clumps being left here and there. Restocking has been very imperfect; small areas here and there have now an abundant growth of lodgepole pine and red fir, but grass, willows, and aspen occupy most of the old burn (Pl. CI, *A*). The fire of 1897 burned about 4 square miles of the same area, killing much of the aspen that had started since the former fire and many trees that had escaped the first. A fire of 1898 north of the lake covered 2 acres, mostly prairie. This seems to have escaped from a camp fire. A fire of 1898 south of the lake escaped from a prospector's camp, and covered some 500 acres, killing nearly all of the trees, and through most of its course rushed through the tops, burning off the leaves and smaller branches. Mr. Doty, forest ranger, was found looking after this fire on September 24. It was still burning slowly September 27, and was extinguished by a snowfall three days later. But little of the timber killed was log timber, probably not more than 100,000 feet, but some 6,000 cords of spruce and pine pole timber were killed.

Dead timber.—That killed by the fire of 1898 is standing and good, if used soon; on the old burn there is nothing but fuel, and this is much scattered and not worth marketing, unless increased settlement should create a local demand.

Cutting.—Some 30,000 feet of spruce, red fir, and lodgepole pine were cut during the spring of 1898. Some 20,000 feet of this lumber



A. BURN OF 1885 PARTIALLY RESTOCKED WITH LODGEPOLE PINE (PINUS MURRAYANA), NORTH OF UPPER ST. MARYS LAKE.



B. DENSE MIXED FOREST ALONG RED EAGLE CREEK, ST. MARYS VALLEY.

is now stacked for sale near the post-office at St. Marys. It was cut on Squaw Creek, which empties into the foot of Upper St. Marys Lake from the south, and sawed there by a portable mill. No other cutting has been done, except for trails, mining prospects, and an old ranch building north of the lake.

Demand.—Demand is limited at present to the small settlement at the foot of the lake, dependent upon mining operations. But a few thousand feet could be sold annually, which might bring $20 a thousand. No mining timber has been used as yet.

Agricultural land.—About 2 square miles lying along the north side of the lake below Roes Creek is very good agricultural land. Besides this, that south of the lake, to be described under Red Eagle and Divide creeks, would be, with the aid of irrigation, well adapted to agriculture. One ranch is now located north of the outlet of the lake and there is room for two more along the north shore of the lake.

Irrigation.—No irrigating has been done; large areas east of the forest reserve could be irrigated from the river, while 2 square miles north of the lake could be watered easily from the mountain tributaries. All the agricultural land within the valley west of the reserve line could be irrigated at moderate expense, without using any water from the main stream.

Water power.—Water power has not been used. There is abundant power for large manufacturing. The best site is below the upper lake.

Mining.—Many mining claims, both placer and ledge, have been staked, and several properties are being developed, but it is said that many of the so-called "placer claims" have been taken merely to hold land for other than mining purposes.

RED EAGLE AND DIVIDE CREEKS.

With few exceptions, these two valleys might be described as part of the St. Marys Valley, to which they are tributary. Red Eagle Valley is a counterpart of the Upper St. Marys, but smaller (Pl. CI, *B*). About 10 square miles of it are wooded with lodgepole pine, spruce, and balsam. Roughly estimated, the log timber standing is about 6 million feet B. M., about half of which is spruce. There are about 65,000 cords unfit for the saw. About 4 square miles of the land is agricultural, irrigable, at some expense, from Red Eagle Creek. Divide Creek has about 6 square miles wooded, containing about 4 million feet of log timber, about 60 per cent of which is lodgepole pine and 40 per cent spruce. None of the land on Divide Creek is agricultural. No serious fires have occurred recently on either Divide or Red Eagle creeks. Water power is good on both streams, but Red Eagle is more favorable because of the lake for storing water. Mining properties are being developed, but no mines are shipping at present.

CUT BANK CREEK.

In general topography this valley is very like St. Marys. The distance between the bare mountains at the reservation line is about 2 miles. Upstream this first widens, then at each tributary narrows. It is 1 mile wide 3½ miles above the reservation line. Above the forks, 5 miles from the line, the bottom is a half mile wide. The South Fork bottom pinches out about a mile above this point. On the North Branch, above the falls, the elliptical bottom is about a mile long. The whole valley is walled in by mountains several thousand feet high, only the lower slopes of which are wooded (Pl. CII, *A* and *B*).

Soil.—What soil there is is fertile enough, containing much lime. Vegetation grows well, but there is much gravel and many bowlders in the bottom land, and the slopes are usually rocky. The arable land is confined to the narrow benches in the lower portion of the valley.

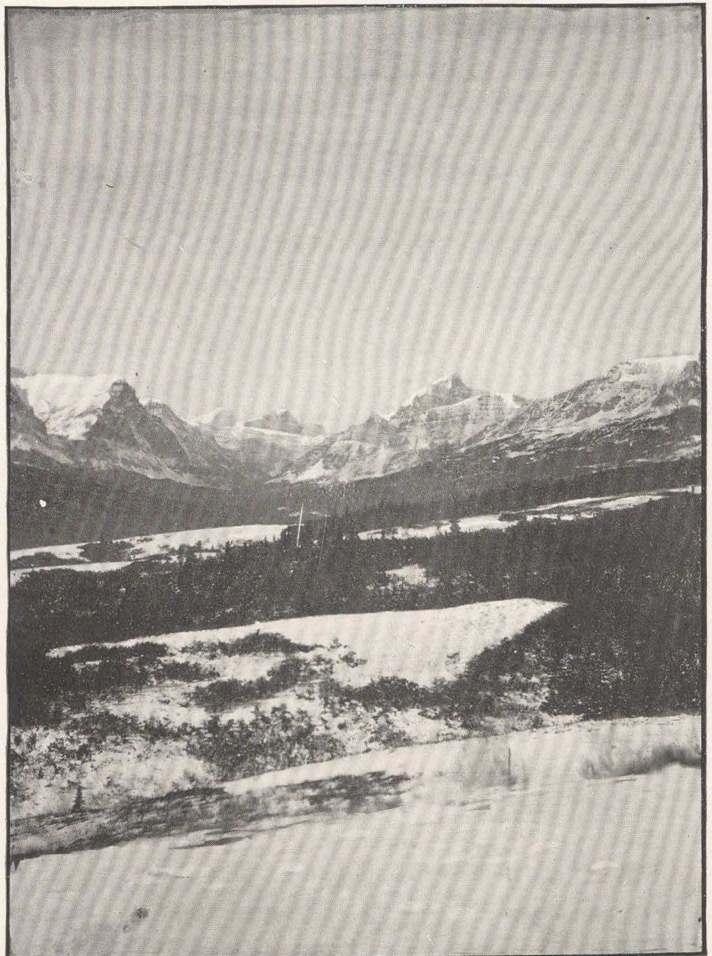
Litter and humus.—Both litter and humus are light. The recent fires that have occurred about 3 miles above the reserve line have left deadwood that is now falling. Humus is fairly abundant in the lower prairie, where the soil is a deep, dark loam, except on the gravel ridges. The upper valley has a medium depth except on the burn, where it is light.

Trees and timber.—In general, the trees of this valley are young and small. Few are over 100 years old except near the basins, at the heads of the streams, and few exceed 10 inches in diameter and 60 feet in height. Very few are large enough for saw timber. There are hardly a million feet of log timber in the valley, and this amount is so scattered that logging for ordinary prices would be unprofitable, unless for some special use. Much of the lodgepole pine has a pitted grain, like that of pin maple. About 70,000 cords of wood are in the valley, half of which is suitable for fencing or house logs (Pl. CIII).

Young growth.—Few of the trees are very old, most of them about 70 years, and, being too small for log timber, constitute a stock that, if cared for, may some day be valuable. On a burned tract of about a mile square, about 4 miles above the reservation line, is a scanty stock of lodgepole pine, 5 to 25 feet high and about 25 years old. On the burned slide, south of the spur between the two forks, the very scanty stock of balsam (Pl. CV, *A*) is about 10 feet high and 20 years old. A similar growth extends from near this point several miles along the talus south of and toward the head of the fork.

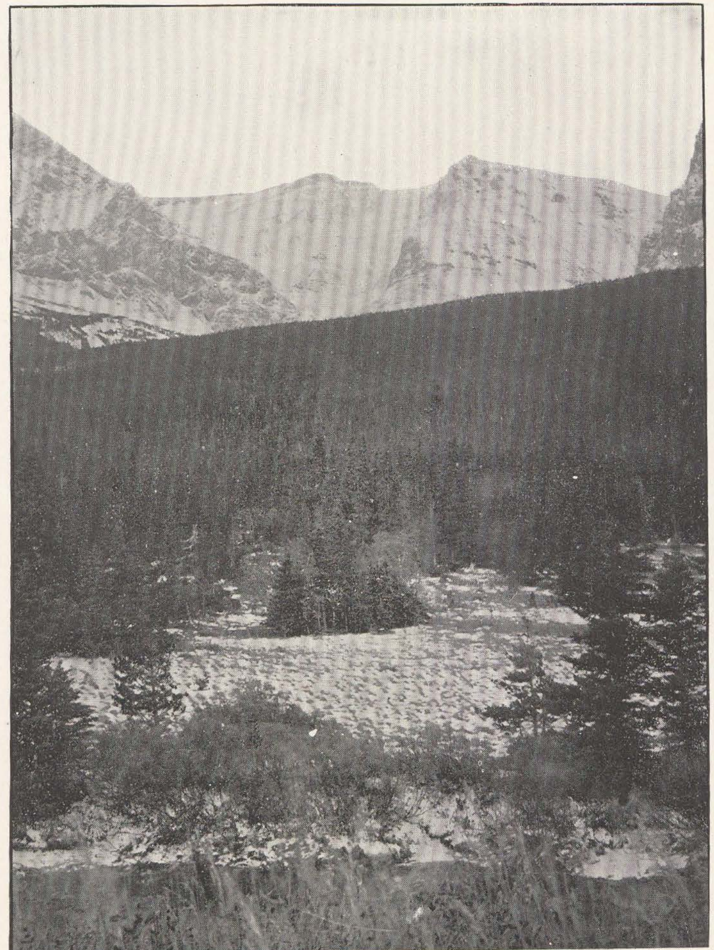
Underbrush.—Underbrush is less abundant than in the other valleys east of the mountains, except on the bottoms, where there is much willow and alder. These shrubs also grow densely along some of the tributary courses, but the intermediate ground is fairly free.

Fires and reproduction.—The few severe fires (four) have been followed by a scanty reproduction of the same species that occupied the



A. NORTH FORK OF CUT BANK CREEK; CUT BANK PASS IN DISTANCE.

Lodgepole pine (Pinus murrayana), spruce Picea engelmanni), limber pine (Pinus flexilis), and balsam (Abies lasiocarpa).



B. ALONG TRIBUTARY OF NORTH FORK OF CUT BANK CREEK.

Two miles west of reserve line; lodgepole pine (Pinus murrayana) and spruce (Picea engelmanni).

SUBALPINE FOREST NEAR CUT BANK PASS.

Large limber pine (Pinus flexilis), 34 inches in diameter and 50 feet high, among Engelmann spruce (Picea engelmanni) and balsam (Abies lasiocarpa).

the ground before. The lower and most recent of these, about 1½ miles from the reserve line, has some lodgepole pine, but hardly enough for a good stock. The burn 3 miles from the boundary is about one-fourth stocked, and that 5 miles from the line is still more scantily supplied. The prevalence of gravels and dry areas is unfavorable to restocking.

Deadwood.—There are about 200 cords of deadwood. This is suitable for fuel only.

Cutting.—There has been no cutting except for camps and trails.

Transportation.—The stream is drivable, but with some difficulty on account of rapids and bars. A wagon road could be made with slight expense to within 2 miles of the summit of the pass.

Demand.—There is no demand for timber at present, though were the valley eastward settled, it would be needed for fencing and house logs.

Irrigation.—No water need be taken from the main stream for irrigation in the forest reserve, but below it, on the Indian reservation, is enough irrigable land to use all and more than the stream can furnish.

Water power.—The sites for dams and use of water power are frequent. The stream is moderately rapid. Two miles below the reservation line the stream, on October 7, was about 75 feet wide and 10 inches deep, moderately rapid, flowing over small bowlders.

Mining.—Some prospects are being developed, but no mines are shipping.

SOUTH FORK OF CUT BANK.

As the forest reserve includes only the higher sources of this stream in the mountains, which are steep and rocky, with no agricultural land and very little forest, a detailed description is avoided. About a thousand acres are wooded, and would yield some 10,000 cords of fuel, fencing, and house logs.

NORTH FORK OF TWO MEDICINE CREEK.

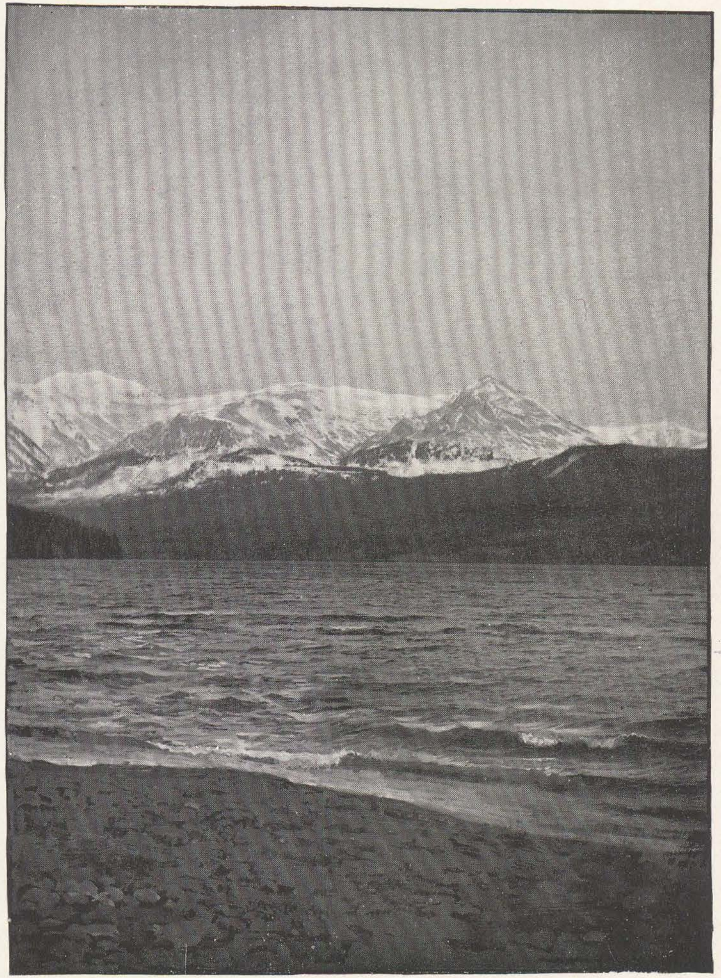
Topography.—This valley, parallel and similar to that of the North Fork of Cut Bank, has a length of about 10 miles within the reserve (Pl. CIV, *A*). The stream, moderately rapid, had a width of about 70 feet and a depth of 1 foot in October a mile west of the reserve line. There are two lakes within the reserve. The upper beads close against the bare mountain wall that forms the Continental Divide. It is about a mile and a half long and half a mile wide. The middle lake, about 3 miles below, is nearly 2½ miles long and a mile wide. It lies above the great terminal moraine, across and through the north side of which the outlet has worn a sharp ravine. Four considerable tributaries, two from the north and two from the south, and from 3 to 5 miles long, heading in high and bare mountains, have modified the main valley by the gravel and finer material they have brought into it. For a mile and a half above the reserve line the bottom is nearly a mile wide, forming about 800 acres of slightly sloping land. Above the middle lake there are some 300 acres of moderately sloping land, and along the south side of the middle lake the gravels from the South Fork have formed some 800 acres of low ridges. Elsewhere the slopes are steep. The area of the arable land in the valley is about 1,500 acres.

Soil.—Derived from slaty schists, limestone, and quartzites, the soils of the valley have the reddish-brown color common in limestone regions, and are productive wherever moisture and physical properties are favorable. In this valley the fine earthy sediments are chiefly about the heads of the two lower lakes. Bordering these loams are gravels that continue up the valleys, but reach only a little way up the mountain sides.

Litter.—Litter is in medium quantity. The unburned woods are passable for saddle horses, with little need of an ax. The few tangles of fallen trees can usually be avoided. On the burned areas few of the dead trees have fallen.

Humus.—Where unburned, especially under spruce trees, in the valley bottom, the partially rotted vegetation is frequently 6 inches deep. About the mouths of small water courses and on the damp land about the head of the lakes, black earth is frequently several feet deep, but these are exceptional spots.

Trees and timber.—Spruce is the principal timber, and is found both on the main bottom and on moist ground elsewhere. The maximum size is about 2 feet in diameter and 100 feet in height. Such trees are about 200 years old, are sound and thrifty, but, with few exceptions, are knotty. About the head of the middle lake a small area of this timber would yield 5,000 feet B. M. per acre. This is pure spruce. Elsewhere the growth is mixed, and as nothing but spruce crowds spruce enough to keep down the branches, the timber is usually very knotty. Red fir grows with lodgepole pine on southern exposures, especially on the foothills north of the stream. It is usually short, with one or two, seldom three logs to the tree, and these are knotty. Most of the trees are 100 to 150 years old, 6 to 12 inches in diameter, and 50 to 80 feet high. Lodgepole pine is frequently of timber size below the middle lake and south of it. A few such trees can be cut north of the lake. Balsam (*Abies lasiocarpa*) and silver fir (*Abies grandis*) are occasionally large enough for sawing, but are always knotty and frequently otherwise defective. The nut pine (*Pinus albicaulis*) is found in the upper portion of the valley, and the soft or limber pine (*Pinus flexilis*) on the foothills. These species rarely, if ever, furnish log timber, though large enough in trunk. They are usually too crooked and otherwise defective. There are about 10 million feet of log timber in the valley, 70 per cent of which is spruce, 20 per cent lodgepole pine, 5 per cent red fir, and 5 per cent



A. LOWER TWO MEDICINE LAKE.

New snow on mountains; none on lowland.

B. WHITE PINE (PINUS MONTICOLA) SEEDLINGS UNDER LODGEPOLE PINE (PINUS MURRAYANA).

North of Columbia Falls.

other species. Of other wood there are 50,000 cords, 50 per cent of which is suitable for house logs and fencing.

Young growth.—Nearly all the material that is too small for log timber is in fair condition to form a growing stock should the larger trees be cut.

Underbrush.—Underbrush is not heavy excepting along the water courses and wet bottoms, where willow and alder are dense. Elsewhere *Menziesia* and huckleberry form most of the underbrush, which was nowhere found impassable for horses.

Fires and reproduction.—About the middle lake have been several severe burns 30 to 50 years ago. About a thousand acres along the south shore have been burned and densely restocked with lodgepole pine. North of the lake two old burns of some 500 acres each are rather sparsely restocked with balsam, spruce, lodgepole pine, and limber pine. Below the middle lake are several recent burns, both on the forest reserve and on the Indian reservation. These have occurred at several different times, partly on the same ground, and have extended each time into green forest. On the forest reserve an area of about 1,000 acres was burned in 1897. Part of this was scantily wooded; most of it was a grassy and brushy bottom. These recent burns have not been restocked. This fire extended eastward along the ridge into the Indian reservation, its effects being noticeable over at least 2,000 acres, where it killed the timber it ran through, frequently rising into the tops. Where the dwarf juniper and limber pine were matted over the ground but a few roots of the miniature forest remain. No young seedlings were noticed on this burn. Reaching out toward the prairie, along the lower lake on the moister portions of the benches, are considerable areas of aspen and spruce. These trees are young and seem to be extending gradually into the prairie. Young seedlings are seen coming up in the grass along the edge of the woods.

Dead timber.—On the lower benches some 5,000 cords of lodgepole pine and spruce are standing dead. These dead trees are suitable for house logs, fencing, and fuel, being from 6 to 12 inches in diameter and 70 feet high. About 200 cords of recently killed timber stand on the summit of the ridge north of the lower lake within the forest reserve. The timber on the Indian reservation is being cut and hauled away eastward for fuel and house logs.

Cutting.—There has been no cutting except for cabins and trails.

Transportation.—The stream is drivable and wagon and other roads could easily be made.

Demand.—Sawed lumber could be sold and shipped from Midvale to prairie towns eastward in competition with lumber from west of the mountains. Naturally the timber of this region would be used on the Blackfeet Indian Reservation, and as this tract especially lies near the agency at Browning, it would seem feasible to operate a mill at the foot of Lower Two Medicine Lake, logs to be cut from the forest reserve above by the Indians if possible. Prices would depend largely upon prices of western lumber, but this lumber, without railroad freight, should be marketable at a less figure than that brought across the mountains.

Agricultural land.—Agricultural land is confined to some 500 acres between the two lower lakes, and is not very desirable. It is best adapted to hay and grazing. One ranch there would perhaps be profitable at once. There is grazing land on the middle slopes of the mountains northward. The present value of this land for agriculture is nominal.

Irrigation.—All the land that is possibly agricultural can be irrigated from the small side streams, without using the creek. All of the creek water could be used for irrigation on the Indian reservation.

Water power.—There is abundant fall, and the lakes, with a surface of about 3 square miles, can be raised indefinitely to increase their storage capacity. On October 12 the present stream below the lower lake was some 75 feet wide, a foot deep, and moderately rapid.

Mining.—No mines are shipping at present and few claim stakes were seen.

MIDDLE FORK OF TWO MEDICINE CREEK AND ELK CREEK.

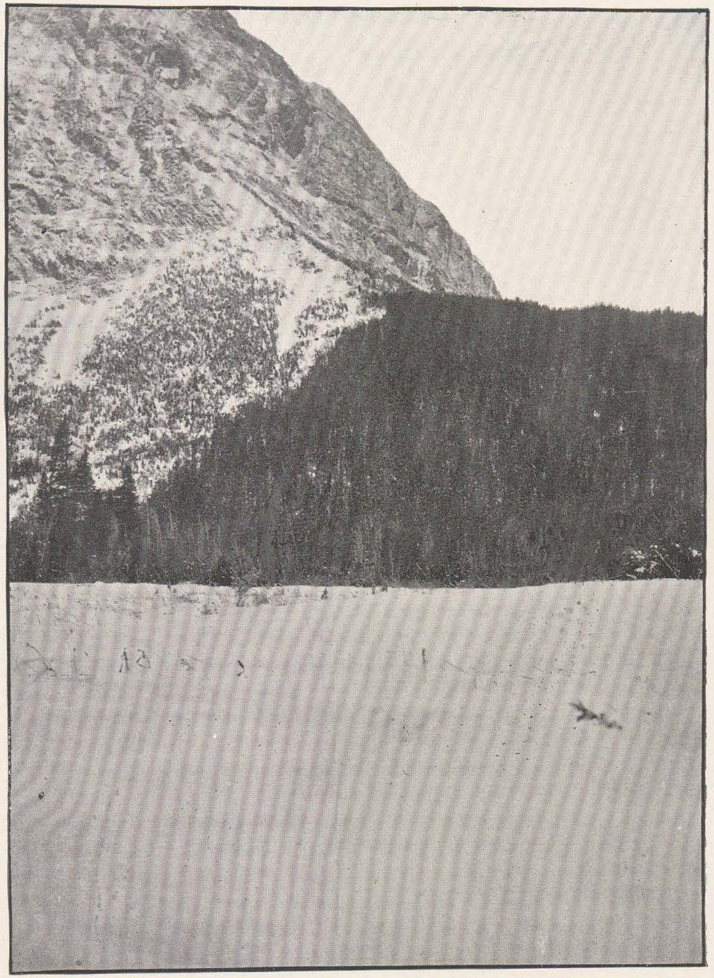
Topography.—With a more southern exposure and less rugged contours, these two valleys head in the high mountains just north of the Great Northern Railway, but soon join the North Fork in the foothills on the Indian reservation, about 4 miles east of the reserve line. In altitude this land varies from 5,000 to 9,000 feet.

Soil.—The soil in the lower portions of these valleys is clayey, very dark, and fertile. Vegetation is vigorous. The clays are confined to the lower lands, however. The ridges leading down from the mountain spurs contain much gravel and sand.

Litter.—Very little dead material is lying on the ground, but much that is standing dead will soon fall.

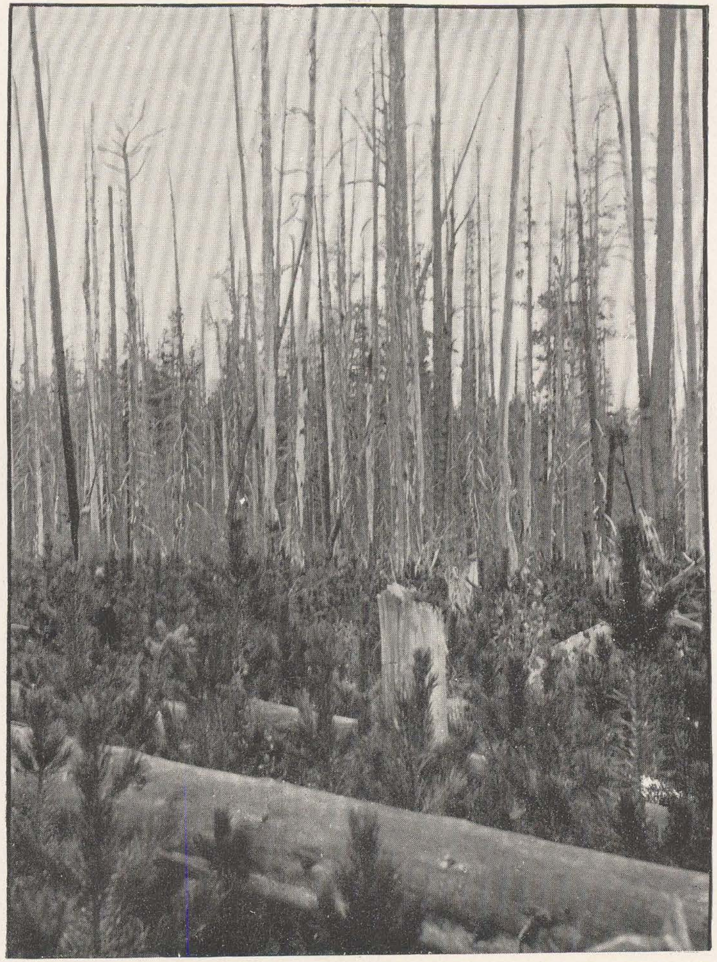
Humus.—The humus is light on the hills and deep in the ravines. The higher mountains are bare rock, and have little humus above 6,000 feet.

Trees and timber.—Lodgepole pine is most abundant, forming about 80 per cent of the entire forest. Spruce is on the damper land, and, with aspen, forms about 15 per cent. The remaining 5 per cent is balsam and red fir. The slopes of the mountains and the higher basins have only balsam and limber pine. Very few trees of any kind are over 12 inches in diameter. In these valleys and northward to the head of Lower Two Medicine Lake, within the reserve, are some 4,000 acres, on which 5 million feet of log timber could be cut, and on Elk Creek there are about a million feet. About 70 per cent of this is lodgepole pine, and the remainder is spruce and red fir. As log timber,



A. TRACK OF SNOWSLIDE, CUT BANK CREEK.

Lodgepole pine (Pinus murrayana), limber pine (Pinus flexilis), balsam (Abies balsamea), and spruce (Picea engelmanni).



B. BURN OF 1889 ON BLACKFEET RESERVATION, NEAR MIDVALE.

Densely restocked with lodgepole pine (Pinus murrayana). Some unburnt cones in tops of dead trees.

however, this is so small and so knotty that it probably would be of more value for house logs, fuel, and fencing. On this area are about 90,000 cords of such material.

Young growth.—All of the young trees are thrifty and promise to lay on wood rapidly if the forest should be thinned. The cutting of marketable timber could be made a thinning process.

Underbrush.—On the ridges saddle horses can be taken through the woods without cutting. The ravines and lower slopes, however, have alder and willow that is frequently difficult to pass through.

Fires and reproduction.—From the railroad to the lower mountain slopes the land has been repeatedly burned over. Vegetation on the old burns is now varied between patches of grass, aspen, willow, and occasionally an area that is fairly restocked with lodgepole pine (Pls. CV, *B* and CVI, *A*). The fires of about 8 years ago reached considerably into the woods left unburned by former fires, and now an irregular belt of dead timber borders the green forest. Growing under deadwood in this belt is dense young lodgepole about 7 years old and 1 to 4 feet high.

Deadwood.—On this recently-burned belt within the reserve are some 1,500 acres of standing deadwood that would yield 20 cords per acre for house logs, fencing, and fuel, or 30,000 cords altogether, and other deadwood is scattered about on the older burns, most of it in places difficult of access, and therefore of little value. There may be 15,000 cords of such material.

Cutting.—No cutting has been done within the reserve except for roads, railroad, and camp use. Deadwood is being cut on the Indian reservation adjoining, however, for sale on the plains eastward.

Transportation.—Wagon roads have been made into the dead timber on the Indian reservation, and they could easily be extended to the deadwood on the reserve. The Great Northern Railway crosses Elk Creek and furnishes transportation to the best market on the plains eastward. This material could be taken out best in winter, when sleds could be used. A down-grade road could be made to the railway, which is not over 3 miles distant from any part of the tract.

Demand.—The timber is being used on the plains eastward. It is being cut now on the Indian reservation, near the reserve line, and is sold on the car at Midvale for $30 a car, or 1 cent a lineal foot for house logs and fencing; but this is considered a high price. It is believed that if a constant supply of this material were kept at the railroad ready for shipment and at reasonable price, a large quantity could be sold. It would probably bring 25 cents a cord on the stump.

Agricultural land.—There are, perhaps, 2,000 acres of arable land within the reserve, and 3,000 more that could be used for grazing. The lower lands grow grass very well, and are evidently fertile. Most of them could be irrigated at moderate expense.

Irrigation.—There is perhaps more water than could be used on this land within the reserve, but all the surplus may be needed on the Indian reservation eastward. There is limited water power. The middle fork could be dammed near Midvale Station, where, on October 15, the stream was 10 feet wide, 8 inches deep, and moderately rapid. Elk Creek at the falls, a mile south, was at the same time 20 feet wide, 2 feet deep, and rapid.

Mining.—No mining claims were seen in this tract.

SOUTH FORK OF TWO MEDICINE CREEK.[1]

Topography.—This drainage area, covering about 30 square miles, has a varied topography. The bold mountain slopes, with a narrow belt of talus, change to rounded foothills of drift, and these to grassy benches and level bottoms that widen toward the plains to the eastward (Pl. CVI, *B*).

Soil.—Derived largely from lime-bearing rock and slaty shale, the soil seems everywhere fertile, but is often scant on the frequent knolls, though the gently-sloping lower areas have a liberal supply of dark, fertile loam.

Litter.—Fallen wood killed by fire is occasionally found impassable to horses, though by occasional detours horses may be taken through most of the valley. The great amount of standing deadwood must, however, soon fall, and form a dense network over most of the surface.

Humus.—Fires have in varying degree burned the decaying vegetation. On most of the land there is very little left above the soil on the dry ground, but the earths washed down from the hills are dark with humus, and the wet bottoms have their accumulated vegetable soil undisturbed.

Trees and timber.—Very few trees have escaped fire. An occasional strip remains along the bottom of the ravine, or a triangular patch may be seen high on the mountain slopes, where protected both by moisture and by lack of combustible material. These all together would form an area of about 5 square miles. In the bottoms of some ravines there is some spruce, and on their slopes is some red fir among the lodgepole pine. None of it is desirable for sawing. On the high places is scattered balsam, dwarfed and knotty. All the green timber in the valley would not amount to over 10,000 cords.

Young growth.—Among the growth that is large enough for market there is enough smaller material in thrifty condition to make a good growing stock. Elsewhere there is no young growth except small seedlings that are coming in on the burned lands.

Underbrush.—There is very little underbrush except on bottoms and in the ravines on the northward slope south of the stream.

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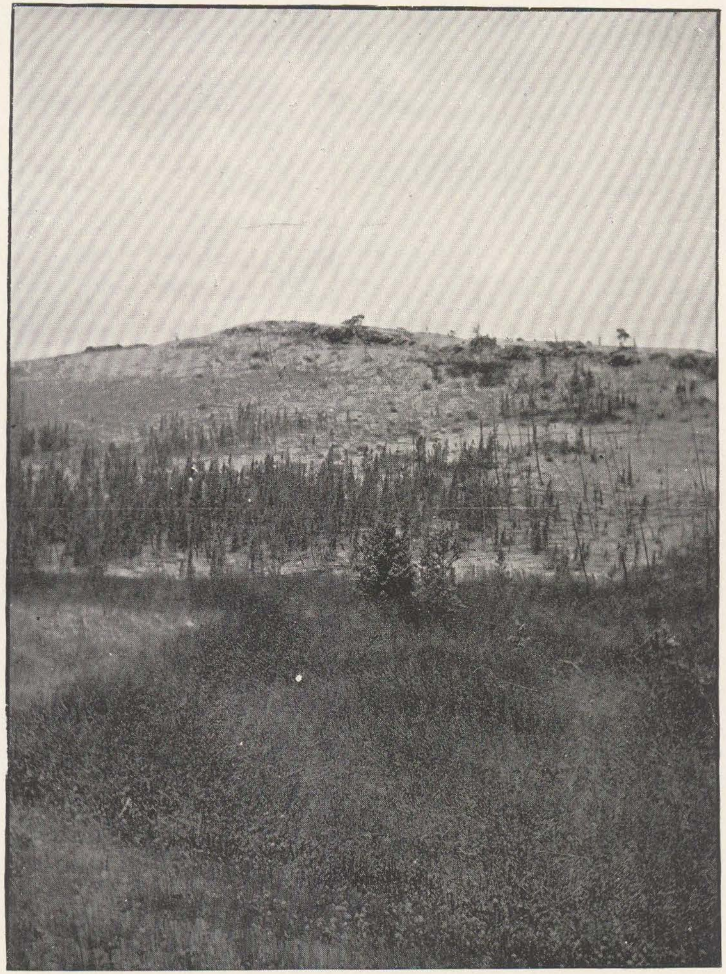
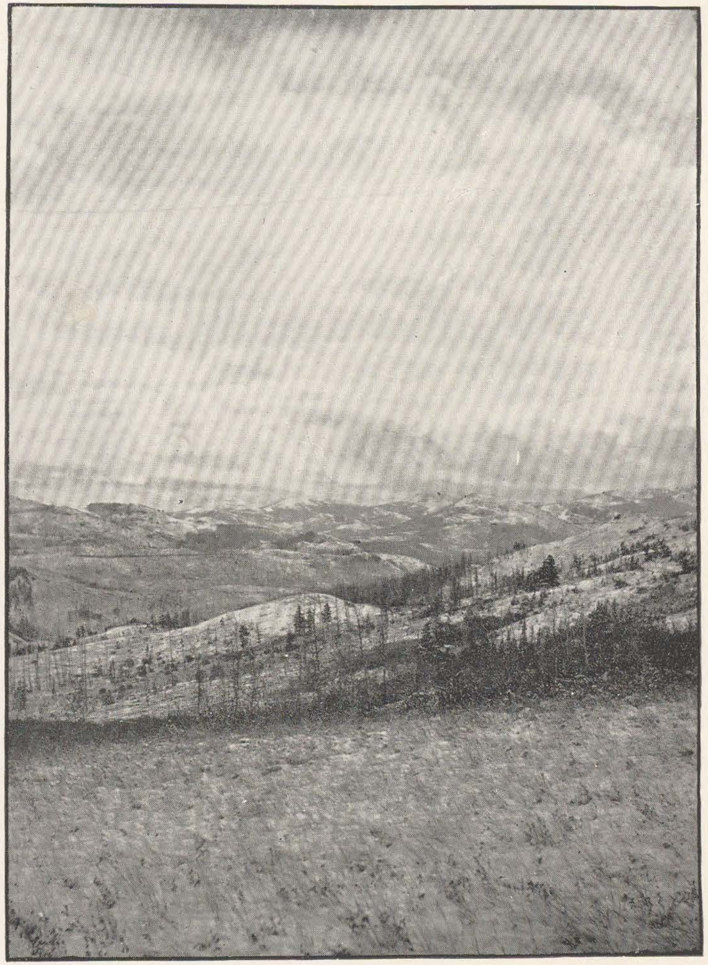
[1] This lies south of the Flathead Reserve.



A. FOOTHILLS NEAR MIDVALE.

Severely and repeatedly burnt, and slightly restocked with lodgepole pine (Pinus murrayana).



B. FOOTHILLS NEAR MIDVALE.

Severely and repeatedly burnt, the forest being replaced by grass.

Fires and reproduction.—For many years fires have crept into this valley from the prairie eastward, and others have been started probably by hunting parties, and have been swept eastward by prevailing winds (Pl. CVI, *A*). The land between the South Fork and Elk Creek has been most subject to forest fires, and is now reduced to occasional patches of dense young stock among dead and fallen trees; large areas have only scattered young trees about 10 feet high and some brush along the streams and ravines, while three-fourths of the surface is grassy. South of the South Fork and about its head waters, under the dead standing trunks killed by railroad fires, a dense young stock, some about 7 years old, is common. Much of the severely-burned land has no young stock (Pl. CVI, *B*). The reason for this variance in reproduction was not definitely learned, but it was noticed that the most dense young stock was found where cones remained unburned in the dry tops (Pl. XCIII). Lodgepole pine, like several of its relatives, has the faculty of holding its seed in the cone on the tree many years, where cool and moist. Fire, killing the trees, often does not burn the cones, but either cracks them open or they are later opened by the exposure to the heat and drying winds that occur in dead timber. Other species than lodgepole pine are spruce in the ravines and balsam upon the mountain ridges. These places have been less burned. The restocking with spruce and balsam on recently-burned lands is much less free than with lodgepole pine. Spruce and balsam prefer to come in under other trees.

Dead timber.—The land south of the creek and north of the upper portion of it to Elk Creek, excluding some 1,500 acres of prairie and willow bottom in the lower valley, is covered with standing deadwood. It will average about 10 cords per acre. In the portion of the valley within the reserve there are about 320,000 cords. It is suitable for house logs, fencing, and fuel, and a little of it could be used for inferior lumber, but for that purpose it is so small, knotty, and worm-eaten that it would not sell well. It should be worth about $2 per cord on the cars.

Cutting.—Aside from the cutting connected with the building of the railroad, there has been none except for camping purposes.

Transportation.—The problem here is to get the material to the railroad. Along the lower portion of the valley the surface is so hilly that the land is difficult of access, but the wood from the upper portion could be hauled to the railroads on sleds in winter, or if much were taken out a spur could be led to and along the stream. Probably the most feasible transportation would be an electric railway. By connecting with the present railway a mile west of Midvale a spur could be laid that would need no power except to take empty cars up the valley.

Demand.—On the plains eastward such material is needed for house logs, fencing, and fuel, and is worth about $2 a cord on the cars at Midvale. Varying according to accessibility, it should be worth 10 to 25 cents on the stump.

Agricultural land.—Probably not more than 1,500 acres could be used for agriculture in this valley. Most of the slope is too steep to be arable. As its elevation is about 5,000 feet, and is exposed toward the east, frosts will be liable to injure crops at any time in the year. Much of the area could be used for grazing. The older-burned portion, some 4 square miles, is now very well grassed, and on the recently-burned portion much grass is coming in.

Irrigation.—The arable land could easily be irrigated, but this would require only a small portion of the water available. On the Indian reservation all the water of the stream could be used.

Water power.—There is power sufficient for small manufacturing, and there are several very favorable sites.

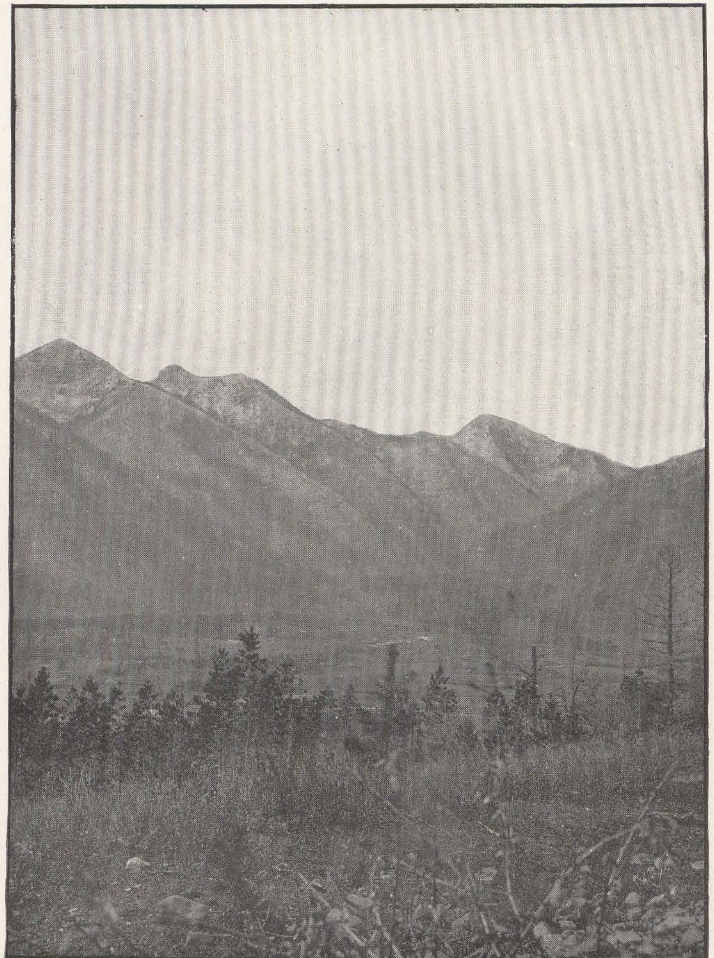
Mining.—No mining operations or prospects were found in the valley.

SUMMIT CREEK.

Topography.—This valley, having an area of about 75 square miles, is continuous with the valley of the South Fork of Two Medicine Creek, excepting a very slight divide—a ridge of glacial drift—between the two. It has at its head quite a wide basin with moderate slopes, about a square mile in area. Leaving this basin through a narrow ravine, the first appreciable bottom was found about 2 miles west of Summit Station. Three miles from the station are terraces which form a level area of some 20 acres, and at the mouth of Bear Creek is a flat of about 500 acres extending downstream several miles, finally narrowing to a stony canyon bottom and so continuing to the mouth of the stream where it empties into the Middle Fork of Flathead River, about 14 miles west of Summit Station. The mountains on both sides are of moderate height. Most of the tributary valleys are short and have narrow mouths, but at their heads have the fan-shaped basins common in mountains of soft rock (Pl. CVII, *A* and *B*).

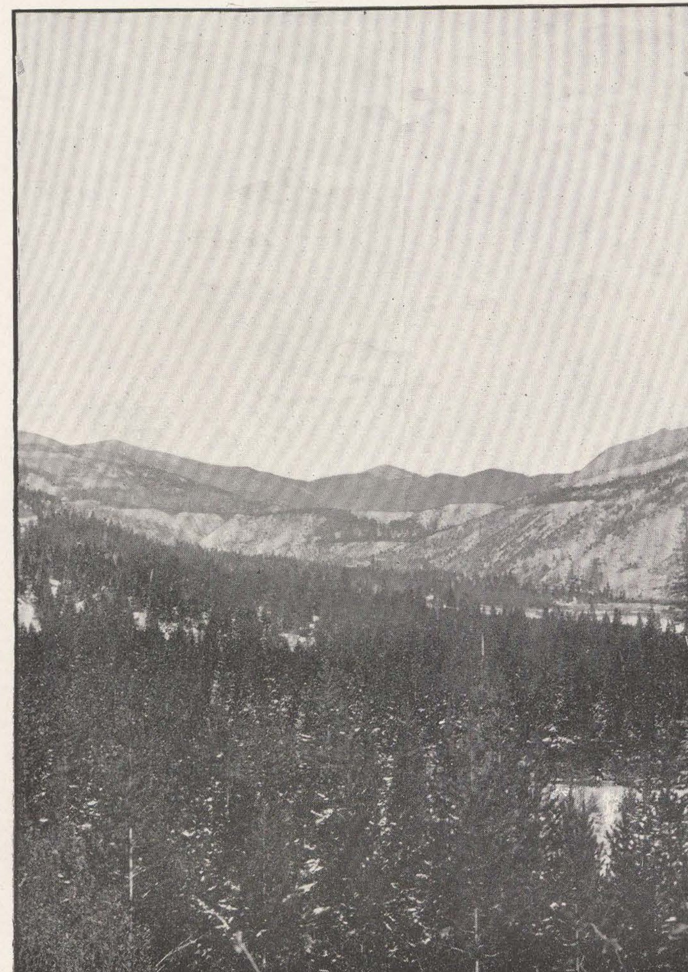
Soil.—Wherever the slopes permit soil to accumulate it seems productive, and along the creek bottoms and on the damper portions of the terraces vegetation is vigorous. The lower slopes of the mountains are frequently sandy or gravelly, and on these, too dry for most plants, the lodgepole pine is able to grow when fire does not prevent. Toward the summits the greater erosion and snow fall give less opportunity for plants to grow, and vegetation is, accordingly, less.

Litter.—Most of the material killed by old fires has been consumed. The trees killed by the railroad fires are mostly standing, but are beginning to fall. In a few years much of the surface will be covered with a net work of fallen trees.



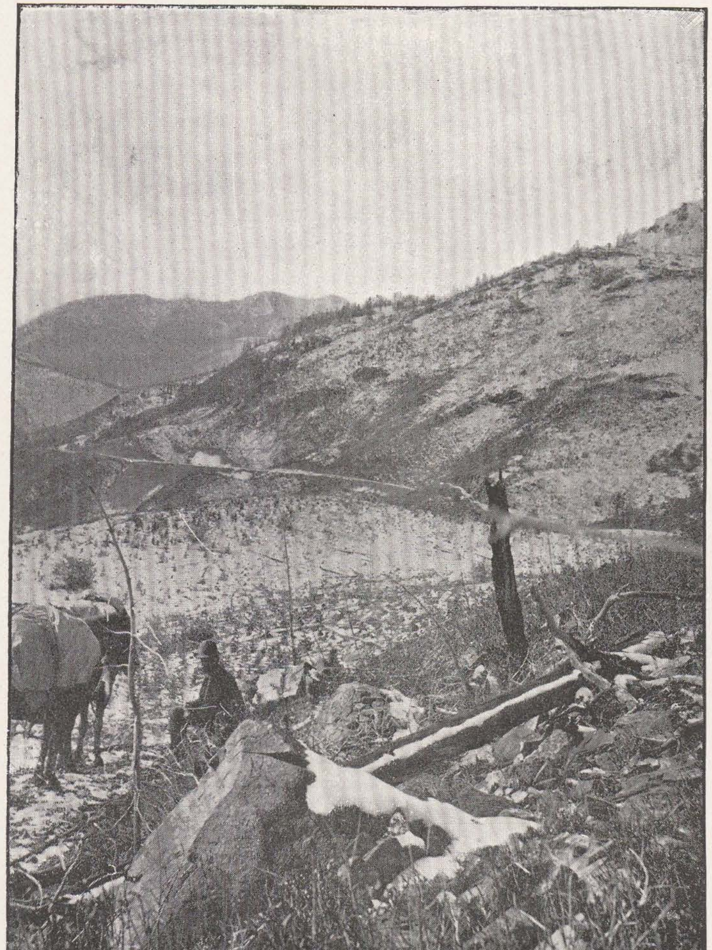
A. VALLEY OF SUMMIT CREEK.

Looking west near Bear Creek Station; severely burnt.



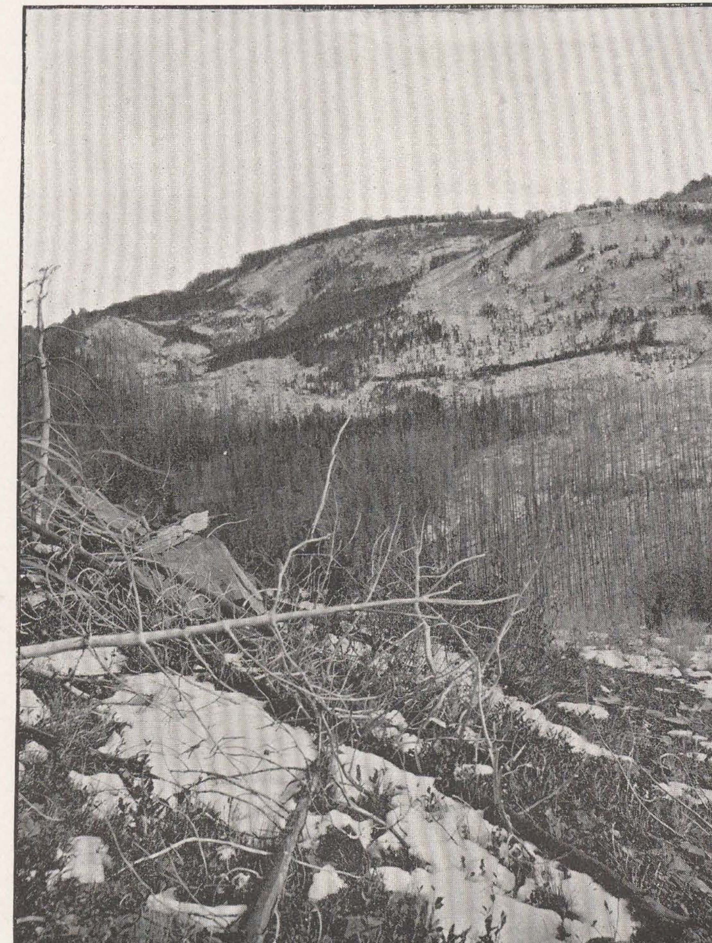
B. VALLEY OF SUMMIT CREEK.

Looking southeast from near Bear Creek; repeatedly burnt.



A. SUMMIT CREEK VALLEY.

Looking southwest along Great Northern Railway, 1 mile west of Summit Station.



B. SUMMIT CREEK VALLEY.

Patches of lodgepole pine (Pinus murrayana) which escaped fire, 1 mile west of Summit Station.

Humus.—Nowhere very deep, humus is especially light on the burned mountain slopes. In the bottom, below Bear Creek, on an area of some 500 acres, the soil is quite dark even to a depth of 10 inches.

Young growth.—Young trees of two distinct generations are found throughout the region above Bear Creek, the older 12 to 25 years of age and 10 to 30 feet high, in strips and patches irregularly blotched by recent fires. Most of this stock is seen between the first and the second tributaries from the south. The younger stock is found on the lands burned during and since the building of the railroad. Most of it is under dead timber and it is frequently dense, sometimes 40,000 trees to the acre. It is, however, irregular in distribution. Places where no young have come in are common. The burned areas are perhaps one-fourth restocked. All of the young growth is less than 25 years old, and is principally lodgepole pine.

Underbrush.—Underbrush is so slight as to be no appreciable hindrance to travel with horses.

Trees and timber.—In this valley are only small areas of unburned forest standing. About the head waters of the south branch, nearest Summit Station, is the largest green area. This lies near the head waters of the branch and extends over the divide into the Middle Fork drainage. Its area is approximately 10 square miles. It would yield about 10 cords of wood per acre. Next in importance is an area of about 2 square miles, lying south of Summit Creek near its mouth. This averages about 2,000 feet of log timber per acre. The timber is small and knotty, seldom over 14 inches on the stump. Red fir, larch, lodgepole pine, Engelmann and white spruce, with an occasional white pine, occupy the bottoms and lower slopes; while on the higher slopes are balsam, Engelmann spruce, and nut pine.

Estimates.—In this valley are about 45,000 feet of log timber, 36,000 ties, 24,000 cords of live wood. Some 20,000 feet of the log timber is spruce—standing in the valley bottom—that has escaped fire. There are remaining unburned, near the mountain tops, small isolated tracts of practically no economic value and of little promise.

Fires and reproduction.—Fires have swept the whole valley, the upper part of it repeatedly. Above Bear Creek, with the exception of the head waters of that south fork nearest Summit, all has been burned years ago. A partial restocking took place, and now are found here and there groups and patches of a stock 20 to 25 years old blotched by more recent fires (Pl. CVIII, *A* and *B*). On the sandy and gravelly benches, where the second fire was not so severe, owing to the stock being less dense, are scattered survivors slightly injured by the second fire. The railroad fires of about 7 years ago have but few seedlings following them where on land previously burned. Below Bear Creek there was little or no fire prior to the beginning of the railroad construction, and here the dead trees are standing with occasional areas well restocked, principally with lodgepole pine.

The bench lands are best restocked, while large areas on the slopes have no young stock at all. This seems to be especially the case where a second fire has occurred. Presumably, the second fire has killed the seedlings that appeared after the first fire. About 2 miles below Bear Creek, in the bare earth of the old tote road, is a dense stock of young lodgepole pine about 6 years old, while outside of the road there are very few (Pl. CIX, *A*). Whether a second fire had occurred in this instance, killing the seedlings not in the road, or whether those outside of the road had been choked by weeds, was not determined.

Dead timber.—West of Bear Creek the whole valley, excepting about 2 square miles, is covered with dead standing trees. In the bottoms some of the trees could be used for log timber, but they are worm-eaten and otherwise defective, and have no market value on the stump, unless for fuel, house logs, or fencing. In the valley about 75,000 cords of such material are standing, dead,

Cutting.—Along the railroad over 100 buildings were made for grading camps; ties, bridge timber, and cribbing were cut for railroad construction, and much fuel was used during the building of the road (Pl. CIX, *B*). In making the tote road the necessary roadway was, of course, cleared, and 12 bridges and several corduroy roads were made. Some few prospectors have done a slight amount of cutting for their camps; otherwise no cutting was noticed but that connected with the building of the railroad.

Transportation.—As the Great Northern Railway follows the entire length of this valley it furnishes the best and only means of transportation to be expected.

Demand.—It is questionable whether the dead material could be marketed with profit. There is demand on the plains east of the mountains for such wood for house logs, fuel, and fencing, and $30 a carload is being paid at Midvale for it. From this valley the freight charges would be greater, and this material is on such rough land that it is less accessible. Ten cents a cord would probably be a good price for this deadwood on the stump.

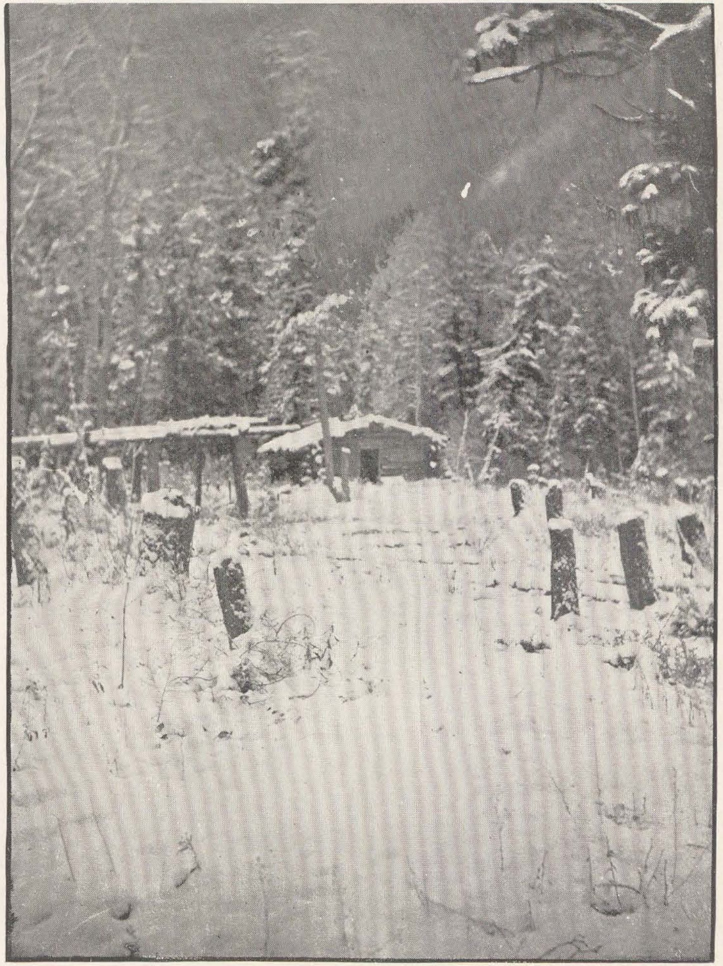
Irrigation.—There is abundant water to irrigate all the arable land in the valley. None of the land is irrigated at present, and but little of it ever will be, except to raise hay and a few of the hardier vegetables, as it is too liable to frost throughout the season.

Water power.—A moderate quantity of water power is found along the entire stream.

Agricultural land.—Probably the only crop that could be grown successfully in the valley would be hay. Timothy is now growing luxuriantly there, wild. About 1,200 acres would make good hay

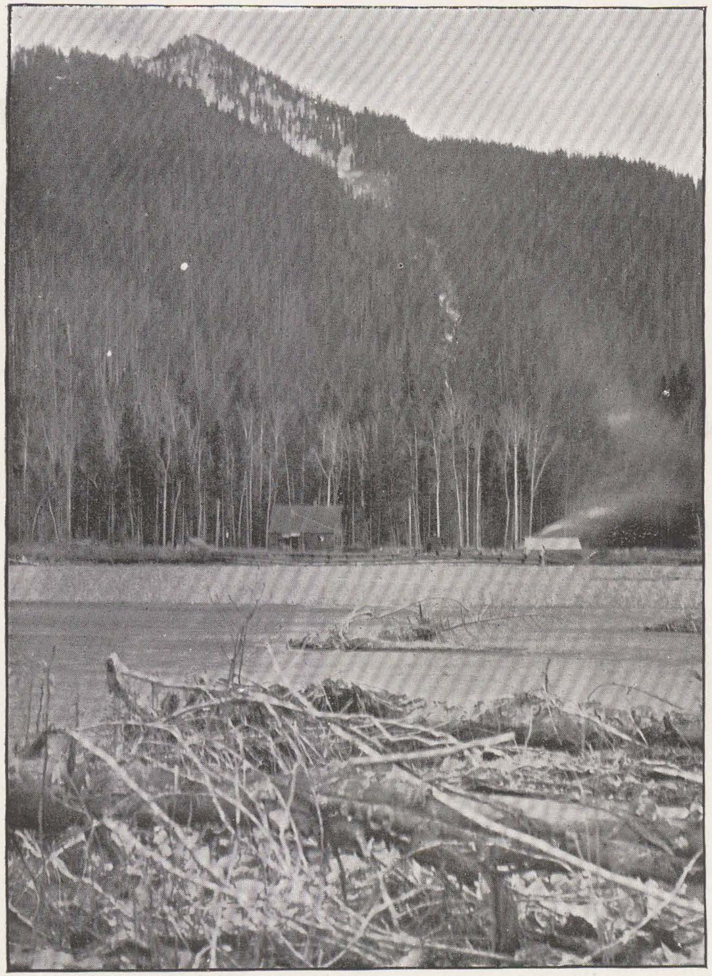
A. BURN OF 1889 IN SUMMIT CREEK VALLEY.

Very scantily restocked except in road, where restocking is dense with lodgepole pine (Pinus murrayana).

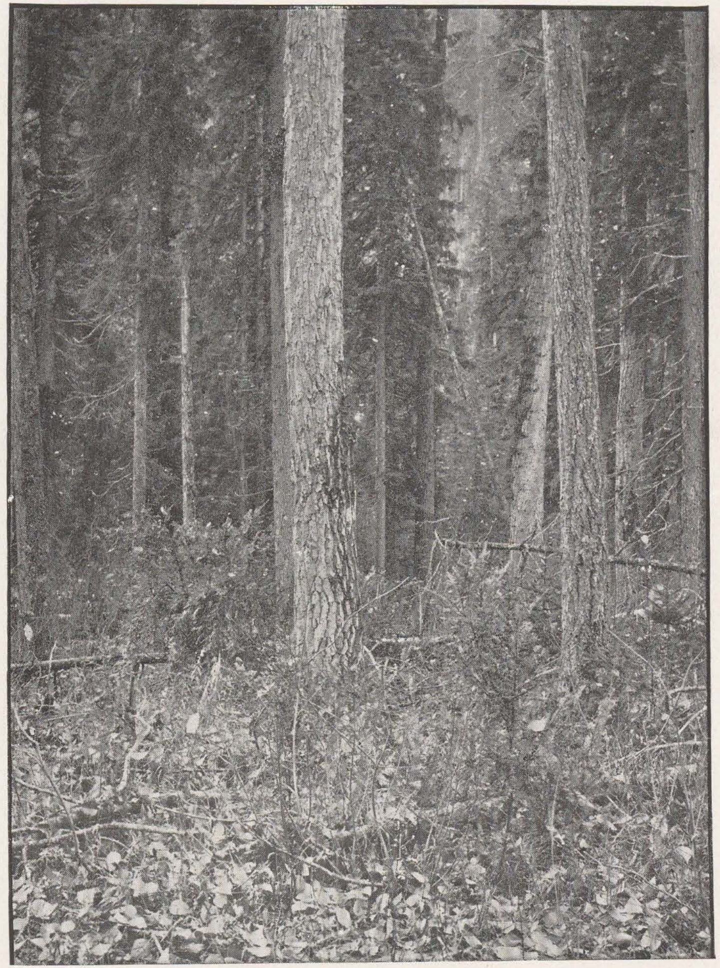


B. OLD TIE CAMP NEAR MOUTH OF SUMMIT CREEK.

Red fir (Pseudotsuga taxifolia) and balsam (Abies lasiocarpa).



A. NYACK STATION, LOOKING ACROSS MIDDLE FORK OF FLATHEAD RIVER.



B. SPRUCE AND COTTONWOOD ON RIVER BOTTOM 1 MILE ABOVE NYACK.

land. This lies about the mouth of Bear Creek and continues along Summit Creek, about 3 miles below.

Mining.—No mines are shipping at present. Several new claim stakes were seen between Bear Creek and Java.

MIDDLE FORK OF FLATHEAD RIVER.

Topography.—As seen from the mountains, this valley seems continuous with that of the North Fork, except for the ridges north and south of McDonald Lake. It lies between the high mountain ranges, which are snowy most of the year and have glaciers in their high basins. The river has many tributaries, both from the east and west, those from the east being much longer. Some of these are about 15 miles long. Above Nyack the valley bottom is deeply cut by the river, sometimes terraced with gravel benches, as at Essex and Paola; sometimes with sheer walls of rock, as near Java and about the mouth of Coal Creek. About Nyack the valley is much wider (Pl. CX, *A*). Land with slopes moderate enough to be arable, reaches, on Mud Creek, about 6 miles up that stream. From Mud Creek to near the mouth of Little Saint Marys the river valley is about a mile wide. At the mouth of Little Saint Marys, however, the valley narrows to a canyon that continues, with rarely enough level land for a garden, to Belton.

Soil.—Derived largely from limestone, the soils of the valley grow the natural vegetation well. Excepting on the mountain and hilltops and the burned areas, a dense forest proves the soil favorable to a growth of trees. Clays are found on most of the steeper slopes and more or less mingled with the sands in the bottoms. Gravels predominate on the lands having slopes moderate enough to be arable and irrigable. Sandy areas are limited usually to the lower bottoms.

Litter.—The litter is quite variable in quantity, the average of the valley being medium in amount. The trees killed by natural overcrowding are everywhere falling and lying upon the ground, being most abundant in the spruce bottoms. Where burned, unless burned several times, the falling deadwood renders such areas almost impassable, but the scantily-watered ridges have only a few overcrowded trees and fallen leaves in the process of decay.

Humus.—Where unburned, humus is, on the hillsides, seldom more than 2 inches deep, but in the spruce bottom of Mud Creek it is found sometimes 6 inches. On the burns the amount that is left depends upon the intensity of the fire. Above Paola the fire has been severe, and east of the river the humus left is very light. Below Paola, and especially in the canyon below Nyack, the fires have been less severe, and several places were noticed where an inch, and occasionally 2 inches of decayed vegetable material remain unburned by the fire that passed over it. As a rule, the humus does not penetrate deeply into the soil.

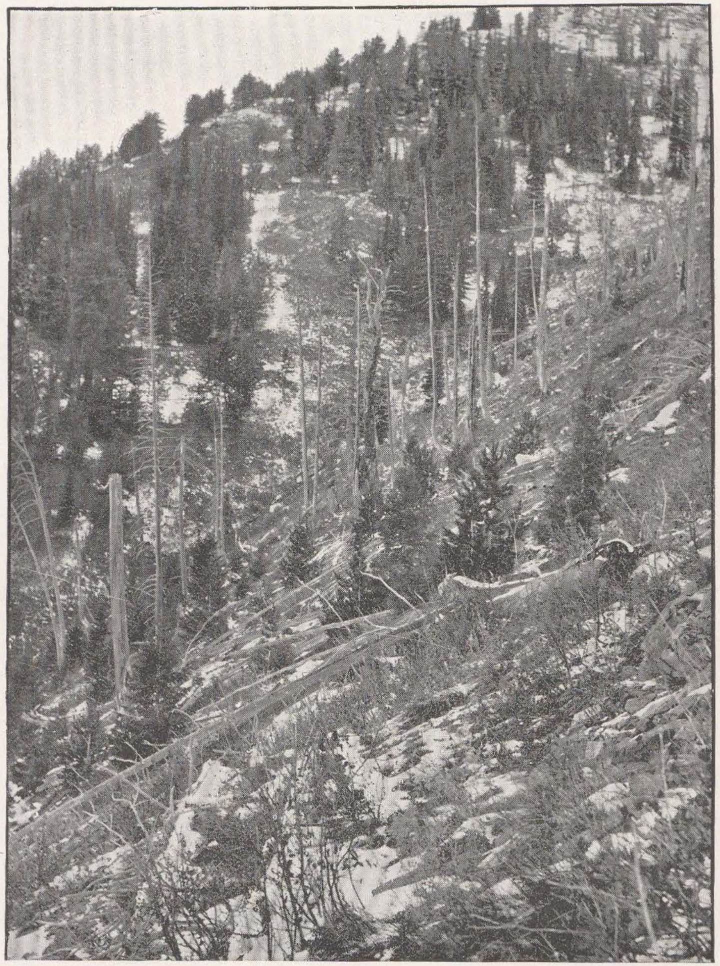
Trees and timber.—But a small proportion of the trees are above 20 inches in diameter on the stump. Larch, spruce, red fir, and yellow pine are found larger, but the larger trees are not abundant except on Coal and Mud creeks. There has been much large timber along the Middle Fork, but most of this has been used in building the railroad. The largest tree seen was a larch, 48 inches on the stump and 180 feet high (Pl. CXI). Approaching this in size was a yellow pine, near Mud Creek, 40 inches in diameter and 100 feet high. Occasional acres were found that would yield 10,000 feet B. M., but areas of such timber are small. The greater portion of the log timber is about the size for tie making. The log timber altogether would average about 20 logs to a thousand feet. The timber runs fairly sound, but some of the larger trees are decaying. Most of them are knotty. In the valley below Java are probably 125 million feet B. M., 60 per cent of which is larch, 25 per cent red fir, 5 per cent lodgepole pine, 9 per cent spruce, and 1 per cent yellow pine and cottonwood (Pl. CX, *B*).

Young growth.—Here and there are tracts of varying size that have been lightly burned over without killing the main stock of trees. The seedlings, started in the ashes, are now growing subordinate to the old stock. On the slope north of Mud Creek, where a fire had run through red fir and larch about 25 years ago, killing and injuring very few trees, young red fir is found as an undergrowth, very irregular in distribution, but in places forming thickets. These young trees are about 10 feet high and 1 to 2 inches in diameter, and frequently stand 10,000 to the acre. On the ridge between Mud Creek and Harrison Creek spruce, balsam, and cedar are found to have started under the general stock of lodgepole pine, larch, and red fir. These are of various sizes, and have evidently started whenever the conditions were favorable, as after windfalls or after crowding has reduced the lower branches enough to let in light. Toward Belton, where the valley narrows to a canyon, and fires occurred some 25 years ago, killing substantially all the old stock, a second generation, mostly of lodgepole pine, fully occupied the ground. Now, parts of this have been burned a second time, and very little of the second growth has escaped the second fire. On timbered lands the subordinate stock, in most cases, is in condition favorable for a second growth of timber trees, were the mature trees cut.

Underbrush.—Nowhere very dense; brush is thickest on the bottoms, along the foot of mountain slopes and in ravines. In such places dogwood, yew, and devil's club are seldom too dense for horses to penetrate. Elsewhere huckleberry, *Menziesia*, and other brush are found, but usually a light growth.

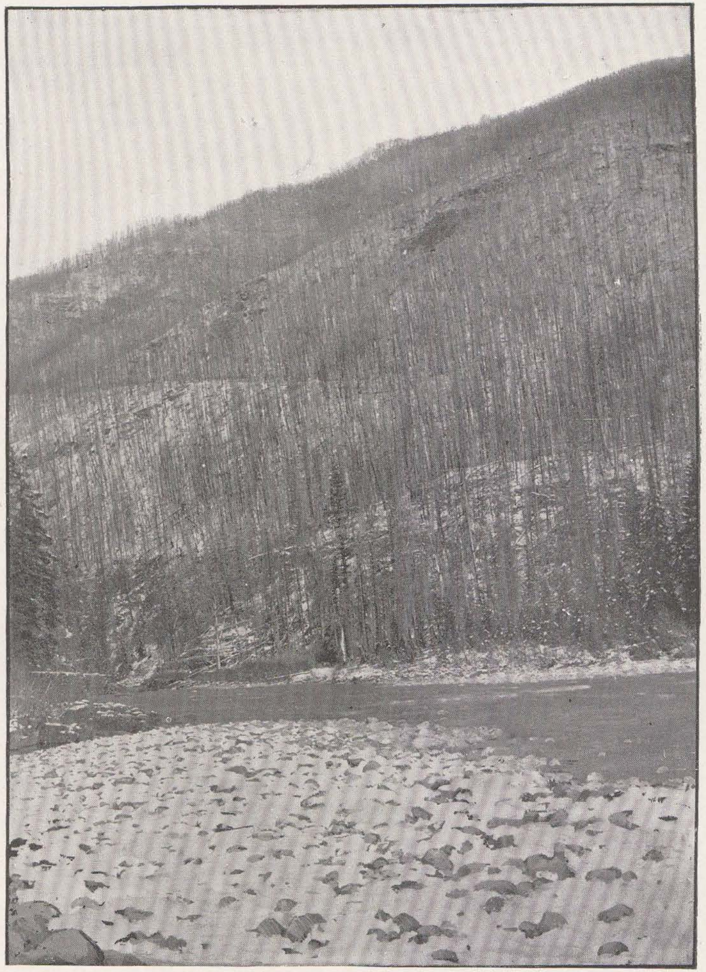
FOREST ON MIDDLE FORK OF FLATHEAD RIVER, 2 MILES ABOVE NYACK, CULLED FOR RAILROAD CONSTRUCTION.

Large Engelmann spruce (Picea engelmanni) and larch (Larix occidentalis). Spruce, 36 inches in diameter; larch, 48 inches in diameter; each 150 feet high.



A. MOUNTAIN SLOPE NORTH OF NYACK.

Burnt and scantily restocked with balsam (Abies lasiocarpa), Engelmann spruce (Picea engelmanni), and nut pine (Pinus albicaulis).



B. MOUNTAIN SIDE 1 MILE BELOW JAVA, MIDDLE FORK OF FLATHEAD RIVER.

Burnt severely; all trees killed; no young stock coming in.

Fires and reproduction.—The upper portion of the valley is very nearly all burned over, and the fires have been severe and repeated. The hills opposite Paola have only scanty patches of brush (Pl. CXII, *A*). The mountain slopes have suffered from fire rather more than the bench lands, although more cutting has been done on the benches, and the branch wood from the cuttings has been left to feed the flames. The freer access of sunlight and wind, due to the thinning of the forest, has also greatly favored fires on the cuttings. Below Paola the extent of the burns diminishes, being frequently confined to the ground upon which cutting has been done. As usual, the reproduction has been best on the moderate burns. Some of these have been well restocked with seedlings of the same species that were killed by the fire. One of the best-stocked areas found was near Belton. On a square rod of cut and burned land the following seedlings were found, from 4 to 30 inches high, and 2 to 6 years old, viz, 23 cedar, 65 hemlock, and 36 larch. The larch were growing most rapidly. Some areas, principally east of the river, in the upper portion of the valley, would be restocked slowly, because they have been so severely burned. There are no trees to furnish seed, and the ground was burned over so long ago that it is not now in condition favorable for receiving and starting the seed, but the greater portion of that burned by the railroad fires, some 50 square miles, now has young seedlings growing upon it, probably averaging 100 per acre. The stock of seedlings usually has more lodgepole pine and balsam in it than the original stock.

Deadwood.—On the 50 square miles burned over are about 300,000 cords of deadwood (Pl. CXII, *B*). Much of this is worm-eaten and beginning to decay; some of it has fallen. A few more years will render it worthless. It may possibly have a slight value now, but not over 10 cents a cord.

Cutting.—Log timber, railway ties, bridge timber, cribbing, bridging, corduroy timber, and house logs have been cut in large quantities for the construction of the railroad (Pl. CXIII, *A*). For the railroad bridges portable mills were placed near the proposed bridges, and the best and most accessible red fir was sawed. For ties, the bench lands along the railroad have been cut over, some of them quite thoroughly, especially in the lower portion of the valley. Such cutting took but part of the trees suitable for tie timber, and, as a rule, the trees left have been killed by fire, which found extra food in the tops of the trees cut. Several million feet of dimension timber have been used for the bridges and tunnels and several hundred thousand hewed ties have been used.

Between Harrison Creek and Little St. Marys Creek about 20,000 ties were cut during the winter of 1891–92, and other cuttings were noticed that were not thoroughly examined. No time was given to counting the ties or scaling the timber cut, for a careful estimate would have taken more time than was available.

Transportation.—The transportation is excellent. Both the railroad and the river are available the entire length of the valley. Coal Creek, Mud Creek, Harrison Creek, and Little St. Marys, on which streams nearly all the timber of the valley is located, are drivable.

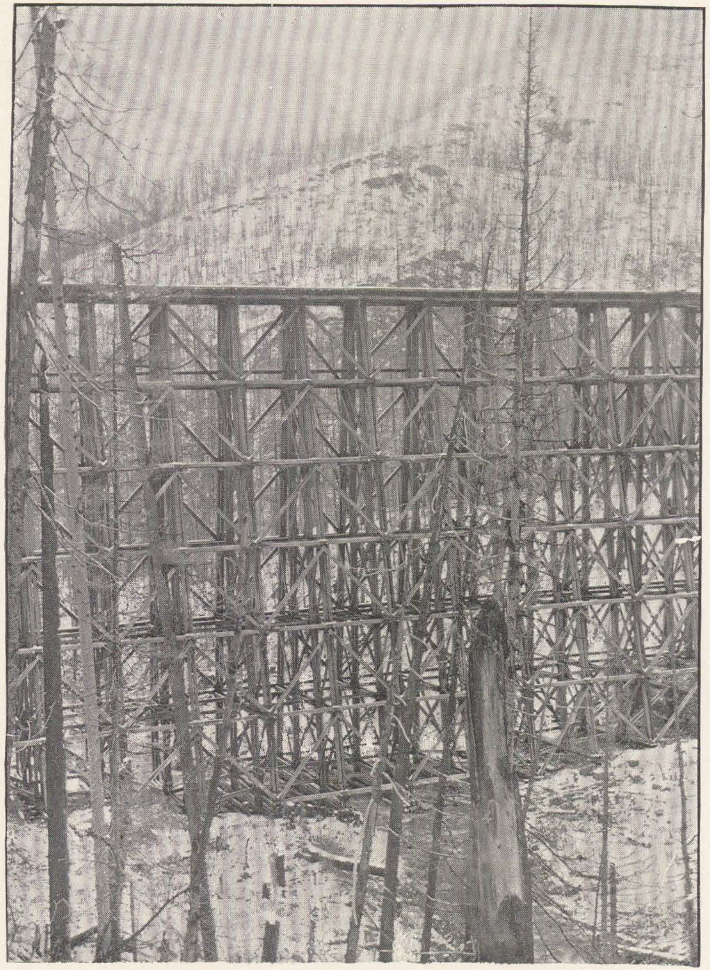
Demand.—Ties are in demand for the railroad, and other timber finds a ready market on the plains east of the mountains. Prices for ties are about 20 cents, and for sawed lumber $7 to $10 a thousand. There is no local demand at present for mining timber.

Agricultural land.—There is no cultivated land. Not even a garden is seen in the valley. Mr. Doyle, a resident squatter near Essex, says potatoes can not be grown, as he has seen 8 inches of snow fall there on the 20th of June. Agriculture has not been thoroughly tried in the valley. Its possibilities are somewhat conjectural. The probabilities are against it. Hay will grow. Timothy is abundant along the tote road made in building the railroad, and some of the hardier vegetables could be grown for local use. Opposite Nyack, on Mud Creek, are about 8 square miles of arable land, but none of this land has any market value now as agricultural land.

Irrigation.—No water is used at present for irrigation. The supply is abundant for all the land of the valley.

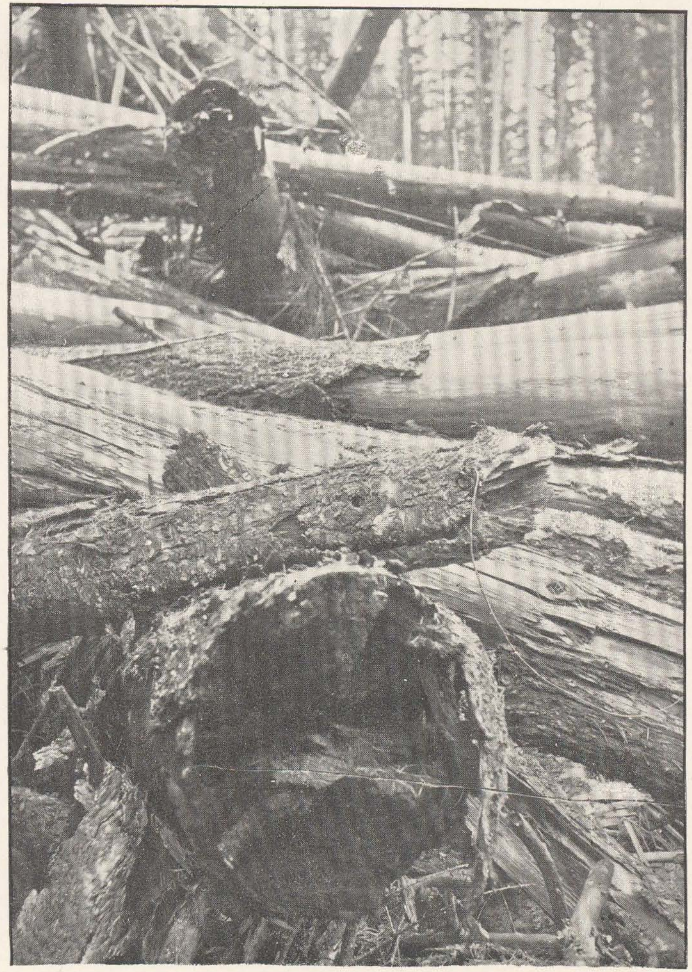
Water power.—Water power is abundant, but unused.

Mining.—No mines are shipping at present, although some claims are held in the valley.



A. TRESTLE AND BURNT MOUNTAIN SIDE ON LINE OF GREAT NORTHERN RAILWAY, BELOW PAOLA.

Trestle was built of timber cut and sawed in the vicinity.



B. TREES BROUGHT DOWN AND BROKEN BY SNOWSLIDE, NORTH SLOPE OF MUD CREEK VALLEY, NORTH OF NYACK.

BITTERROOT FOREST RESERVE.

By John B. Leiberg.

TOPOGRAPHY.

The Idaho portion of the Bitterroot Forest Reserve is situated almost wholly within the Clearwater River drainage area, a tract along the southern boundary on the Salmon River slope being the only exception (Pl. CXIV). The Clearwater drainage consists of a number of large forks or tributaries, which divide into an intricate system of long and short canyons, mostly narrow and winding. Its main arteries are the North, Middle, Lochsa, South, Lolo, and Selway forks. Of these tributaries the area of the reserve includes the entire length of the Selway and Lochsa forks, about 15 miles of the Middle, the upper half of the South and Lolo forks, and a small portion of the southern drainage of the North Fork. The canyon system, of which these affluents form the main trunks, is by far the most noteworthy and striking feature in the topography of the Clearwater basins. Its windings and ramifications are very great. Excluding the Salmon River Gorge and lateral canyons and the small draws or mere creases in the mountain sides in the Clearwater areas, I estimate that the canyon system of the Clearwater basins within the reserve measures more than 5,000 miles in aggregate length.

The western slope of the Bitterroot Mountains is primarily formed by a few great branches from the main range, which in their turn branch out into a vast mass of curving, winding, peak-crowned spurs, constituting the watersheds of the Clearwater basins. As there will be occasion to refer to the primary divides further on in this report, it is necessary to designate them more particularly, and they are therefore named as follows: (1) The main range of the Bitterroots, which is the backbone of the entire ridge system, and which stretches from north to south across the reserve, dividing the Idaho portion from the one situated in Montana; (2) the North Fork–Lochsa divide, which separates the waters that flow into the North Fork of Clearwater from those that flow into the Lochsa, Middle, and Lolo forks; (3) the South Fork–Middle Fork divide; (4) the South Fork–Selway divide; (5) the Lochsa–Selway divide, ridges separating the various streams whose names they bear; (6) the Salmon River divide, which separates the Salmon River Basin, in part, from that of the South Fork and in part from that of the Selway. The appended sketch (fig. 1) is intended to give a general view of the position of these divides and the basins they inclose. The primary divides here designated, with the great number of lateral spurs to which they give rise, form a perfect maze of bewildering ridges. From the summit of an eminence that commands a clear view of the surrounding country for many miles the exact course of even one canyon or spur can not be

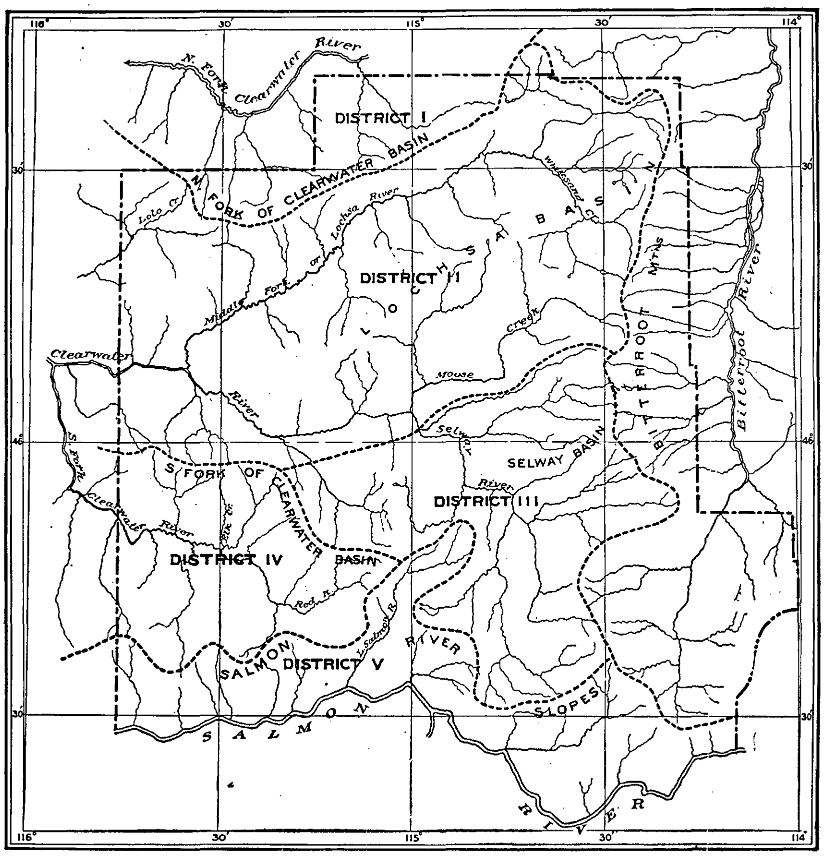


FIG. 1.—Bitterroot Forest Reserve, showing districts used in description.

traced for more than a mile or two at most. The curvings, windings, ascents, and descents are incessant and confusing, and in every case only actual travel can determine the precise point at which any particular canyon or spur originates or ends. The primary divides vary considerably in their topographic details, depending on the amount of erosion they have undergone and the agent that effected it. The lateral spurs, on the contrary, do not vary very much, except near the main range of the Bitterroots.

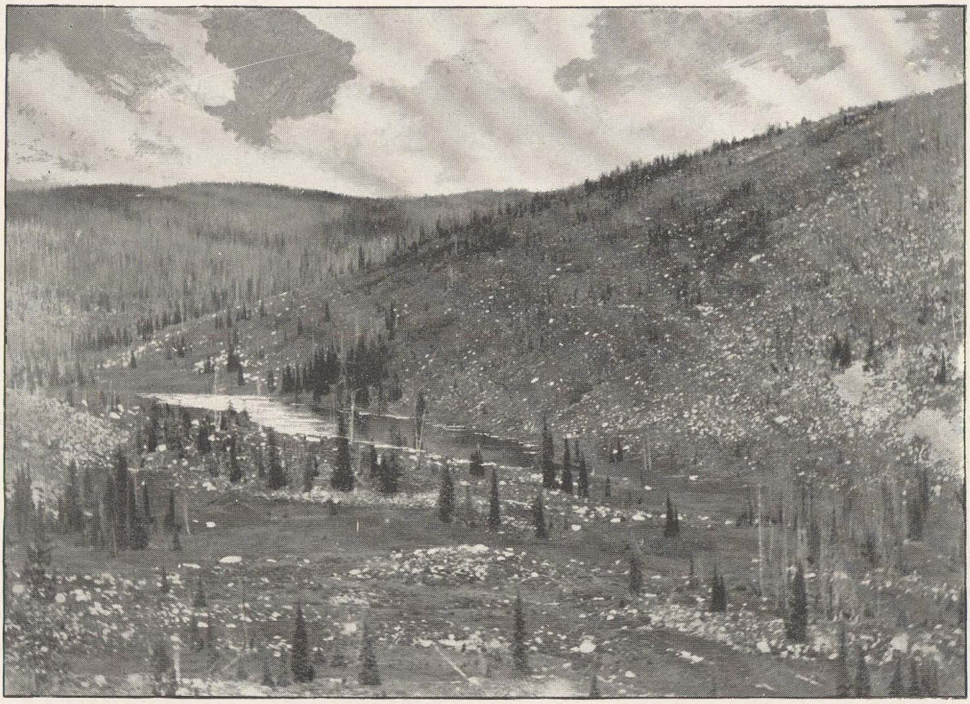
It is in the main range of the mountain system that the most rocky and precipitous areas exist. From Lolo Pass to Nez Perces Pass the rock formation is a massive, hard granite. The crest of the range is a succession of sharp, craggy peaks and "hogbacks," with long east and west swinging curves alternating with deep saddles where the larger canyons have their rise. The peaks attain elevations of 8,000 to 9,000 feet—in some instances 10,000 feet—while the deeper saddles, which form the passes of the range, have elevations of 5,800 to 6,500 feet. The direct western slope of the main backbone of the system has been cut and fissured by great glaciers that have long since disappeared, but which left behind beetling crags, deep canyons with precipitous walls, and a general ruggedness in the landscape that time has not yet succeeded in modifying, except in a very small degree.

The general aspect of the crests of all the primary divides for distances of 40 to 60 miles west from the main range, indicates the existence of past glaciers on their summits and upper slopes. The sculpturing of the slopes and the peculiar recessing of the heads of the larger canyons into the divides are, in their general features, precisely the same on the primary divides as they are on the main range, where no doubt exists as to the presence and work of big glaciers in past times. The most rugged and elevated portion of the Bitterroot Range lies north of Nez Perces Pass. South of this place the crest averages 1,500 to 3,000 feet less in elevation and is for the most part a narrow ridge with rounded outlines occasionally rising into small peaks, but on the whole is more like the primary divides toward their terminations on the west. The main range of the Bitterroots north of Nez Perces Pass has always proved a formidable barrier in the way of travel from east to west in this region. The difficulty does not lie in the approach from the eastern side, though this declivity has by far the shortest and steepest slope. It is the descent on the western side that presents the chief obstacles. The immediate slopes from the crest are here very abrupt, are cut up by immense gorges, and abound in precipices and extensive rockslides to such a degree that they are entirely impassable. The three trails extending across the reserve, the Lolo trail on the north, the trail through Lost Horse Pass in the center, and the Nez Perces trail on the south, were laid out by the Indians ages ago and their course was made to coincide as nearly as possible with the crest of the primary ridges, the North Fork-Lochsa, the Lochsa-Selway, and the Salmon River divides, the canyons being utterly impassable without much grading and rock cutting.

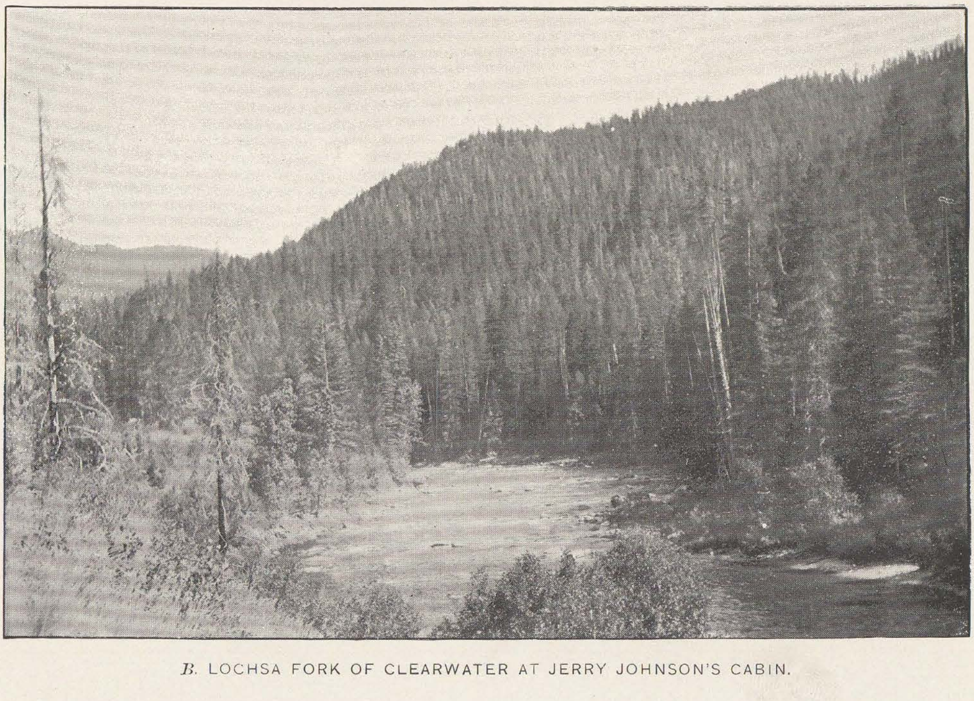
The primary divides which extend westward from the main range in general possess, though in a minor degree, the same features that characterize the rugged portion of the Bitterroots. This is especially the case with the Lochsa-Selway divide, which lies somewhat north of the center of the reserve. For a distance of 25 miles this ridge is a succession of sharp crests and rocky, precipitous peaks, some of them rising to elevations of 9,000 feet and presenting many features of extensive glaciation. The North Fork–Lochsa divide is much less broken along its crest line. It abounds in deep saddles and corresponding rises, but lacks the extremely rocky and sharp peaks that characterize the Lochsa–Selway divide. The effects of glaciation are less conspicuous and consist mostly in the recesses excavated in the ridge at the head of the canyons. The Lolo trail follows the crest line of this divide very closely, as it affords the easiest route for travel across the Bitterroot Mountains in this latitude. The Salmon River divide is an extremely tortuous ridge, due to the various tributaries that enter the Salmon from the north and whose heads lie far back from the main stream. East of Little Salmon the divide is a narrow crest, crowned at intervals with rocky eminences that do not rise high enough above the general level to deserve the name of peaks. It presents all the common marks of glaciation found elsewhere. West of Little Salmon the divide becomes broad and has a nearly due east and west course, with no very clear evidences of ice erosion until the region of Buffalo Hump is reached. A peculiar feature in all the primary divides is that only certain portions exhibit the effects of glaciation. The western terminations of the North Fork–Lochsa and of the Lochsa–Selway divides are not sculptured as if by ice, nor is the Salmon River divide west of the Little Salmon, as already remarked.

The lower slopes of the primary divides, as well as all the lesser spurs, have very steep descents to the canyons, in some instances, near the main range of the Bitterroots, being nearly perpendicular. They are not infrequently extremely rocky and covered with masses of slidden rock, but usually, notwithstanding the high angle of slope, they have a fair amount of soil covering, which, in some instances, as on the ridges in the Lower Selway Basin and in the Lolo and South Fork basins, becomes 6 to 10 feet in depth. The Salmon River slopes are uniformly excessively steep. Near the crest-line of the ridge the descent is more or less broken by terraces which, along the section west of Little Salmon, become almost plateau-like, but eventually they break off to the gorge below with slopes that vary from 50 to 80 degrees.

The western termination of the North Fork–Lochsa divide consists of a mass of low spurs. Their outlines are broad and rounded and were not fashioned by the wearing power of ice. They appear to have once formed part of the east shore line of the large lake which covered the Plains of the Columbia. The detritus that lies on these spurs under the top soil consists of rounded waterworn stones and bowlders, wholly unlike glacial débris, but exactly such as the beating and washing of water piles up along a shore. In general, all the ridges of the western slope of the Bitterroots below elevations of 4,800 feet, and



A. HOODOO LAKE IN LOCHSA-SELWAY DIVIDE.



B. LOCHSA FORK OF CLEARWATER AT JERRY JOHNSON'S CABIN.

fronting on or adjacent to the plains, exhibit the marks incident to an ancient shore line. Some of the interior basins do the same, notably the upper portion of the drainage area of the South Fork of Clearwater. Immense masses of gravel were heaped up along this shore line, smoothing out the roughness of the weathered and wave-beaten rocks.

The valleys of the Clearwater drainage within the reserve are mostly canyon-like. Near the main range of the reserve they form immense gorges with almost perpendicular walls for many miles. The larger canyons that head in the principal divides have, commonly, one or more lakelets at their heads; in fact, there are no places in the glaciated areas along any of the primary divides where the elevation reaches or exceeds 6,000 feet that these lakes do not exist, or have not existed within recent geologic times. They are mostly small—rarely one-half mile in length by one-fourth mile in width—very often mere ponds. They owe their existence either to an excavation in the solid bed rock or to a talus or, more properly, a morainic embankment across the head of a small feeder of the main canyon. The lakes are always surrounded by springy margins, supplied by the seepage from the adjacent ridges. A gradual filling and drainage process is taking place in these lakelets. Some are filled with accumulations from adjacent ridges; others are drained by the wearing away wholly or in part of the débris at their outlets. When drained they become meadows at first, with a small stream flowing through them for the reception of seepage from the springy margins. Later, when the stream has cut its way down to a sufficient depth to wholly or partially drain the meadow, the forest takes possession of the tract. Lakelets are found in all stages of this progress toward dry ground and canyon slopes. They have been and are yet important reservoirs for the streams whose head they form. The lakes and the subalpine meadows are most abundant in the main range of the Bitterroots and in the high, rugged portion of the Lochsa-Selway divide. The regions where most of them occur coincide exactly with the areas exhibiting the most obvious marks of intensive glaciation (Pl. CXV, *A*).

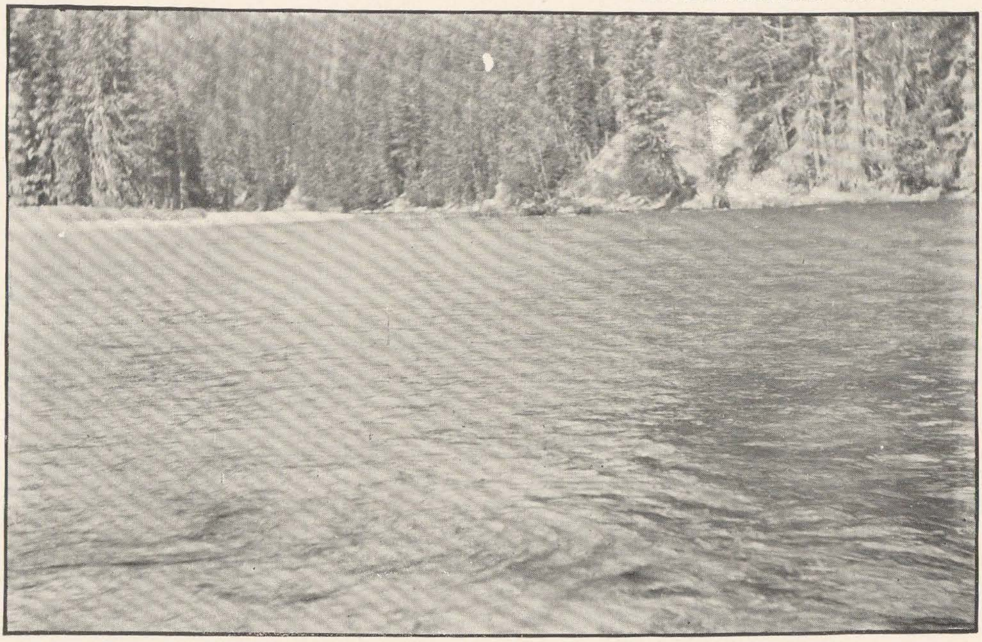
Below the comparatively level meadow and lake areas the canyon bottoms fall away rapidly. The mountain spurs on either hand close up and form gorges or box canyons, or recede slightly and give room for narrow strips of bottom land. In the upper portion of the streams the canyon bottoms are often terraced, with very steep descents between, but lower down this feature is lacking. The stream beds are littered with great bowlders in many places. None are free from these bowlder-strewn stretches, not even the largest of the rivers. Where the canyon walls are steep, masses of slidden rock have descended and block the canyon floor. Where the mountains recede gravel and bowlder bars have formed, which in time have become covered with trees. These are the only bottom or bench lands in the Clearwater canyons outside of the South Fork Basin. The largest natural meadows in the reserve are in the district formed by the Upper South Fork of Clearwater. This region is somewhat peculiar and does not very closely resemble any other portion of the reserve. The rocks here are soft, granitic, porphyritic, and talcose. The erosion in the basin has been on an immense scale, but, as before noted, does not appear to have been due to ice. The broad meadows that line the streams owe their origin to other causes. A great mass of lacustrine deposits—mud, silt, fine and coarse gravel—has been spread out over a rough, much-weathered bed rock, leveling the inequalities and forming the smooth and comparatively level tracts of land we now find there. These meadows are situated at elevations of 3,500 to 4,200 feet and clearly have been below the highest water level of the ancient lake, which left beach lines on the mountain sides at least as high as 4,800 feet elevation (Pls. CXV, *B* and CXVI, *A*).

The Clearwater canyons are tortuous throughout their length, as a rule. Near the main range they often pursue a nearly straight course for a mile or two, but as they recede from the areas where past glaciation exerted its greatest force they become more or less winding, with many sharp turns. They are exceedingly difficult to travel, owing to their lack of bottoms or benches, and the declivities of the mountains, which even in the largest valleys slope directly into the bed of the stream often for distances of many miles, afford a precarious footing either for man or beast. Taken in its entirety the topography of the Clearwater drainage can be defined as a maze of deep, very narrow, winding canyons with a succession of steep, high, rocky, narrow-crested ridges separating them.

ACCESSIBILITY OF RESERVE AREAS.

Upon the topographic configuration of the Clearwater Basin depends its accessibility and the opening of its timber resources. Much the greater portion of the reserve can not, at the present time and with the prevailing prices for lumber, be regarded otherwise than as an inaccessible region. This is true of at least 90 per cent of it. The obstacles in the way of providing transportation facilities from the interior areas are many and great. No roads can be built up any of the canyons or valleys, small or big, except by blasting out the way through the slopes of the mountains, and the attendant expense would be prohibitory of such an undertaking. The streams furnish the best facilities for transporting timber, but, with the exception of the Salmon River, none are fit for driving without large preliminary expenditures in the removal of numerous bowlders that obstruct their channels.

In noting the advantages possessed by the various streams for driv-



A. LOCHSA FORK OF CLEARWATER AT FORD ON HOODOO LAKE TRAIL.

B. PORTION OF TRUNK OF ALPINE FIR, SHOWING RESIN BLISTERS.

ing, the Salmon River comes first. This stream can be utilized, at least during high water, and, so far as I know, there are no obstacles in its bed that need removal. The difficulties here are of a different sort and begin when it comes to putting the logs in the river. The Salmon River slope is so abrupt and is so broken by sharp terraces, rocky combs and spurs, and short but deep and precipitous canyons cutting back to the inclosing divide, that neither roads, log chutes, nor slides to the river can be constructed or maintained, except in isolated localities and for short distances. It is from 2 to 5 miles from the upper breaks of the Salmon slope to the river, and the really valuable growths of yellow pine and red fir are rarely nearer the river than 2 or 3 miles, necessitating the construction of slides of that length if it be desired to put the logs from the upper terraces into the river. The expense involved would be very great—far more than the value of the timber at present prices. Yet the Salmon River slopes are easy of accesss in comparison with some of the other areas in the reserve.

District IV, the basin of the South Fork of Clearwater, contains no streams suitable for driving. All the timber east of the divide between Newsome Creek and Camas Prairie must either be utilized at home or hauled away by wagon or sled. The really valuable timber in that region is so small in amount, however, that home consumption doubtless can take care of it all. The timber fit for lumbering purposes west of the Newsome–Camas divide can be easily reached from the Camas Prairie side.

The timber in the Middle Fork Basin can be logged and driven by way of the main stream from the junction of the Middle Fork and Selway without special difficulty. Above this point the Lochsa can be utilized for many miles during high water by blasting out the bowlders that litter the bed, a work that would demand the outlay of a very large sum—one wholly beyond the present value of the timber that would be reached thereby. The Lochsa side canyons can be logged by constructing roads up their bottoms and the slopes by means of log chutes. None of the Lochsa canyons contain merchantable timber for more than 3 or 4 miles from their junction with the main stream except on the areas north of the Grave Mountains, and, owing to the broken character of the country, the timber here is practically inaccessible.

The Selway can be utilized for driving during high water for a distance of 15 or 20 miles above its junction with the Middle Fork. Above this the canyon is narrow and rocky in many places, and logs can not be sent down the stream at any time. The only feasible way at the present time to transport the timber of the heavy cedar growths on the Selway tributaries that are above the stretch of river suitable for driving would be to cut the tree up into shingle bolts, which would readily float down the stream and pass the obstructions. The large yellow pine above Moose Creek, together with the vast quantities of red fir in the upper basin, are beyond reach. The Selway Valley, which contains the greatest quantity and the choicest of the merchantable timber in the Idaho portion of the reserve, is by far the most inaccessible of the various districts.

The areas along the northern boundaries of the reserve will have to be logged by way of the North Fork of Clearwater River. What the chances are for driving this stream I do not know. They are said to be good, but are probably so, if at all, only during high water. The streams in the Upper Lolo Basin can not be utilized for driving. Their beds are full of bowlders and the volume of water is small at all times, but most of the valuable timber here can easily be reached by roads from the direction of Weippe. If the value of the timber product warranted the construction of flumes, there are hardly any places in the reserve except the subalpine areas and the Salmon River slopes that could not be successfully logged.

As this is written I learn that articles of incorporation have been filed for a line of railroad up the Middle Fork and Lochsa and across the Bitterroot Range at Lolo Pass into Montana. The construction of such a line would aid very materially in solving the problem of opening up the timber resources of the region adjacent to the line. It would not, however, greatly aid the Selway Basin, where exist the largest blocks of timber in the reserve west of the Bitterroot main range.

MINERAL AREAS.

The mineral production within the reserve is limited almost wholly to one metal, namely, gold. The little silver or copper that comes from the region is mostly a natural alloy with the gold. Lead-silver veins occur, but are not worked at present. The gold is extracted from both placer and quartz, chiefly the former.

The mineral-bearing zones now known consist of a strip running north and south in the western part of the reserve, from the northern boundary to Salmon River. This zone is about 25 miles wide, and contains gold-bearing veins and placer deposits throughout its entire area. The only localities that so far have been worked with profitable results are the areas at and around Pierce, mostly outside the reserve, and the regions around Elk City. Both of them are old placer camps and have yielded large quantities of gold in the past. The second zone of mineral-bearing country exists along the Salmon River Valley, from the eastern to the western boundary of the reserve. To this belong the newly-discovered districts around Buffalo Hump, the older camps at Dixie and Shoup, and various lesser camps along the Salmon. They produce both placer and quartz gold.

At Mineral Hill, which is at the head of one of the western tributaries of the South Fork of the Bitterroot River, and is partly in Idaho and partly in Montana, are found numerous argentiferous copper and galena leads. The mineral-bearing belt to which they belong, or a continuation of it, extends westward along the Salmon River divide, probably standing in intimate connection with the mineralized country around Dixie and farther westward at Buffalo Hump. This opinion would seem to be confirmed through my discovery of lead-silver veins in the gulches of the main Salmon River divide between Dixie and Little Salmon Valley. There are also good grounds for believing that there is a northward extension of the Mineral Hill zone to some point 10 miles, at least, north of Nez Perces Pass. The Upper Lochsa Valley also contains mineralized areas. I frequently picked up auriferous pyrites as float on the gravel bars of this stream high up toward its sources. As now known, about 2,000 square miles of the reserve is a non-mineralized area; the balance will yield new discoveries and further values from the old ones for a long time to come. The regions that appear devoid of mineral-bearing veins are the main range of the Bitterroots and its slopes from near St. Mary Peak southward for a distance of about 50 miles and westward about 40 miles from the summit. The entire reserve has evidently been very closely and thoroughly examined for placers since 1862. The discoveries around Pierce and Elk City caused the sending of numerous prospectors through the entire Clearwater country as far east as the main range of the Bitterroots. Old prospect holes are found in nearly all the larger and more important gulches and in many of the lesser ones, and the same ground has again been gone over within the last decade. It is therefore not at all likely that any new discoveries of rich placers will be made in the region, and the future mining operations will probably be confined chiefly to quartz. The forest and its conservation are questions that bear a most intimate relation to the coming development of the mineral resources of the reserve areas.

AGRICULTURAL AND GRAZING AREAS.

The land fit for agriculture in the Idaho portion of the reserve is limited to a few localities and the acreage is small. The canyon-like formation of the lower portion of the Lochsa and of the entire Selway and Salmon river valleys precludes the existence of any considerable tract of arable bottom lands along these streams. The hillsides are everywhere too steep for cultivation, and the meadows existing on some of the upper tributaries of the South Fork of the Clearwater and the head of most of the tributaries of the Lochsa, the Selway, and the Salmon River drainage within the reserve are either too marshy or too frosty, owing to their altitude, to permit of the growing of crops. Farming, or more properly gardening, is carried on in the valley of Middle Fork at a place known as Syringa, about 8 miles below the junction of the Selway and Lochsa, where there are two farm locations with a total of 20 acres under the plow and a possibility of 100 or 120 more by clearing off the forest. Above this, at the junction of the Selway and the Lochsa, are two more farms, each with 15 acres under tillage and a possibility of adding 10 or 15 more by clearings. There is one ranch location in the Selway Valley about 7 miles above its mouth, with no clearings. Along the Salmon there are patches varying from 2 to 25 acres in extent as far down as Horse Creek, in the aggregate 200 or 250 acres. These lands are bars—gravel beds formed behind outlying angles of the great mountain spurs that inclose the valleys, or at the outlet of small tributaries into the main streams. The gravel which makes up their bulk is overlain with a thin covering of humus and mold, which makes tillage possible. Originally they were covered with forest, but fires and other modes of clearing have destroyed the timber on them. Truck gardening is the chief use to which these lands are put.

The grazing lands within the reserve consist of the large meadows scattered on the upper tributaries of the South Fork of the Clearwater, Elk Creek, American, Red, and Crooked rivers, with the very numerous lesser ramifications of the same along the smaller affluents of these streams, and a tract on Little Camas Prairie, between the Lochsa and Lolo forks, of about 1,000 acres. They contain in the aggregate between 7,000 and 8,000 acres. A considerable portion is occupied by permanent settlers and utilized for hay lands and pasturage. The hay obtained is the common, coarse, natural product of the region and is 60 or 70 per cent sedges, the balance various species of native grasses. None of the meadows is under tillage. Grain, fruit, potatoes, and other vegetables do not thrive, and are not raised on these lands, owing to frost. Some portions are occupied as placer ground, but are not worked. The probability is strong that auriferous gravel exists under all this meadow land, and that eventually it will be worked as placers.

The appearance of the surrounding country indicates that the greater portion of the meadows occupies the place of previously existing lakes, which have been drained by erosion. In the past they have been too wet and marshy for the maintenance of a forest growth, but have become perceptibly drier since settlements began, and are now constantly diminishing in size, owing to the encroachments of the adjacent forest. Some are meadows merely temporarily, due to the denuding effects of repeated forest fires, and will be in time again covered with timber.

The grass lands in the reserve having the greatest extent in the aggregate consist of meadows at the ultimate head of most of the streams and deforested hillsides in the subalpine areas. The hillsides, more particularly mentioned under the head of "Forest conditions," are grass lands solely in the interim between destruction of the forest by fire and subsequent slow return to the original forest cover. The other class, consisting of meadows at the head of the streams, is of a different character. They are either dried up beds of small lakes, or springy margins around depressions, yet holding water and forming lakelets or marshy borders of running streams too wet for the growth of coniferous trees. They are especially abundant in and characteristic of all the areas that have been subject to great glacial erosion. All are covered with a sward composed of 80 to 90 per cent coarse mountain sedges, the remainder a rank grass, mostly species of reed grasses (*Calamagrostis*). In the absence of surveys, it is impossible to state with accuracy the total acreage of these classes of grass lands. They exist in hundreds of localities, and are exceedingly irregular in outline. I estimate that, collectively, they contain about 50,000 acres. The largest areas of the meadow class are found along Hoodoo Creek, a tributary stream of the Upper Lochsa, and in the valley of Little Salmon, where they exist chiefly as a succession of wet glades. There are about 3,000 acres of this class in the Hoodoo Valley and about the same along Little Salmon. The largest areas of grass-covered hillsides are found on the southern slopes of the divide, between the Lochsa and Selway basins and in the valley of this latter stream. The Lochsa–Selway divide contains about 12,500 acres of these grass-covered hillsides in a nearly continuous body, while the Selway Valley has approximately 10,000 acres in interrupted patches along both the east-and-west facing slopes. These lands, excepting small portions of the Selway Valley areas, are situated at considerable altitudes, varying from 5,000 to 8,000 feet above sea level. The season is short in consequence, two to three and a half months being the average time between the snows of two winters. They are much too difficult of access for purposes of pasturage, and if they could be reached intolerable insect plagues in the shape of big horseflies that infest them in huge swarms, would drive the stock away. Besides, all the grassy, springy areas at the head of the streams are water reservoirs of great importance, and can not be disturbed without serious consequences to the run-off. None of the lands are occupied by settlers either for purposes of pasturage or tillage.

There are lands of another class that produce scant quantities of forage. These are the areas covered with a pure yellow-pine forest. These tracts are mostly open, and where reasonably free from underbrush produce a moderate amount of pasturage, especially in early spring, being utilized for this purpose near the settlements.

There are no domestic animals running at large in the interior of the reserve, except horses of the chance traveler, hunter, trapper, or prospector, and small bands of stock in the Elk City region. At this point, however, the lodgepole-pine timber, which covers almost exclusively the entire adjacent country, is so dense that all grass growth is choked out, and the range is confined to the natural meadows and to old fire-swept areas where reforestation has not yet asserted itself.

CLIMATIC CONDITIONS.

There are no accurate or systematic records in existence relative to the quantity of rain or snow that falls in the areas of the Clearwater basins, nor is anything known regarding the mean seasonal or yearly temperatures of the region. Most of our information pertaining to the precipitation is limited to the depth of snow on the ridges. This is said to reach a depth which varies from 10 to 20 or even 30 feet in the months of February or March each winter, at altitudes of 6,000 feet and upward. The above quantity does not represent the total amount of snow that falls during the entire winter season, by any means. A great deal comes down at the beginning of winter, only to be melted by subsequent rain storms. Owing to the absence of frost in the soil, even at the greatest elevations, the layer of snow in contact with the ground is continuously melting, resulting in the settling of the superincumbent mass. There are grounds for believing that the total of the winter's snowfall amounts to between 60 and 70 feet within the areas of heavy precipitation. How great a quantity of water this depth of snow represents we have no means of knowing, but ordinary rules of estimation will not apply here, for by far the larger proportion is extremely wet and heavy when it falls. As to the amount of water that comes down as rain during the balance of the year we are in entire ignorance.

It is evident from the distribution of the forest and, in general, of the entire flora that there are certain areas in the Clearwater basins which have a much heavier rainfall and snowfall throughout the year than others. Such tracts are marked by the exceptionally dense growths of timber on them and by the occurrence of plants and shrubs which require a great deal of moisture. They are situated along definite lines, evidently determined by the trend of adjacent ridges, and are noted among the trappers and hunters, whose work takes them into the Clearwater areas in the winter, for the immense accumulations of snow on them. The regions thus affected are, in general, all the front ranges along the western edge of the reserve and their eastward extensions for distances varying from 15 to 25 miles, and the direct western slopes of the main range of the Bitterroots. The effects of heavy snowfall and rainfall are much less marked on the tracts situated between the two regions noted above and along the Salmon River divide. The areas in the Clearwater basins which receive the least precipitation are the main valleys and slopes of the Lochsa and Selway forks.

LIST OF FOREST TREES GROWING IN THE BITTERROOT FOREST RESERVE IN IDAHO.

Abies grandis Lindl	Great silver fir.
Abies lasiocarpa (Hook.) Nutt	Alpine fir.
Juniperus scopulorum Sarg	Mountain juniper
Larix lyallii Parl	Lyall larch.
Larix occidentalis Nutt	Western larch.
Picea engelmanni Engelm	Engelmann spruce.
Pinus albicaulis Engelm	White-bark pine.
Pinus monticola Dougl	Mountain white pine.
Pinus murrayana Balf	Lodgepole pine.
Pinus ponderosa Laws	Western yellow pine.
Pseudotsuga mucronata (Raf.) Sudw	Red fir.
Taxus brevifolia Nutt	Pacific yew.
Thuya plicata Don	Pacific arbor vitæ.
Tsuga pattonii (Jeffrey) Coville	Alpine hemlock.
Populus balsamifera Linn	Balsam.
Populus tremuloides Michx	Aspen.
Populus trichocarpa Torr. & Gr	Black cottonwood.
Salix nuttallii Sargent; chiefly the variety brachystachys Sargent	Nuttall willow.
Betula occidentalis Hook	Western birch.
Alnus rhombifolia Nutt	Mountain alder.
Cercocarpus ledifolius Nutt	Mountain mahogany.
Amelanchier alnifolia Nutt	Western service tree.
Cratægus douglasii Lindl	Western haw.
Cratægus macracantha (Lindl.) Loud	Large-flower haw.
Prunus emarginata (Dougl.) Walp	Bitter cherry.
Prunus villosa (Sudw.) Cov. & Leib	Woolly-leaf cherry.
Acer glabrum Torr	Dwarf maple.
Rhamnus purshiana DeC	Bearberry.

The deciduous-leaved trees, except the balsam, black cottonwood, and western birch, are sometimes mere shrubs, no matter how far advanced in age. The conifers always eventually attain to the stature of trees if uninjured.

DESCRIPTIONS OF THE CONIFERS.

ABIES GRANDIS Lindl. (Great silver fir).

The great silver or lowlands fir, also called white fir, is the largest of the true firs in the reserve. It is found throughout the entire area within an altitudinal range that varies from 2,000 to 7,000 feet in the central and western portions of the reserve to 6,000 feet near the main range of the Bitterroots in the eastern portion. It presents two forms of development: (1) Small trees 50 feet to 75 feet in height, with diameters rarely exceeding 16 inches, having a thin, nonfurrowed, greenish bark, with numerous prominently raised resin vesicles. In this state the tree has no distinct clear trunk, the long and sloping branches of the permanent crown commencing near the ground. This form is of rapid growth and short lived. It is of no value commercially, but sometimes springs up in the greatest abundance on ground newly burned over, and thus prepares a suitable seed bed for the advent of the more valuable coniferous trees. (2) A tall form of the tree of much larger growth, reaching 200 feet in height and diameters up to 5 feet. It has large, clear trunks, which are one-third to one-half of the total length of the tree. The crown consists of short branches diverging at right angles to the trunk. The bark in mature trees is deeply fissured and quite free from resin vesicles. Its range is with the smaller form throughout the reserve below subalpine areas. In numerous localities a large percentage of the forest is composed of this type of the species, as on the ridges west of Newsome Creek, in the southwestern portion of the reserve, where on many of the slopes it occurs as an old growth, 200 to 400 years old, constituting fully 90 per cent of the total forest growth between elevations of 3,500 and 6,500 feet, and attaining a greater development in point of numbers of mature trees than anywhere else in Idaho. The trees here are comparatively low, averaging between 60 and 90 feet in height, but the diameters are large, many reaching 5 feet and a majority reaching between 3 and 4 feet. The larger form of this species, when fully developed, much resembles the white fir (*Abies concolor* Lindl.) of the region farther southwest. In fact, the differences are so slight and obscure that none but the trained botanist can detect them. The quality of timber obtained from mature *Abies grandis* is practically the same as from *Abies concolor*. The tree is seldom utilized for lumber, being defective in many ways. The small form is too knotty and the wood too spongy to be of any value. The larger form usually develops wind shakes with age. Great quantities of fermenting sap are apt to collect in such fissures, which increase in size with each winter, owing to the expansion of the frozen sap. The wood of the larger form is soft and moderately close grained, but warps easily. The tree is very sensitive to the effect of forest fires in its young stage, less so when older, but it is never at any age a fire-resisting tree. In young trees the resin vesicles, which are rather superficial and stand out like blisters, are extremely inflammable. When they burn the bark is destroyed and the tree dies. In mature individuals, where the resin vesicles have entirely disappeared from the bark in the process of evolution from the smooth-barked state to the deeply-fissured one, there is very commonly found a resin streak extending from the crown to the base of the trunk. This resin streak is the superficial indication or mark of a deep-seated fissure in the body of the tree, often extending from the periphery to the center. The cause of these fissures is obscure, but is likely due to some vegetative process. In a forest fire the flames follow the resin streak to the crown of the tree, more or less completely destroying the foliage. These modes of destruction are, in addition to the one produced by the cooking of the roots embedded in the flaming or incinerating humus, a mode of destruction common to all the species of forest trees excepting the western yellow pine.

In the Bitterroot Reserve the species is not a free seeder. Doubtless many successive years may pass without cone production over large areas. No cone-bearing individuals were seen by me during the summer and fall of 1898, though thousands of trees were examined. Near my home, at Lake Pend Oreille, are a group of trees of this species about 150 years old, vigorous of growth and in good condition. They have been under my observation for a period of twelve years. During this time none of them have produced any cones.

The cones are produced on short branches near the top of the trees and but few at a time. I estimate about 100 years as the age at which the species begins to perfect cones and seeds. In this latitude the cones mature in the latter part of August or the beginning of September. The seeds are liberated by the disarticulation of the cone scales from the rachis or central column of the cone. This is not a very rapid process, requiring from one to one and a-half months, depending upon the situation of the individual with reference to the more or less free sweep of the wind. In sheltered localities the entire winter is sometimes required for the complete disarticulation of all the cones upon a tree. The seeds are broadly winged. Where free traverse of wind exists they are wafted widely about. In other localities most of them fall close to the parent tree. A very large percentage of the ovules develop into perfect seeds.

Germination begins very soon after liberation of the seed. It is not necessary that they should be covered. Cotyledons and radicle develop upon mere contact of the seeds with the wet humus. Should the humus upon which the seeds are resting dry out, germination is arrested and death follows. Germination takes place readily upon burned areas well supplied with moisture as soon as the brush growth, the first stage in the reforesting process, is well under way. It takes place much less freely when the tracts have become grassed over, but in all cases the rapid reproduction of the tree upon any area is a very uncertain matter, owing to the intermittent cone production. In spite of the terebinthine character of the seeds, squirrels are very fond of them and store up large quantities of the cones for winter food.

The root system of the tree is shallow and does not spread very widely. There is a short conical taproot on the younger trees, which usually disappears as age comes on. The upward growth of the tree is indefinite in duration unless the leader is killed by external injury, which commonly happens when an individual reaches any considerable height above the general level of the surrounding forest. Wind or snow breaks it off and the upward growth is arrested.

Little or nothing is known in regard to the diseases of the species. Decay at the root and at the center of the trunk, both doubtless caused by fungi, are of more frequent occurrence than any other form of disease. No species of the mistletoe family (the Loranthaceæ) infest the tree in this region.

The port of the small form of the species is symmetrical and graceful where not crowded by too close growth of other trees. The large form is symmetrical in trunk development, but the crown is very irregular, owing to the branch growth not maintaining an even balance around the trunk.

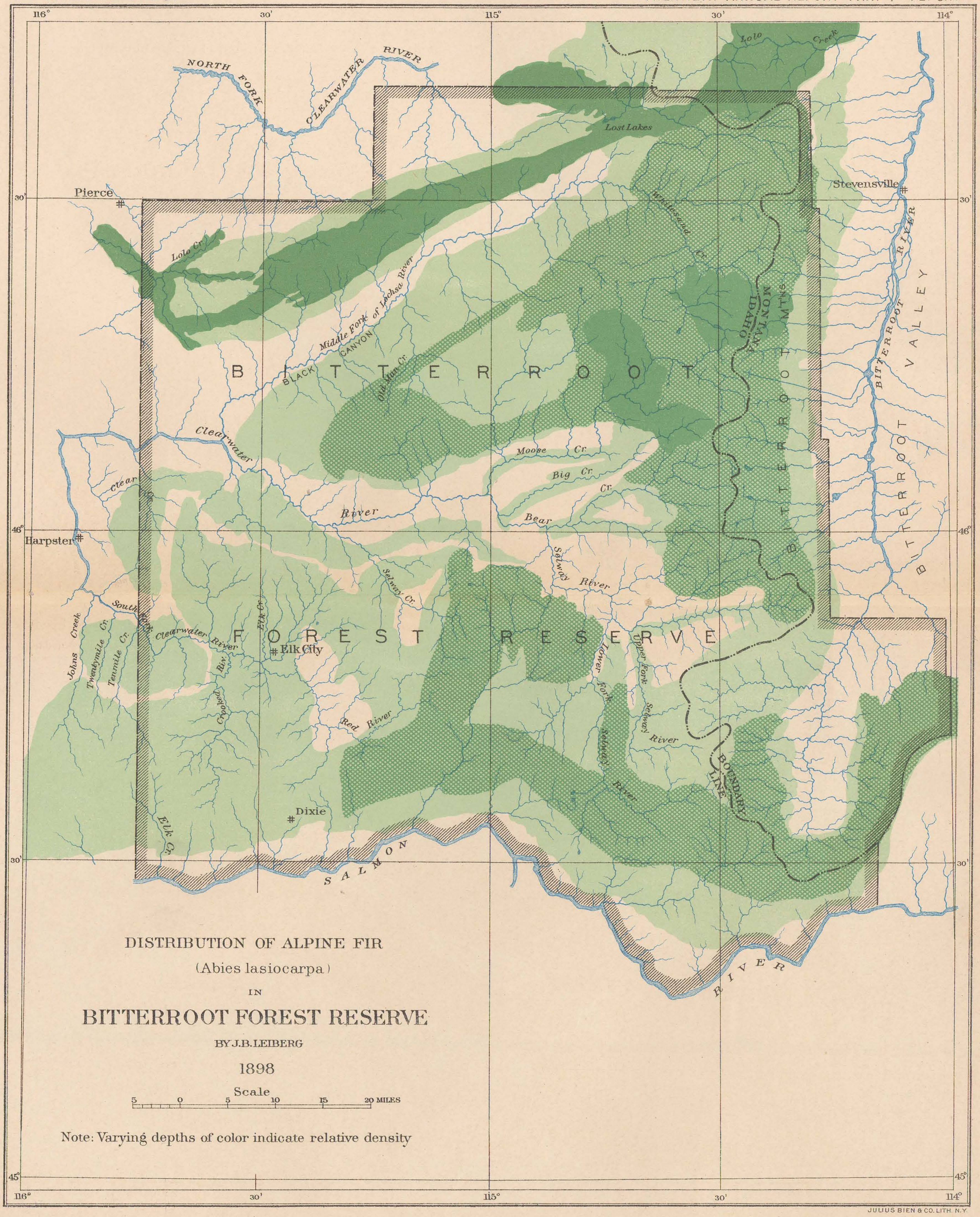
The species forms about 6 per cent of the forest growth in the reserve, and the total stand is 422,200,000 feet.

ABIES LASIOCARPA (Hook.) Nutt. (Alpine fir).

The alpine fir grows in great abundance throughout the reserve and has a wide altitudinal range (Pl. CXVII). Essentially it is a tree of the ridges above 5,500 feet elevation, but it often descends to altitudes of 3,000 feet in valley bottoms where suitable temperature and moisture conditions prevail. On the high ridges and slopes, associated with Engelmann spruce, white-bark pine, and sometimes alpine hemlock and Lyall larch, it forms the upper of the three chief types of forest in the reserve—the alpine-fir type. Within its chief altitudinal range there are no localities in the reserve where the species especially predominates, but owing to past forest fires the ridges of the Salmon River divide and those in the central areas of the South Fork of Clearwater Basin have a smaller percentage of the species than the areas farther north.

The alpine fir is a small tree, never reaching the dimensions of the large form of the great silver fir. At elevations of 6,000 feet and upward it is low in stature and commonly of slow growth, averaging 30 to 50 feet in height, with diameters up to 18 inches and showing age limits of 100 to 160 years. In low, swampy valleys, as along the Musselshell, Brown Creek, and other tributaries of the middle sections of the Lolo Fork of Clearwater, the tree is of larger and more rapid growth, attaining 60 to 90 feet in height, with diameters up to 2 feet and age limits that often do not exceed 75 years for these dimensions (Pl. CXVI, *B*).

The species shows two types of development, resembling in this the great silver fir. One is a smooth-barked form; the other has deeply-fissured bark. Unlike that tree, however, the form with deeply-fissured bark does not develop larger dimensions than the one with smooth bark, often not so large. The fissuring of the bark in the two species



DISTRIBUTION OF ALPINE FIR

(Abies lasiocarpa)

IN

BITTERROOT FOREST RESERVE

BY J. B. LEIBERG

1898

Scale

5 0 5 10 15 20 MILES

Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

of firs of northern Idaho is a very prominent feature of their vegetative characters and is, at least in the case of the alpine fir, in no wise connected with their age. The phenomenon appears to represent a distinct evolutionary type or period in the general life history of the species. Many of the individuals of the alpine fir grow to a very advanced age and decay without exhibiting any trace of the bark-fissuring process. Others reach the stage where the fissuring begins at a very early age. Between the two extremes are many intermediate phases. The rough-barked forms are the most vigorous in their vegetative processes.

The wood of this species of fir is soft, spongy, and unfit for lumber. The more rapid the growth has been, the softer the wood. At high elevations the tree is deficient in clear trunk development; at low elevations one-third to one-half of the total length of the tree is clear trunk; but much depends upon the general density of the surrounding forest in regard to this, open growth favoring branch development at expense of trunk, close growth doing the reverse. No use is made of the wood. In common with the great silver fir it would doubtless furnish a fair article of paper stock, being fibrous in texture and free from resin. If cut green and allowed to season, the timber of the species, when grown at high altitudes, becomes hard and dense, but develops numerous seasoning cracks. The chief use of the tree lies in its abundant growth on the areas of heaviest snowfall, where it becomes an important factor in screening the snow masses from the direct rays of the spring and early summer sun. In this way it is an important tree in the regulation of the year's run-off in the subalpine regions. The tree possesses a low fire-resisting power—as low as, if not actually inferior to, that of the great silver fir. The bark, previous to the completion of the fissuring process, is well supplied with large, sometimes extremely large resin vesicles filled with balsam, which ignites readily. The variety with fissured bark resists fire much better.

The tree is a moderately-free seeder and cone producer. It often misses a season or two over immense areas, completely failing to perfect its cones. The cause of this failure is obscure. Young cones are produced in abundance, but do not develop beyond an inch or so in length, then they die, dry up, and remain on the tree for a year or two. During the season of 1898 I did not see a tree of this species with mature cones in the reserve. The cones are produced on short, horizontal branches near the top of the tree, few at a time. Cone production begins early. I have seen trees 20 years old mature perfect, well-fertilized cones. Such young trees, while producing cones, do not apparently produce staminate buds or flowers, but are fertilized from the older trees. Whether this is a regular or merely an accidental phase I can not say, as my observations on this point are not extensive enough. The bulk of the ovules are fertilized and develop into perfect seeds. Dispersion occurs, as in the great silver fir, by disarticulation of the scales from the rachis, beginning at the summit of the cone and extending downward. The seed wing is large, and, owing to its growth at high elevations, where the winds are strong and have free traverse, the seeds are wafted to long distances. The cones mature and seed dispersion occurs in August, hence earlier than in the case of the great silver fir. Germination of the seed is apparently not so rapid as in that tree. Observations upon this point are deficient, however. The presence of a certain amount of humus appears to be indispensable to germination and growth; at least it is noticeable that the tree does not readily spring up on burned-over areas until the brush period is well advanced, sometimes not until after a growth of lodgepole pine has sprung up and grown to maturity, involving periods of 90 to 150 years. A peculiar feature of the species consists in its almost complete extinction upon various areas, due to obscure natural causes. One meets such tracts everywhere, At subalpine elevations, where most of the trees have died and lie prostrate, the ground has become covered with a growth of *Menziesia* shrubs, and no saplings of the species are springing up to take the place of the dead forest. In the reserve as a whole, however, the species is maintaining its stand and making slight gains on all but the freshly-burned areas. The gains are chiefly along the Salmon River divides, where portions of the lodgepole growth have arrived at maturity and are beginning to give way to the genuine alpine-fir type of forest.

The root system of the species is shallow. The trees are therefore easily uprooted by strong winds. Its roots endure a superabundance of soil moisture much better than do the roots of the great silver fir. Very often the place of growth is around springy, marshy meadows, which the tree surrounds with a dense fringe of forest. Its upward growth is indefinite and is only arrested upon decay of the trunk or some other form of injury. An injury to the leader is repaired by one of the lateral branches becoming leader in its turn. Were it not so the species could not exist in the regions of heavy snowfall. It is indeed rare to find a tree of any size with the original leader unbroken. The tree possesses a peculiarity not found in any of our other conifers. This consists in the development at mature age, or, more commonly, in the retention from the sapling state, of a fringe of long, ascending branches from near the base. A layer of decaying humus gradually accumulates and covers these branches to a distance of 3 to 5 feet from their origin in the trunk of the tree. An examination of them will show that they root in the accumulation of humus. Gaining a more erect position with age, they resemble a fringe of saplings set around the parent tree, and are then capable of maintaining an independent existence. It is chiefly on high ridges, where the trees are separated by considerable intervals, that this mode of growth occurs.

The growth serves evidently as a sort of mulch to afford shade and to preserve the humidity of the soil directly above the root system during the severe heat of the dry season of July and August.

The diseases of the species are obscure and have been little, if at all, investigated. In addition to the ordinary rot at the root and center of the trunk, to which it is much subject, there are species of fungi attacking the foliage, causing it to drop and the tree to die. Another disease, due either to fungi or to the stings of insects in youth, causes swellings to form on the main trunk and branches. On the branches these swellings vary in size from a marble to a large apple, and are arranged one beyond the other with a short interval between. On the main trunk they are often 18 to 20 inches in diameter. The latter form may, however, be distinct from the former. In texture they are harder than the wood of the tree. None of the mistletoes grow on the tree here.

The species forms about 5 per cent of the forest growth in the reserve.

JUNIPERUS SCOPULORUM Sarg. (Red juniper).

The red juniper is a small, straggling tree 10 to 25 feet high, with diameters up to 5 inches. It occurs along the lower Middle Fork of the Clearwater; therefore barely within the reserve limits. It is too scanty in quantity to form any noticeable proportion of the forest growth.

This western juniper is now named *J. scopulorum* and is regarded as a distinct species. It is an undersized, depressed tree, much branched even from the base, and is sometimes only a mere shrub. It grows in rocky situations, clefts or crevices of bare ledges, or in hard, gravelly soil, rarely, within our limits, away from the proximity of running water. In central Idaho it does not range across the mountains unless it be at the unexplored heads of the Salmon. In northern Idaho it extends across the State into Montana along Clark Fork, reaching the Columbia Valley by way of Pend Oreille River. From the Columbia up the Snake River, thence up the Clearwater is doubtless the route by which it reaches the Middle Fork of Clearwater River.

LARIX LYALLII Parl. (Lyall larch).

The Lyall larch is essentially the timber-line tree in the reserve. It is a tree of low stature, but occasionally of large diameters. Its chief habitat is at altitudes above 7,500 feet, where it thrives in the rockiest soil and in crevices of the broad, rugged, granite slopes where soil is scarcely to be seen. Its range in the reserve is on the summits and slopes of the main range of the Bitterroots from Lolo Pass, where it enters the reserve from points farther to the north, to within a few miles of Nez Perces Pass, at the head of the West Fork of the Bitterroot River. Farther to the west, on the divide between the Lochsa and Selway basins, it is found in small, detached groves on a few of the higher peaks and summits in the region about Grave Peak. It is a tree of slow growth, living to a great age. It usually shows a clear trunk, which varies in length from one-third to one-half of its total height. It is of no economic importance, being too scarce and growing only in the most inaccessible places. The average height of mature trees is 25 to 40 feet; diameter, 2 to 4 feet; age, 200 to 400 years. Its amount in the forest of the reserve is insignificant.

The Lyall larch is the tree above all others in the reserve that is fashioned to withstand successfully the rigorous climatic conditions prevailing on the high and bleak summits of the main Bitterroot Range. With a light and graceful foliage, offering slight resistance to the winter's blasts, a compact, strong trunk, and a root system firmly anchored in the crevices of the underlying rocks, it can bid defiance to winds of any violence, and it is very rarely, indeed, that one sees an individual of this species uprooted. Fires have not damaged the growth of the species, partly because it is not readily fire killed, but chiefly owing to its isolated mode of growth. It sometimes produces cones abundantly, many of which remain on the tree until the following spring, but in general its reproduction is poor. One rarely sees any seedling trees or saplings of it. Its vegetative activity in the spring begins before the snow has disappeared. On the Grave Mountains in July I found many trees putting out leaves while they were standing in 6 to 8 feet of snow. The only disease observable on the species consisted of large, irregular swellings on the trunk, due to some unknown cause. If rot occurs the species must be exempt from it to a very advanced age, as none was noted. No varieties of the mistletoe family were observed on the species.

LARIX OCCIDENTALIS Nutt. (Western larch).

The western larch is not a tree of universal occurrence in the reserve. Its range is confined to the northern and western areas, which may possibly mark the boundary of its southward range in Idaho. Within the reserve limits it is found as follows: (1) Along the northern boundary on the ridges, slopes, and valleys that drain into the North Fork of Clearwater River, extending from the western edge of the reserve to the distinctly subalpine areas of the main range of the Bitterroots, a distance of 8 to 10 miles west of the crest; (2) throughout the valley of the Lolo Fork and its tributaries; (3) along the valley of the Lochsa, chiefly on the south bank, where it rarely extends more than three-fourths of a mile to 1 mile back from the river; (4) in the western portion of the basin of the South Fork of Clearwater River, where it follows southward the ridges between Newsome and Elk creeks to their junction with the Salmon River divide. At this point it turns eastward and continues along the Salmon River divide and the higher summits of the lateral ridges to a point about 6 miles east from the head of Crooked Creek, a Salmon River tributary. It also occurs as scattered trees on the ridges between Newsome Creek and Camas Prairie and on the divides between the South Fork of Clearwater River and the Middle Fork of the stream, where it connects with its range in the Lochsa Valley. Formerly the species extended farther eastward than it does now. I found numerous prostrate and standing dead trunks of the tree in the dense lodgepole-pine forest on the Salmon River divide to within a few miles of the Little Salmon Valley, where now not a living individual, large or small, can be found.

In this region the altitudinal limits of the species are subject to great variations. In the northern areas of the reserve they rarely exceed the 6,000-foot contour, ranging thence down to elevations of 3,000 feet. The region of heaviest growth is between the 3,800-foot and 5,300-foot contours. In the South Fork of Clearwater Basin the upper limit of its growth is about 7,000 feet above sea level, thence down to the 4,500-foot contour. Its heaviest growth occurs between 5,000 and 6,500 feet.

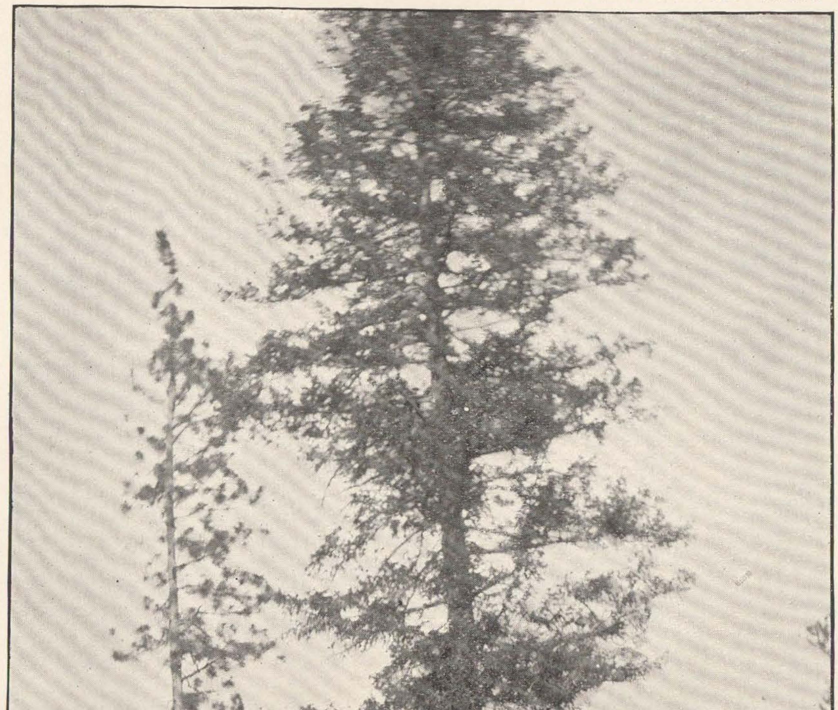
There is but one pronounced vegetative type of the tree, which shows variations due only to age. In youth the tree is rough barked, with nearly straight, longitudinal fissures, the trunk development is rapid and ample, and the crown is symmetrical. With age the bark becomes thin and close, with shallow, irregular fissures; the peripheral trunk development is often excessively slow; the upward growth is much checked or ceases altogether, and the crown loses its symmetry. At the base of the tree, however, and extending 3 to 6 feet from the ground, the bark remains rough and the fissures increase in depth, being sometimes 6 to 8 inches deep in old individuals.

In the reserve the tree occurs as an old growth and as a second growth after forest fires. The old growth is mostly confined to the ridges and slopes in the basin of the South Fork of Clearwater and the Salmon River divide, but veteran individuals also occur mixed with the lodgepole-piné growth in the valleys of the Lolo Fork tributaries. In these localities the tree reaches dimensions that vary from 60 to 150 feet in height, 1½ to 4 feet in diameter, with clear trunks 30 to 90 feet in length, at ages of 150 to 400 years. In the northern areas of the reserve the species occurs chiefly as a second growth with smaller dimensions, the average being 30 to 80 feet in height, 12 to 20 inches in diameter; clear trunks, 20 to 40 feet in length; age, 90 to 120 years.

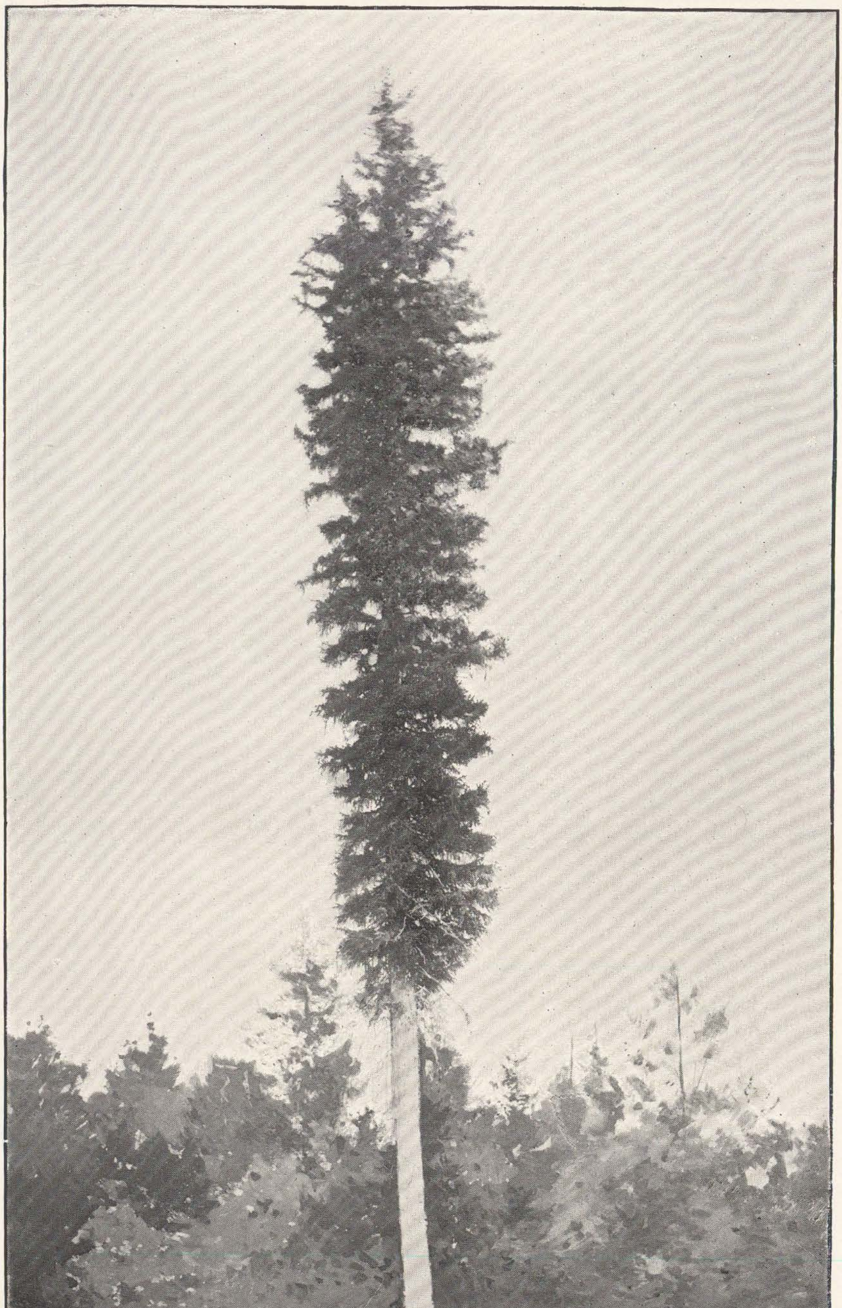
The species is of great economic value, particularly so between the ages of 40 to 80 years. It is then much used for railroad cross-ties, being next to the red fir the most valuable tree for this purpose in the reserve. Stands of this age exist in moderate quantities in the northern areas and along the Lochsa. There is little or none on the tracts in the South Fork of the Clearwater Basin. The old growth is not commonly utilized. There is a prejudice against the lumber manufactured from it. Around Elk City and Dixie I saw quantities of shakes made from large, mature trunks of the species. They had split out from the blocks as smooth and straight as if made from Pacific arbor vitæ.

The tree resists forest fires moderately well—much better in its youth than when mature or far advanced in age. A great heap of rubbish accumulates around its base composed chiefly of flakes of bark shed from the upper portion of the trunk. A mass of this sort of litter will burn for an hour or two before it is reduced to ashes. If there is a gum crack in the basal portion of the tree, which frequently happens, the fire is sure to be communicated to it, and a hole is burned in the trunk as the result. The thick, deeply-fissured bark which persists on the lower portions of the trunk, helps very materially to support the fire. Resin streaks containing gallons of a soft, limpid, terebinthine balsam often exist in the trunks as a result of wind shakes where the tree grows in the open without sufficient support from the adjacent forest, and large, irregular swellings abundantly supplied with balsam cracks are of common occurrence in the upper or crown portion of the tree. These resin streaks and balsam cracks are extremely inflammable. It is not unusual to see trees with the clear trunk untouched by the fires exhibit large holes in the crown portion where the flames have followed the balsam swellings into the interior of the tree. In such cases the top soon breaks off and the lower and uninjured section of the individual dies.

The tree is a free and abundant seeder in the northern tracts of the reserve, but is noticeably deficient in this respect on the southwestern areas. Of the thousands of individuals examined here not a dozen trees bore cones and they carried but a scant quantity. Normally the species produces cones in abundance, about two-thirds of the length of the crown having cone-bearing branches. Forty to fifty years is about the age at which the tree begins to produce seeds; in individual cases as early as twenty-five years; at other times one hundred years may pass before the cone-bearing period arrives. The seeds mature in August or September and are shed by the opening of the cone scales. As they open freely only in dry weather and close during rains, the process of seed dispersion is not rapid; sometimes not being accomplished before the following spring. In consequence, much of the seed is scattered on the snow. A large percentage of the ovules produce perfect seeds. Reproduction of the species within the reserve limits is good on the northern areas; deficient on the southwestern. The aspect of the growth on these latter tracts gives an observer the impression that the species is slowly disappearing as a component of the forest. Seedlings or saplings are here extremely rare except upon a few minor tracts near the head of Crooked River,



TYPES OF ENGELMANN SPRUCE, SELWAY BASIN.



TYPES OF ENGELMANN SPRUCE, SELWAY BASIN.

and the old growth is fast being exterminated by the forest fires. The seeds evidently germinate readily, for where suitable conditions prevail the tree springs up in immense numbers. Burned-over areas upon which a moderate brush growth has obtained a good foothold, when favorably situated with reference to a high degree of soil humidity and on elevations below 4,500 feet, are the favorite places for a heavy stand of seedlings or saplings. In the northern areas of the State on such ground the tree sometimes crowds out all other species. A locality of this sort in Kootenai County, Idaho, burned about sixteen years ago and under my observation for the past twelve years, now carries from 10,000 to 15,000 saplings, 4 to 6 years old, to the acre. Originally the stand was composed of a mixed forest of red fir, great silver fir, and western tamarack, and the tamarack did not reach a higher percentage than 25. It is now 99 per cent. In the Bitterroot Reserve there is no evidence that the species is gaining on the other components of the forest. On the contrary, it is losing on the whole. Its area of greatest density as regards young growth is in the Musselshell and other valleys of the Lolo Fork Basin and on the ridges of the same, a distance of 20 miles east from the Lolo trail crossing of the Musselshell.

The root system of the tree is well developed. The taproot is not very long, but the primary laterals are strong, deeply-penetrating roots, with a firm hold on the soil, and are usually very evenly balanced on all sides of the trunk. The tree is, therefore, not easily uprooted, but the strain produced by high and strong winds expends itself on the trunk and creates the large wind shakes for which the species is notorious. Both the upward and peripheral growths are of indefinite duration if not arrested by external causes. I have seen specimens 220 feet in height in which the leader was still vigorous.

Many diseases afflict the species. Rot of various kinds at the root, periphery, and center of the tree is common, also a fungus that shows as black, sooty patches or streaks on the bark and causes deformities in the development of the trunk. An undescribed species of mistletoe, a *Razoumofskya*, is a pest that almost invariably accompanies the tree in Idaho. It is to the growth of this parasite that is due the formation of large, irregular lumps on the crown portion of the trunk.

The species forms about 1.8 per cent of the forest growth in the reserve, and the stand of merchantable sizes is 250 million feet B. M.

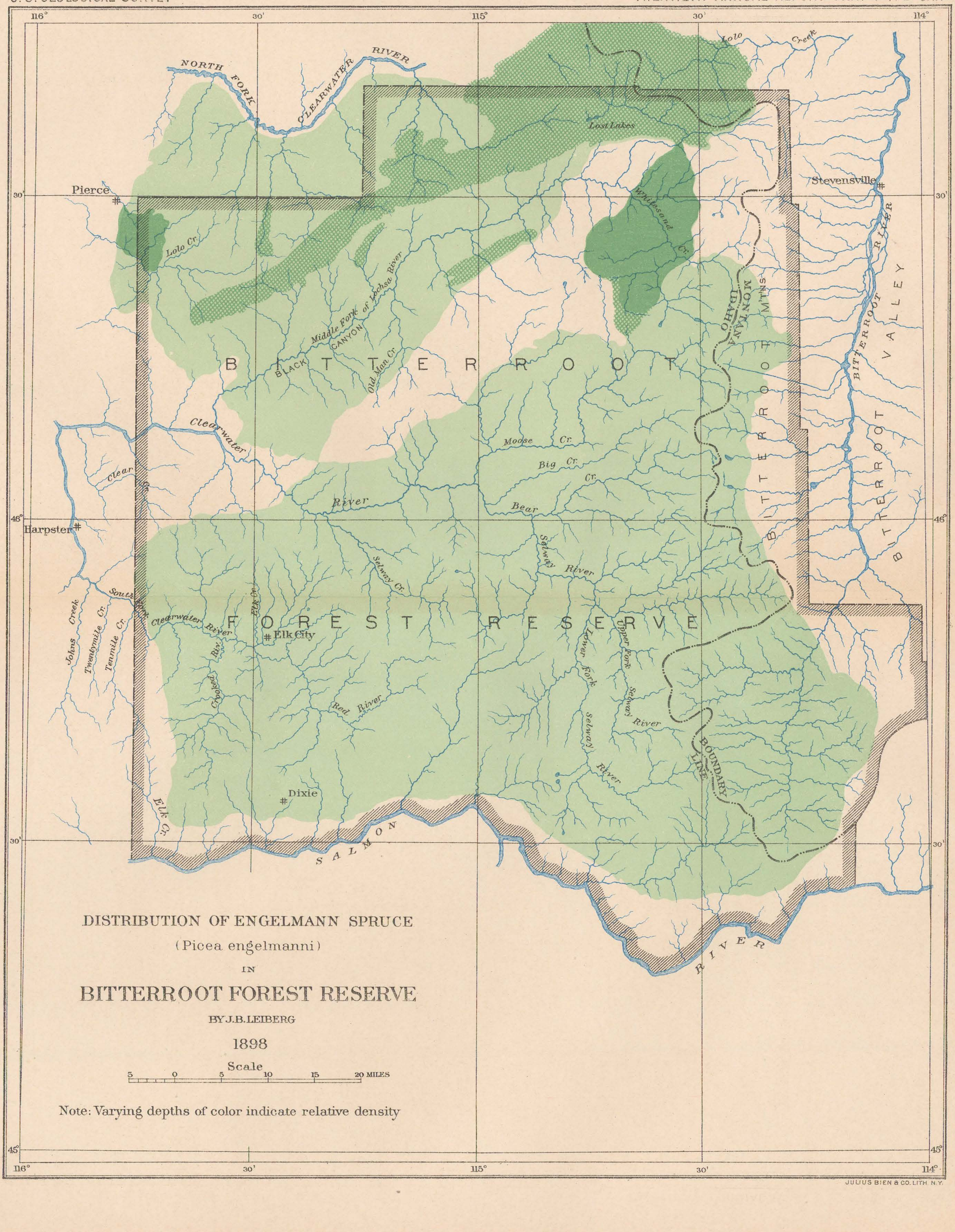
PICEA ENGELMANNI Engelm. (Engelmann spruce).

The Engelmann spruce, the only one of the genus within the reserve, is here of wide distribution (Pl. CXX). It occurs everywhere at all elevations, with the exception of certain tracts along the crest of the main Bitterroot Range, where essentially alpine conditions prevail. The species thrives best, however, between elevations of 4,000 and 7,000 feet, on slopes and in valleys where the required humidity is present.

There is but one truly distinctive type of the species, which, however, assumes two aspects, depending upon soil, moisture, and climatic conditions. The form most commonly seen in the reserve has a symmetrical, well-balanced branch development and a tall or short trunk, with small diameter, on which the lowest living branches begin not far above the ground, thus leaving no clear trunk. The other form of the tree is tall, with a long, clear trunk. This form prevails on areas of old growth. The tree most plentiful in the reserve—the low, much-branched form—is commonly a second growth, but occasionally is found with age limits up to 250 years. It grows on ridges and slopes, in the wet bottoms of valleys, and fringes the margins of lakes and pools throughout the reserve. In company with the alpine fir and white-bark pine it composes much of the alpine type of forest. In height it varies from 30 to 80 feet, with diameters up to 2 feet and age limits up to 160 to 175 years. The stand is often very dense, and in general the tree may be said to be of very great value as a factor in the equalization of the season's run-off, especially from the subalpine areas. The tall, clear-trunked form of the species is always an old growth. Sometimes small stands of it are sandwiched in between masses of lodgepole pine, great silver fir, or mountain white pine. These are remnants of an old growth which once existed over large areas but which has long since been consumed by fire. In other cases tracts of considerable extent are forested with growths of the species 75 per cent pure. Of such the region north and east from Grave Peak is an example, and the only one in the reserve. The tree here reaches heights of 80 to 100 feet, with diameters up to 3 feet, clear trunks from 20 to 40 feet, and age limits of 250 to 350 years (Pls. CXVIII and CXIX).

The commercial value of the tree as it grows in the reserve is low. There is not sufficient of the old growth on accessible areas. The much-branched tree is valueless, owing to its knotty character. The large form furnishes a soft, nonresinous, white lumber, sometimes clear, but commonly with some knots scattered through it; not enough, however, to render it unsuitable for many purposes where lumber is used.

The fire-resisting qualities of the tree are low. The older the individual, the easier it succumbs to the flames. There is nearly always a heap of litter at the base of the older trees, and with advancing age the species has a fashion of partly raising itself out of the ground. I presume this is caused by strong upward pressure exerted by the big primary laterals of the root system when they impinge upon the underlying, solid bed rock. Whatever may be the cause of this lifting of the tree, the result is the elevation of the root crown above the soil,



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accompanied by more or less fracturing of the surrounding wood and the formation of pitch streaks; together causing an ideal condition for rapid destruction of the tree by fire.

Bears and porcupines have a peculiar penchant for the bark at certain seasons and strip off a triangular piece near the base, when food of this sort is wanted. It is really surprising to observe the many thousands of trees scarred in this manner. Each scar develops a dry zone on the wood and a resinous fringe of bark around it, both highly inflammable.

The species is an extremely free seeder and abundant cone producer. The pendulous cones are borne on the upper two-thirds of the crown, mature in the middle and latter part of August, and, owing to their thin, papery texture, the scales open quickly for the dispersion of the seeds, after which the cones soon fall from the tree. Cone production begins at an early age, 25 to 35 years, and appears to continue without intermission until the tree dies. I do not recollect ever to have seen an individual of the species, of proper age, that did not produce its quota of cones in season. Nothing is known as to the germination of the seed in this latitude, in the forest. It may, and probably does, germinate and produce the young seedling in the fall of the year in which the seed matured, but it is by no means certain that such is the case.

The root system is shallow, though it spreads widely. The tree, therefore, is easily uprooted, especially where it grows in wet localities. Together with the alpine and great silver firs it produces a very large percentage of the litter in the unburned forests of Idaho north of the Salmon. The reproduction of the tree is good throughout the reserve, but is nowhere excessively abundant. Its increase is held in check by various diseases. Especially common is a fungus which affects the foliage and kills vast numbers of trees in solid blocks. Along the upper and middle portion of the Lochsa are tracts containing 2,000 acres upon which 95 per cent of the species are dead from this one cause. None of the mistletoes are known to infest it here.

The species forms about 11 per cent of the forest growth in the reserve and the stand is 505 million feet B. M. of commercial-sized trees.

PINUS ALBICAULIS Engelm. (White-bark pine).

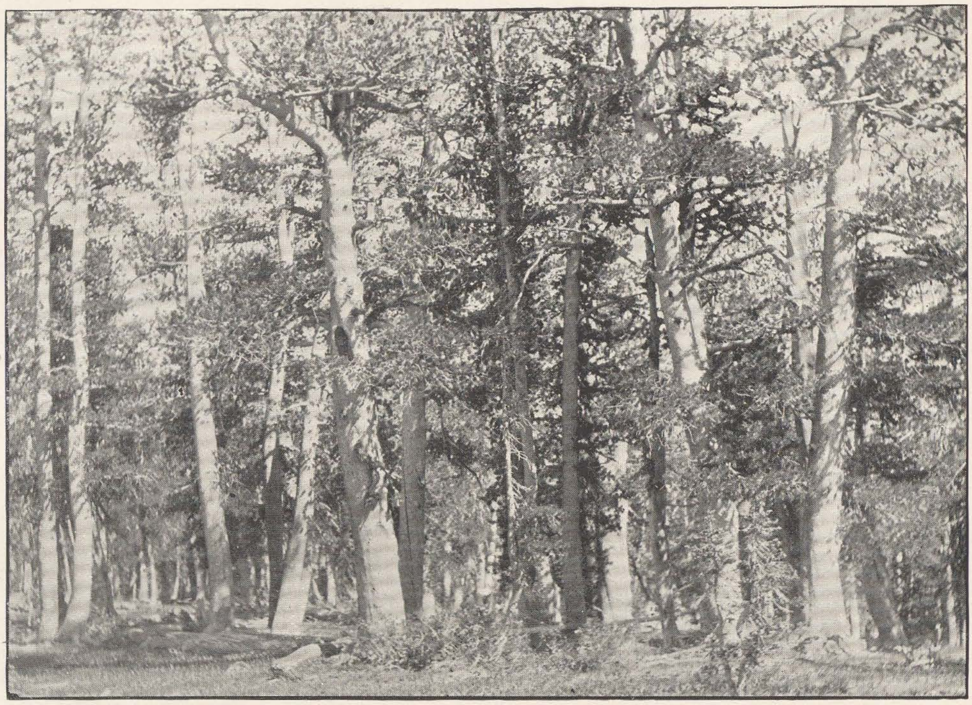
The white-bark pine inhabits the upper slopes and crest lines of the subalpine ridges throughout the reserve, generally not descending below the 6,000-foot contour. Associated with the alpine fir, and along the main divide of the Bitterroots with the Lyall larch, it forms the true alpine-fir type of forest. It is a tree of low stature, devoid of symmetrical proportions, the main trunk almost invariably dividing from the base and the crown composed of large, widely-spreading or ascending branches. The tree varies from 20 to 40 feet in height and 1 to 4 feet in diameter, with clear trunks 10 to 15 feet. The age limits are between 80 and 400 years. While widely distributed over all the subalpine areas of the reserve, it is found in much greater abundance in some localities than in others. The regions of densest growth are on the ridges of the upper portion of the Selway Basin and along the main Salmon River divide east of Little Salmon Valley, where there are stands of the trees 85 to 90 per cent pure (Pl. CXXI, *A*).

The species is of no commercial value. It makes excellent fuel, but its habitat on high, inaccessible ridges places it beyond reach. It is sensitive to fires; more so in age than in youth. The roots and basal portions of the trunk are commonly very resinous and in consequence, invite rapid destruction from fire. It is of moderately-slow growth and is excessively deficient in cone production everywhere in the reserve. The decaying remains of cones on the ground beneath the trees prove that, in the reserve, five to ten years may intervene between periods of productiveness. It is noticeable that the species rarely fails to bear an abundance of staminate catkins. The cones are produced on the branches in the upper half of the crown, remaining on the tree 2 or 3 years if undisturbed. The scales open tardily and the seed dispersion may require a year or more after maturity of the cones. The seed is large, sweet to the taste, and is eagerly devoured both by the rodents that make their home at high elevations, and by various species of grouse. Owing to its limited seeding capacity the reproduction of the tree is poor. On areas where the fires have exterminated the species and the lodgepole pine has come in, centuries undoubtedly pass before it regains possession. The comparative scarcity of young growth and the many deforested grassy hillsides once covered with stands of this species indicate, in part, that centuries ago the species was far more abundant in this region, and that in modern times it is not holding its own, but is gradually being crowded out by alpine fir, lodgepole pine, and Engelmann spruce.

The tree forms less than 1 per cent of the forest growth in the reserve.

PINUS MONTICOLA Dougl. (Mountain white pine).

This species of pine, a stately, abundant, and very valuable tree in Idaho north of the Clearwater basins, is not well represented in this region, its southern extension in the State terminating in the valley of the Lochsa. The areas of heaviest growth within the reserve limits are in the central portions of the Lolo Fork Basin. Thence it follows the North Fork–Lochsa divide, extending into the valley of the latter stream, which it follows down to its junction with the Selway. On areas contiguous to the reserve it occurs sparingly in the central portions of the North Fork of Clearwater Basin, and in greatest abun-



A. WHITE-BARK PINE, PURE GROWTH, SALMON RIVER DIVIDE.

B. TYPES OF LODGEPOLE PINE, SALMON RIVER DIVIDE.

Growth is 45 to 120 years old and exhibits two periods of fires.

dance on the upper tributaries of the Oro Fino. Its altitudinal range in this region lies between the 3,000-foot and 5,500-foot contours, occasional trees being found up to the 6,000-foot level along the North Fork–Lochsa divide.

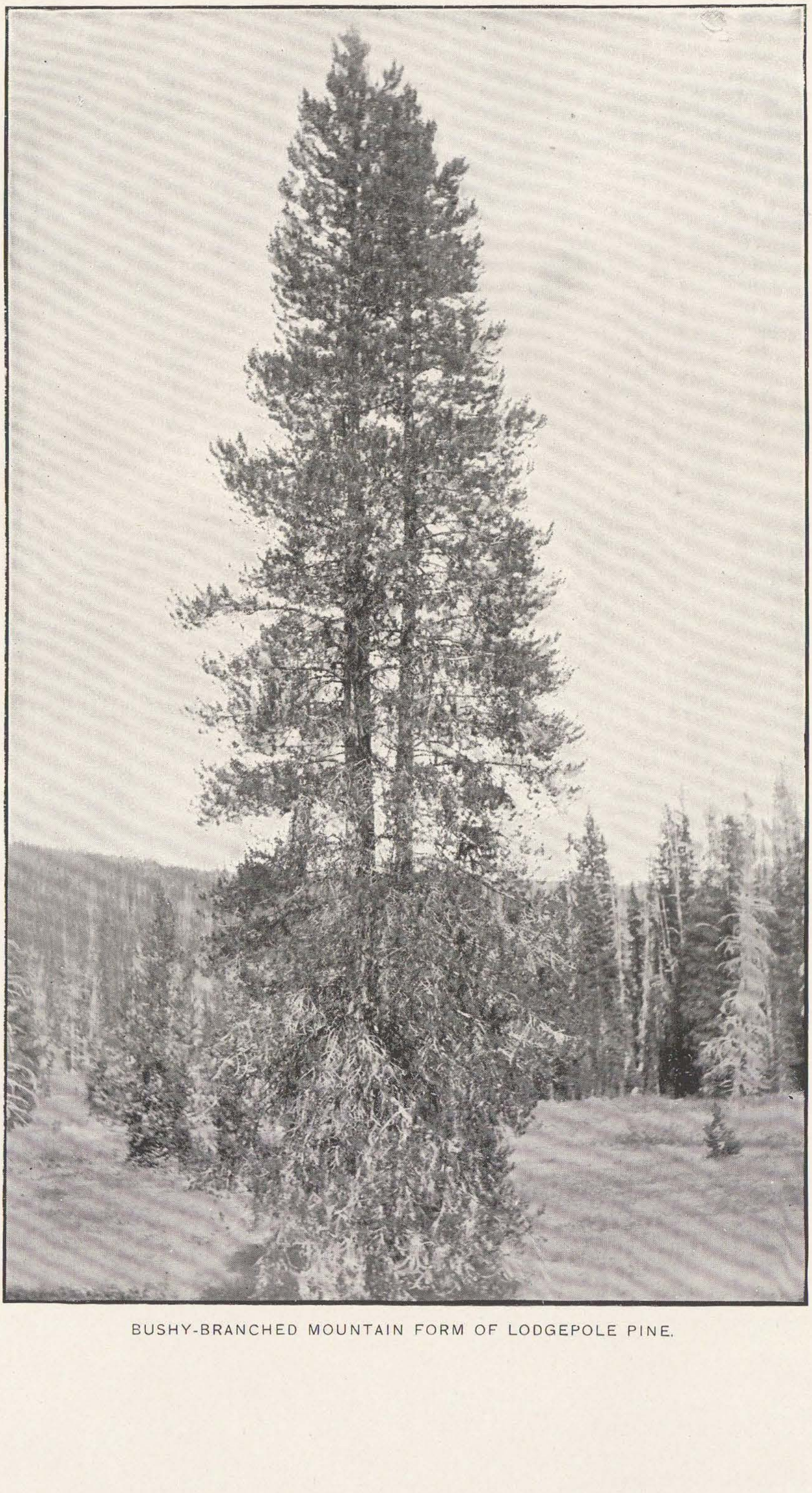
The mountain white pine appears under two forms, not specifically distinct but nevertheless readily separable as two dissimilar vegetative types. One of these is a tree having an average rapidity of growth and vigor, reaching 100 to 150 feet in height with a basal diameter up to 2 feet or more; bark, even in a young tree, dark colored and moderately deeply fissured; clear trunk development deficient even at the highest age; living or dead limbs in extreme abundance from the base to the top, many of the dead basal branches persisting throughout the life of the tree; the wood, in consequence, containing great numbers of small, hard, black knots. The other type is a tree that, in youth, develops extreme rapidity of growth; bark smoothish, light colored during the first century of growth, gradually changing to an ash colored, moderately-fissured one in old age or at maturity; lower branches soon dying and promptly falling away from the trunk, which finally bears a crown composed of short, straight branches. Mature trunks of this type form beautiful symmetrical columns 150 feet to 250 feet in height and 2 feet to 5 feet in diameter, which, while not entirely free from knots, furnish a high percentage of clear lumber. The determining factors of these types of development are unknown. It is neither soil, temperature, nor degree of humidity that controls them, for both types occur under precisely similar outward conditions. More likely it is some inherent quality in the vegetative processes that fixes the type assumed by the growing trees; the phenomenon in reality being an expression of evolutionary forces in the universal life of the species.

The species as it occurs in the reserve is represented chiefly by the lesser of the two types. Not alone is this true for the second growth, but the old growth also shows the same peculiarity. The larger form of the two types never prevailed to any considerable extent in this region, so far as the history of the tree can be traced back through its most ancient growths. It has been noted that the regions of densest stands on areas contiguous to the reserve lie between Pierce and Weippe, and in general on the head waters of Oro Fino and adjacent streams. The growth is of the lesser or branching type to the extent of 85 per cent. On some of these areas the stand is of remarkable density. Taking all trees with basal diameters of 10 inches and upward into account, the stand amounts to 350,000 feet, B. M., per acre on occasional tracts. These heavy stands are not at present of any value whatever for lumbering purposes. Throughout the Lolo and the Lochsa basins the tree is sometimes found of very large proportions. It then represents remnants of an old growth. The tree are isolated individuals, for the most part standing in a mixed forest, survivors from a time when more extensive bodies of the species existed upon these areas. The average dimensions of the tree in the reserve are as follows: for second growths, 80 feet to 120 feet in height, 1 foot to 2 feet in diameter; clear trunks none or 10 feet to 20 feet in length; age 90 to 120 years; for old growths, 100 feet to 180 feet in height, 2 feet to 5 feet in diameter; clear trunks 20 feet to 60 feet in length; age, 150 to 350 years.

The quality of the lumber obtained from the tree varies considerably according to the type of tree that is used. Generally, only the larger form is logged, the trees of which yield a white, soft lumber free from resin, but somewhat fibrous. Comparatively little of the species has as yet been manufactured into lumber, owing principally to the plentiful supply of the western yellow pine in localities that are much easier of access than are those where the mountain white pine mostly grows.

The species succumbs easily to forest fires. The trunks are practically nonresinous, except perhaps a very small zone at and around the center, therefore they do not burn, but the roots are cooked by the incinerating humus, and death follows. The thin bark of the young individuals is extremely sensitive to heat. If touched ever so lightly by the flames it is pretty sure to die, involving, as a matter of course, the destruction of the tree also. The habitat of the species is principally on tracts where an abundance of humus has accumulated in the course of centuries, and in which a very large proportion of the root system is embedded. When fire spreads through this humus, it destroys, with mathematical certainty, all individuals in its path. Owing to the susceptibility of the tree to fire, and its habitat on areas where the fiercest conflagrations commonly occur, the destruction on any particular tract that has been swept by a forest fire is seldom less than 90 per cent.

In the reserve the species is not an abundant cone producer and occasionally it misses a season altogether. It begins to bear cones at any age after 20 or 25 years, but the trees that are destined to grow into the larger form of the species do not reach the cone-producing stage so early, seldom attaining it short of 50 or 75 years. The cones are borne on the branches of the upper portion of the crown, singly or 3 to 5 in a cluster. The cones mature in July of the year following the one in which they first made their appearance. The cone scales are thin and open readily for the liberation of the seeds, which is soon accomplished. The seeds are often widely dispersed from the parent trees. I have known a burned hillside containing several thousand acres to become thickly covered with seedlings in the course of two years with no cone-producing individuals nearer than one-half mile of the locality. Germination of the seed may be rapid or tardy. Sometimes it takes place in the fall; sometimes not until the spring follow-



BUSHY-BRANCHED MOUNTAIN FORM OF LODGEPOLE PINE.

ing the dispersion of the seed. Various rodents are fond of the kernels and prey upon the seeds extensively, and squirrels cut down from the trees and drag together great quantities of the immature cones for winter use.

The habitat of the species is preferably in damp bottoms, flats, or on slopes well supplied with moisture and humus. It will grow where there is little or none of the latter soil constituent, springing up on burned-over areas nine or ten years after the occurrence of the fire, but I have never known the saplings on such ground to present any other appearance than that which indicates, unmistakably, a coming development into the lesser and, so far as lumber products are in question, comparatively worthless type of the species. The large, well-formed tree is invariably found where humus is abundant, and so are the saplings that eventually will develop into it.

The young tree is a fairly rapid grower. During the first sixty or seventy years a usual ratio of growth is 16 to 18 inches in height for each season, and about 10 inches diameter at the base for the entire period. Subsequently the growth is much slower. The age limit of the species is probably about five hundred years, but there are not many individuals in the Idaho forests that reach it. Most of them attain maturity, decay, and die inside of three hundred years. Many diseases afflict the tree. Rot at the core is common, and various species of fungi attack the cambium of the growing trees and destroy them in multitudes.

The root system has a wide spread but is extremely shallow, by reason of which, in connection with a considerable height, the tree is very much exposed to uprooting and overthrow by strong winds.

The reproduction of the species in the reserve is not good. Whatever may be said as to the areas in the Lolo Basin, where, possibly, the species holds its own, it is certain that in the Lochsa Basin there is not the slightest appearance indicative of a return to the much more abundant ancient growth.

The species forms about 2.6 per cent of the forest growth in the reserve, and the stand of merchantable timber upon the areas examined amounts to 280 million, feet B. M.

PINUS MURRAYANA Balf. (Lodgepole pine).

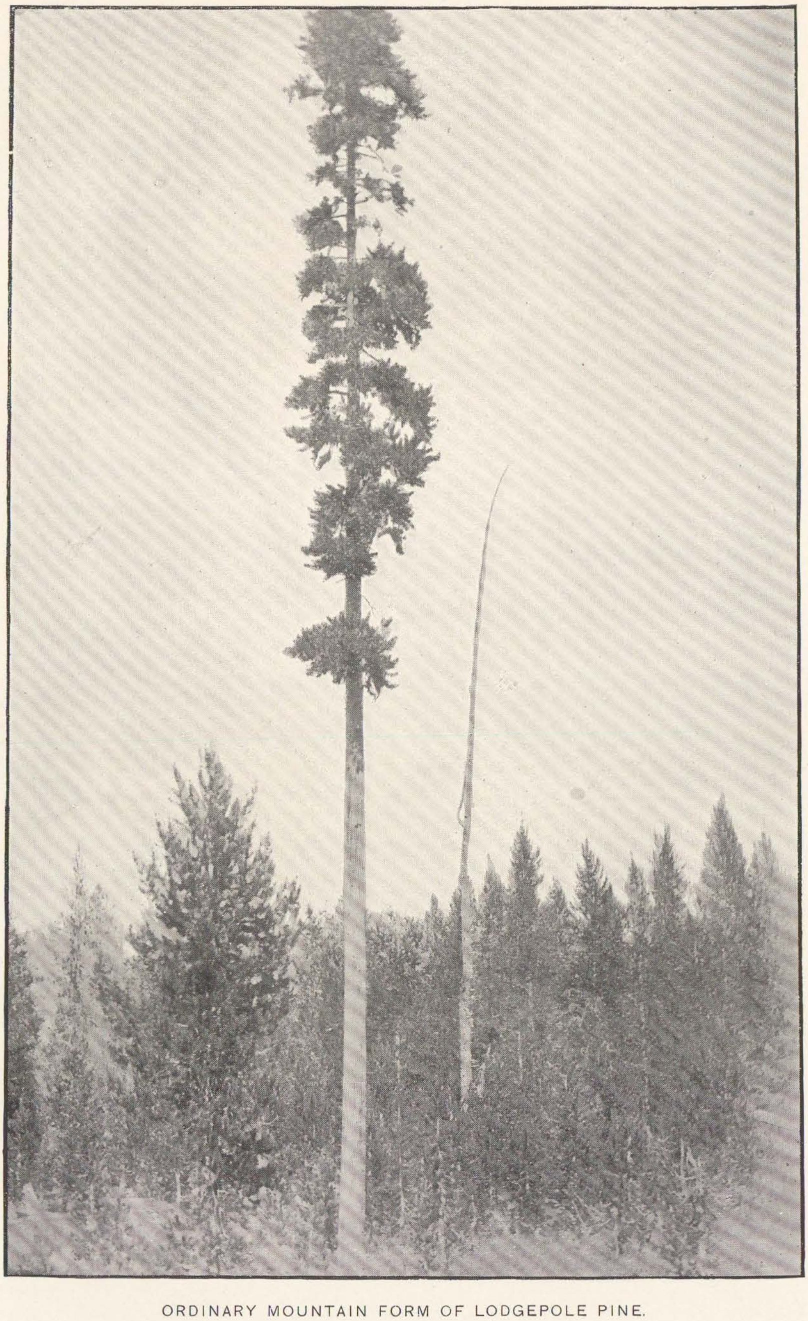
The lodgepole pine, in point of numbers and of extent of the area on which it grows, far surpasses all other species of trees in the reserve (Pl. CXXV). It is of common occurrence everywhere, no considerable tract being without its quota of the tree. Its range is from the subalpine elevations in the main range of the Bitterroots, and the high, bleak summits of the ridges that form the chief divides of the interior basins in the reserve down to the lowest valleys, having thus a vertical expansion of 7,000 feet, an altitudinal range possessed by no other species of tree in the State of Idaho except, perhaps, the aspen. While preferably choosing a deep, humid soil for its habitat, it does not wholly avoid rocky, semiarid slopes, having a truly remarkable capacity for adaptation to the most diverse soil conditions. This has resulted in the production of a great variety of vegetative types or forms. Four of these types are definite enough to deserve recognition.

Type I: In this aspect the tree departs most widely from the common form as it occurs in the reserve, and it is here provisionally named the archaic type. It consists of tall trees, 100 to 200 feet in height, the diameter rarely exceeding 16 inches at the base; clear trunks 60 to 140 feet in length, beautifully clean and symmetrical; growth very slow, trees with diameters of 12 to 14 inches at the base showing age limits up to 275 years; bark smooth, thin, dark, or brownish in color; wood yellow, brittle, easily fissile, and very fragrant; habitat in the reserve, in the swampy tracts northeast of Grave Peak, between it and the main Bitterroots, to which areas it is closely confined.

Outside the reserve limits the form occurs in Idaho only in the marshy meadows at the head of St. Marys River. If it exists in any other localities on the Pacific slope they are unknown to me. It is a remarkable form, and its general aspect and behavior carries the suggestion that it exists as a remnant of a very ancient type of the species. Its growth, wherever I have seen it, is not that of a primary or temporary reforesting after fires, as is the case with the ordinary form, but, on the contrary, it conveys the impression that the type belongs by right and age to the place where it grows, and as exclusively so as do any of the old growths of Pacific arbor vitæ, western yellow pine, or alpine hemlock, for example.

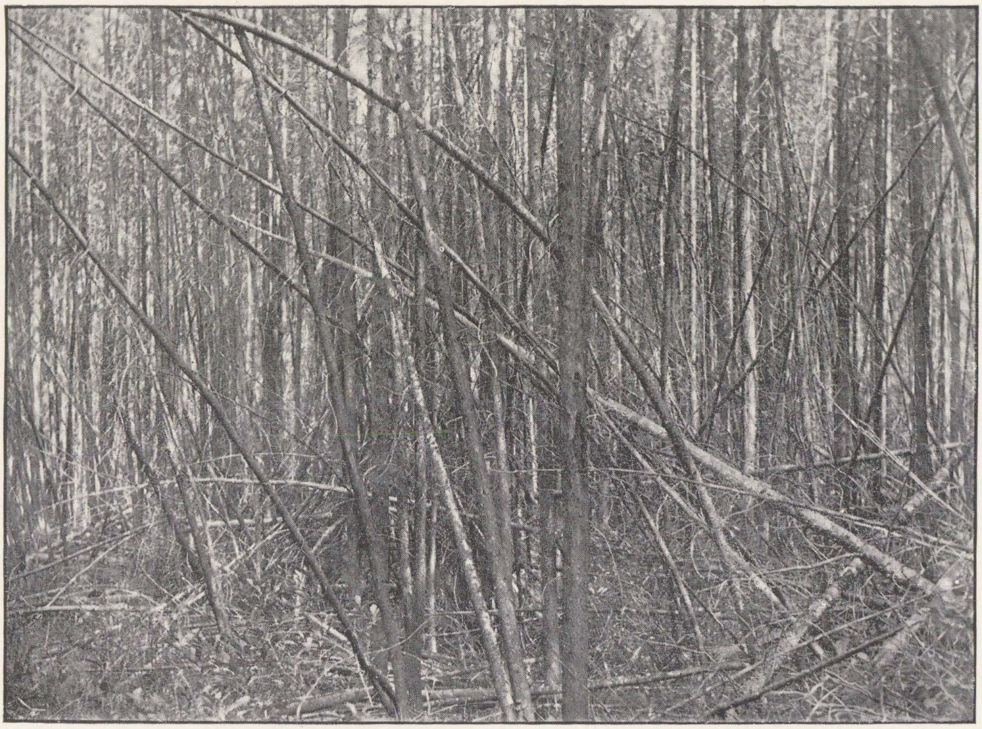
Type II consists of low trees with a spreading, bushy crown, the entire tree rarely more than 30 to 35 feet in height; trunks columnar, very symmetrical, clear for a distance of 12 to 18 feet from the ground with diameters up to 28 inches; age limits not known, but doubtless high; character of wood unexamined, probably tough and moderately resinous; bark thin, light colored, ashy-grey in the sapling state; the general port of the tree not unlike that of the white-bark pine, from which it is not readily distinguishable at first glance. This type is only known to me on the high summits that form the divides between the St. Joseph and North Fork of Clearwater basins, and from the summits of the ridges that lie between St. Joseph and South Fork of Cœur d'Alene rivers about 50 miles farther north. It is exclusively a high altitude form, not, or very rarely, descending below the 6,000-foot contour.

Type III consists of trees that vary from low, bushy-branched forms 20 to 45 feet high, with no clear trunks, to individuals 50 to 100 feet



ORDINARY MOUNTAIN FORM OF LODGEPOLE PINE.

A.



B.

TYPES OF YOUNG LODGEPOLE-PINE GROWTH ABOUT 20 TO 25 YEARS OLD.

high with basal diameters up to 18 inches and clear trunks 20 to 50 feet in length; the wood rarely otherwise than tough, stringy, and sappy; the bark usually close, thin, and scaly, but sometimes showing a slight degree of fissuring. This form seldom reaches a greater age than 150 years, the bulk of the individuals in the stands rarely going beyond 75 to 85 years. This is the prevailing type in the reserve, and is meant whenever lodgepole-pine stands or growths are mentioned in this report. The differences between this and Type I lie in the tall, slow, symmetrical growth of the latter as against the rapid and stocky development of the former; but the chief variation is found in the character of the wood, which is extremely dissimilar in the two types (Pls. CXXI, *B*, CXXII, and CXXIII).

Type IV is formed of low, much-branched trees, 8 to 16 inches in diameter at the base, having a very short, clear trunk, or none. The wood is tough and sappy. The bark is black and deeply fissured, even on young trees. It is rapid in growth and quick to decay. This type is not represented in the reserve, but is very common in the northern portion of the State at elevations below 3,000 feet. It much resembles the twisted pine (*Pinus contorta*).

These types or forms of the lodgepole pine are not specifically distinct, but their ulterior aspects are strikingly at variance with one another and indicate a tree in an active evolutionary stage.

The lodgepole pine is a generous cone producer, often excessively so, loading the branches with great masses of cones, singly or aggregated. Not only do the branches bear cones, but the crown portion of the main trunk frequently produces them also. The species is fruitful at a very early age, saplings no more than 6 years old often bearing cones in small quantities. In older individuals the entire crown is a mass of cone-producing branches, rarely missing a season. The cones are short, 1½ to 2 inches long, attached obliquely to the branch that bears them; or more correctly, the cones are asymmetrical, due to the nondevelopment of a portion of the ovules in each cone, which gives them an oblique or one-sided appearance. The cones are extremely persistent, sometimes remaining on the tree six years or even more before decay sets in at their point of attachment and they fall to the ground. The scales open tardily. A large percentage of the cones retain the seeds for several years, and sometimes nothing short of their decay liberates the seeds.

Reproduction of the tree is excellent. No other species in the reserve can compare with it in this respect. On areas that have been denuded by forest fires it springs up in great abundance as the first tree in the reforesting process, and the stands are often enormously dense—20,000 to 30,000 individuals on a single acre are not uncommon during the sapling stage. With age the stands become much lighter, until finally 200 or 300 trees constitute the number on an acre (Pl. CXXIV).

The species is moderately sensitive to fire, but its resistance ratio depends largely upon the quantity of litter on the ground. If many decaying logs have remained unburned, after a fire which destroyed the original forest that the lodgepole pine has replaced, a subsequent conflagration is almost sure to destroy all of the growth on such areas. If, on the other hand, the tract was originally burned clean a fire in the since-accumulated litter may not destroy above 20 to 40 per cent of the lodgepole pine. To burn the growing tree or to cook its sap-laden bark there must be present on the ground adjacent to the tree a considerable quantity of humus or inflammable litter.

The root system consists of a short taproot and numerous long laterals which bury in the ground at shallow depths. The species is easily uprooted by strong winds.

Many species of fungi attack the tree, causing rot and swelling on branches and trunk. A mistletoe (*Razoumofskya americana*) is a common and persistent parasite. It is absent from trees that grow on wet and cold areas, but elsewhere not 15 per cent of the trees are free from it.

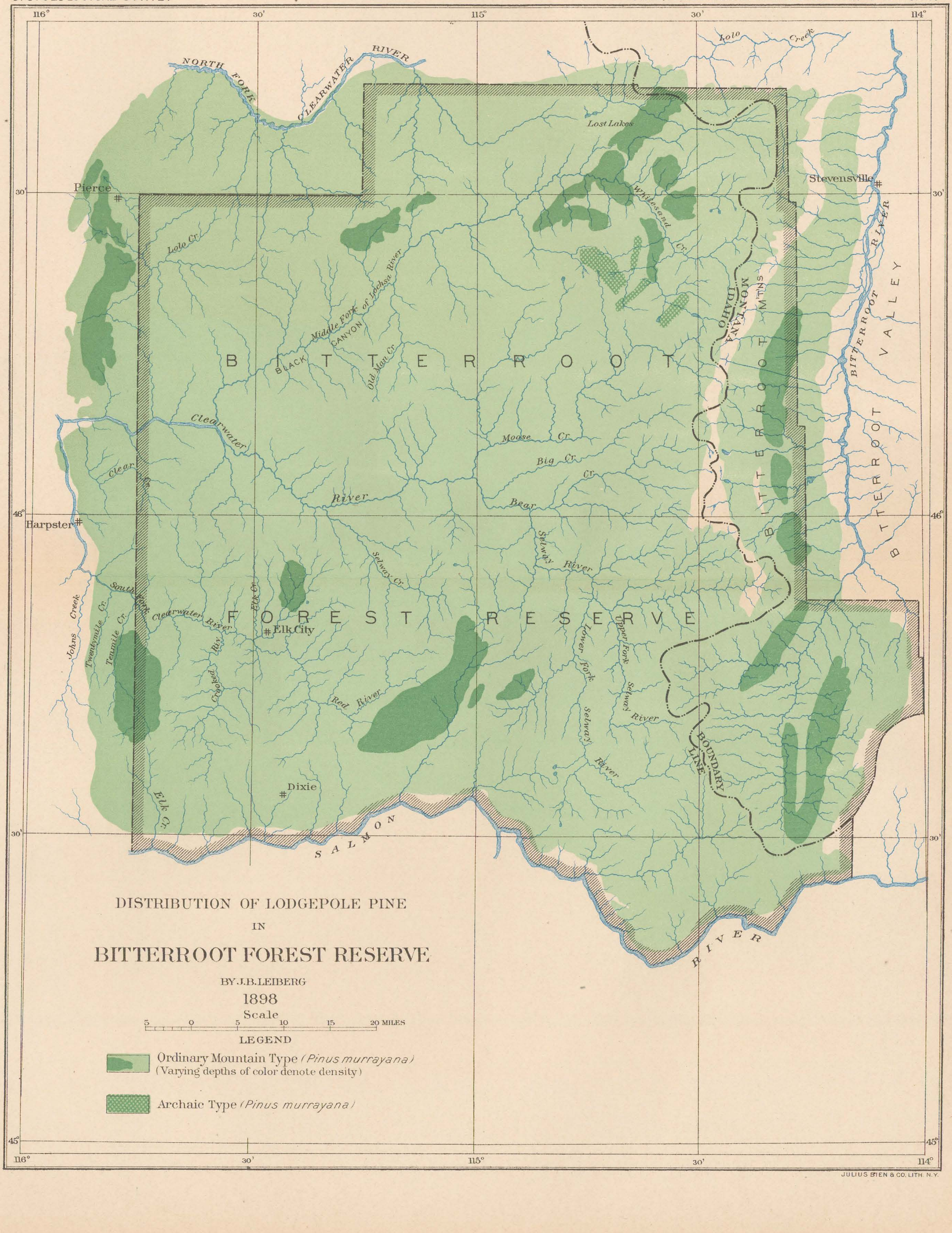
The lodgepole pine is not strictly a merchantable-timber tree. It is sawn in small quantities at Elk City and at Dixie in the reserve, chiefly because nothing better is to be had. The lumber obtained is of very poor quality. Owing to the rapid decay of the wood when placed in close contact with damp soil, the tree is never used for telegraph poles, fence posts, or for any other purpose of like character, if other species be obtainable; if, however, it is used where there is no contact with the soil, as for fence rails, etc., it is fairly durable and may be advantageously employed.

The species forms about 43.2 per cent of the forest growth of the reserve and occurs approximately on 2,400 square miles of its area, a large proportion, estimated at 15 per cent, being a mere sapling growth. The stand of the archaic type, inclusive of trees from 8 to 14 inches basal diameters, is 38 million feet B. M.

PINUS PONDEROSA Dougl. (Western yellow pine.).

The western yellow pine is of universal occurrence throughout the reserve outside the alpine and subalpine tracts. Its altitudinal range extends to elevations of 6,500 feet on southern slopes, and in exceptional cases to 7,500 feet, as on some of the dry and warm crags on the Lochsa-Selway divide, near Oldman Creek. Its altitudinal limit for the production of merchantable timber is about 5,800 feet. At elevations above this the species becomes much dwarfed, with short, ill-developed trunks (Pls. CXXVIII and CXXIX).

The merchantable yellow pine exists in the reserve chiefly as an old



DISTRIBUTION OF LODGEPOLE PINE
IN
BITTERROOT FOREST RESERVE
BY J. B. LEIBERG
1898

JULIUS BIEN & CO. LITH. N.Y.

growth, and from a commercial point of view is here the most valuable of the forest resources. It is also more accessible for lumbering purposes, owing to its place of growth on the lower slopes adjacent to the larger streams and valleys, than any of the other forest trees. The areas in the reserve containing the heaviest growths are the tracts contiguous to the main Selway Valley and the slopes of the Salmon River gorges. In these localities the tree reaches a height of 50 to 120 feet; a diameter of 2 to 5 feet, with clear trunks 15 to 60 feet, and an age of 100 to 200 years. Its greatest height and diameter are found in the stands on the Salmon River slopes, but the largest volume of the species exists in the Selway Basin, where its dimensions average about 25 per cent smaller. Other places having the tree in notable quantities are the valley of the Lochsa and along the western edge of the reserve. In the former it is generally small in size and of inferior quailty; in the latter it reaches proportions similar to those it acquires on the Salmon River slopes, but most of the heavy stands of yellow pine that are situated between the treeless areas of the plains and the mountains are outside the reserve limits (Pl. CXXVII, *A* and *B*).

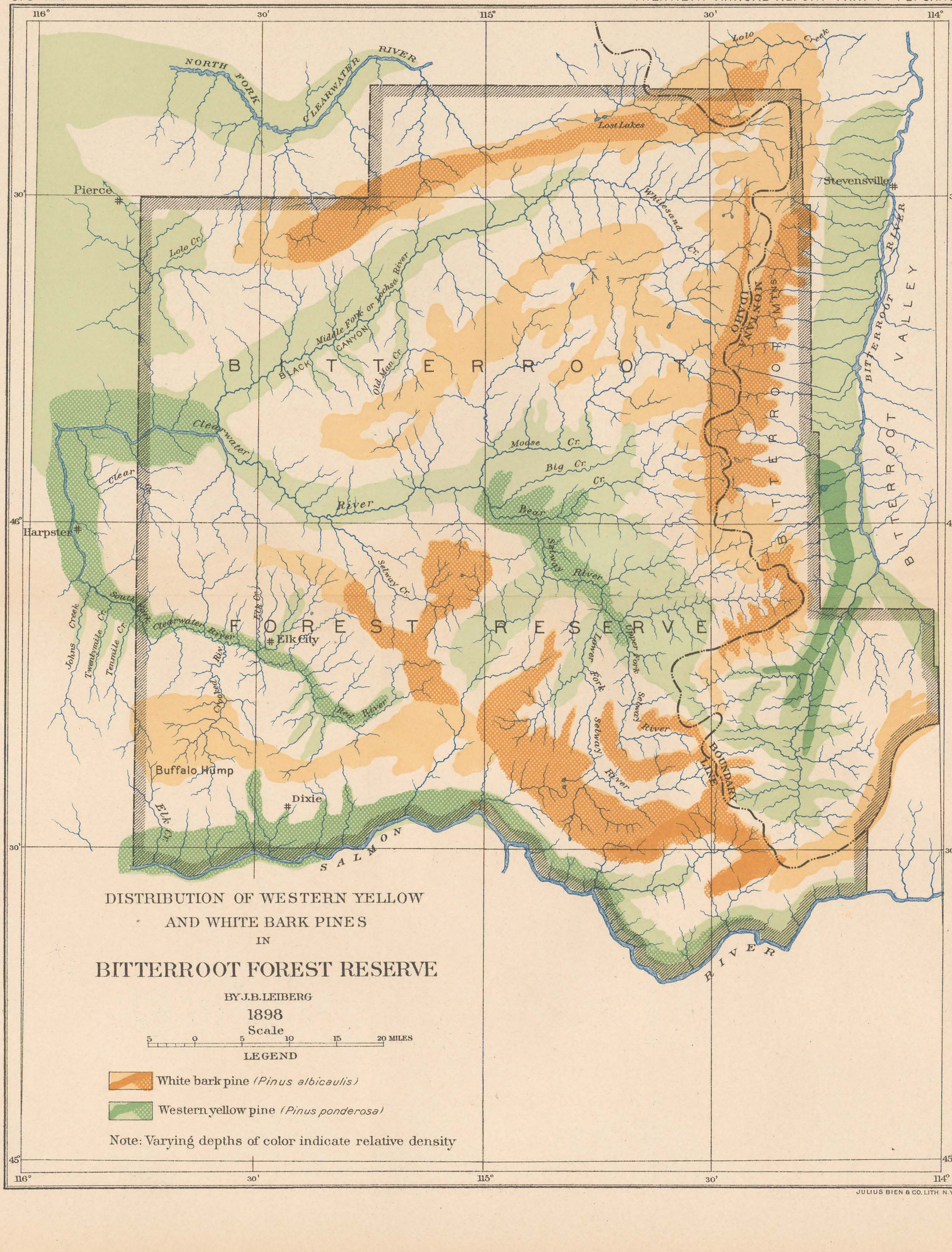
The yellow pine makes a fairly rapid growth. It is found on very dry and rocky soil, even when semiarid conditions prevail, but it is a fallacy to imagine that dry, steep, rocky slopes fit for nothing else are eminently suitable to the production of western yellow-pine timber. There is no forest tree in the reserve that does not require for its best growth a deep, rich soil well supplied with plant food and humidity, and the yellow pine is no exception. A very large percentage of the growth on dry or rocky ground consists of undersized trees well supplied with crown, but deficient in trunk development. The large individuals, showing long, clear trunks, belong to areas with rich, deep soil. The quality of its timber varies, depending on the place of growth. In soil well supplied with moisture, but not too wet, the tree grows rapidly and the wood contains a low percentage of resinous ingredients. In dry soil the growth is slower; the wood becomes resinous, tough, and stringy, or else extremely brittle when loaded with resin to excess. The large amount of terebinthine matter in the timber of this species is its chief defect. The stand upon different tracts fluctuates greatly. On the lowest Salmon River slopes, for example, it will not average 500 feet B. M. to the acre of merchantable timber; that is to say, of logs that would command a purchase price at the ordinary class of sawmills. On the middle slopes of this basin, where soil conditions are more favorable, it runs as high as 30,000 feet B. M. to the acre. In the Selway Basin, among the best stands, it runs from 2,000 up to 10,000 feet B. M. per acre, and in some cases up to 15,000 feet. In the Lochsa Basin it rarely exceeds 1,200 feet B. M. per acre. The general averages for the entire reserve are between 2,000 and 5,000 feet per acre. It can be said of the yellow-pine growth that nowhere, even in the heaviest stands, is there the quantity of merchantable timber per acre that is possible under a scientific method of forest management, and the same remark applies to all the other species of trees and types of forest growth in the reserve, without any exception.

The yellow pine possesses excellent fire-resisting qualities; far above that of any of the other species of conifers in the reserve. This is due to its habitat on dry hillsides, where but little litter accumulates, and to the protection afforded by the thick bark, which does not burn very readily while the tree is alive. Repeated fires, however, are certain to burn their way through the bark in one or more places, resulting in fire scars and pitch streaks which eventually insure the destruction of the tree. The most disastrous of the results that follows fires in the yellow-pine growths is the burning of its seedlings and saplings, and of the seeds as they rest on the soil after liberation from the cones. A certain percentage of saplings usually pass through a fire unharmed, the amount depending on their age and the quantity of litter on the ground, but seeds and seedlings are sure to be destroyed.

The tree is a good cone producer, beginning at an early age—20 to 25 years—and continuing till decay and death ensues, only occasionally missing a season. The upper half of the crown usually bears the cones, but sometimes cone-bearing branches extend to the base of the crown and occasionally they are wholly confined to the uppermost branches. The cones mature in June or July of the year following their first appearance, remaining on the tree sometimes two years, but here, in the reserve, commonly shed during the year following their maturity. A large proportion of the ovules, amounting to 20 to 30 per cent, do not develop into seeds with germinating powers; sometimes the quantity of aborted ovules is much greater. The cone scales open tardily. Nearly as great a percentage of the seeds are liberated after the shedding of the cones as while on the trees. This is of advantage to the species when growing on hillsides, as the cones often roll to considerable distances from the parent tree and thus insure a wider dispersion of the seeds than would otherwise be the case.

Germination takes place in the presence of sufficient warmth and moisture, without regard to season.

The reproduction of the tree in the reserve is not wholly sufficient to maintain the stand. There are many northern slopes in the Lochsa and Selway basins where heavy stands of the tree have been destroyed by fire and red fir has taken their places. Either there is now a heavier precipitation on many of the reserve areas than in the past, or the fires favor a red-fir growth on the yellow-pine tracts as a first step toward reforestation, to give way later to a growth of the original species.



DISTRIBUTION OF WESTERN YELLOW AND WHITE BARK PINES IN BITTERROOT FOREST RESERVE

BY J.B. LEIBERG

1898

Scale

5 0 5 10 15 20 MILES

LEGEND

White bark pine (*Pinus albicaulis*)

Western yellow pine (*Pinus ponderosa*)

Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

The root system consists of a deeply-penetrating taproot and strong, widely-spreading laterals from the root crown. A certain number of the roots of most individuals are always resinous. There are more trees in dry soil than in wet that have this peculiarity. In general, the tree is excellently rooted and is much less liable to be torn up by wind than are the other species of conifers in the reserve. The age limit of the tree is rarely above three hundred years. After two hundred or two hundred and fifty years the tree suffers from decay or deterioration of the wood, due to age and over maturity. Many trees in a stand reach maturity at one hundred and twenty to one hundred and fifty years. At a certain age, varying with the amount of vegetative force inherent in each individual, the leader begins to branch, forming eventually a depressed top. With the branching of the leader all upward growth ceases, but the peripheral growth may continue for a century or more.

The species does not suffer very extensively from diseases. Rot at the heart is not common. A resinous deterioration of the wood sometimes takes place in old individuals. A species of mistletoe (*Razoumofskya cryptopoda*) is a common parasite on the tree at elevations below 3,000 feet in the reserve.

The species forms about 9 per cent of the forest growth in the reserve, and the total stand with basal diameters at and above 12 inches is 1,190 million feet B. M.

None of the yellow pine below 18 inches diameter at the base is strictly merchantable timber. The trees with diameters between 12 to 18 inches rarely have a clear trunk, and the wood is tough, stringy, and unfit for any but coarse lumber. The standard of 12 inches, upon which the estimate is based, is used in conformity with the general scale adopted in this report, for the purpose of furnishing data for a comparison, on equal footing, with the other species of coniferous trees in the reserve.

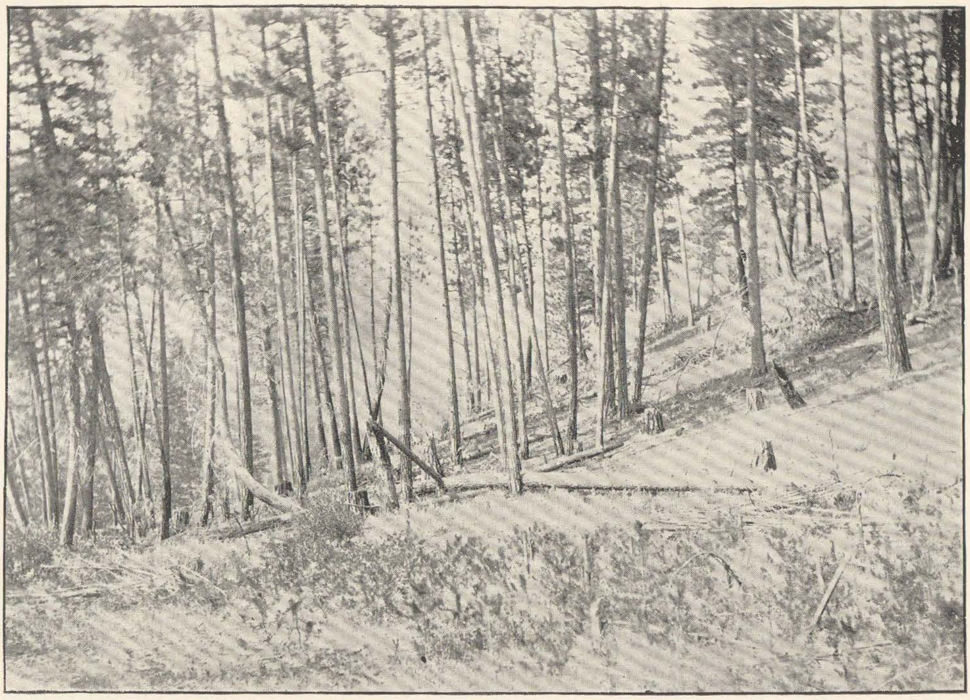
PSEUDOTSUGA MUCRONATA (Raf.) Sudw. (Red fir).

The red fir is found in great abundance throughout the reserve below the subalpine areas (Pl. CXXXI). Its altitudinal range extends to elevations of 5,800 feet in the districts north of Nez Perces Pass, and to elevations of 6,500 to 7,000 feet in the Selway Basin and on the Salmon River slopes. It is a tree that readily accommodates itself to very diverse situations, growing on rocky, semiarid slopes in company with the yellow pine, and in low, moist bottoms associated with great silver fir, western tamarack, and Engelmann spruce. The ultimate dimensions of the species are determined by the soil and by humidity conditions under which it grows. The prevailing form of the tree on all the well-drained slopes in the reserve is what might be termed the interior or monticoline type, owing to its abundance on the dry, rocky, and hilly areas. Trees of this type are low, bushy-branched, deficient in trunk development and growing on rocky declivities; or slender, tall trees with comparatively-short crowns and growing in better and deeper soil on benches or on bottom lands. The individuals of this type vary in height from 20 to 90 feet, from 8 inches to 2 feet in diameter; clear trunks none or 20 to 50 feet, and age limits up to 150 years. The larger or subpaludose form of the species consists of tall, columnar trees with excellent trunk development, short crowns, and very deeply-furrowed bark. This type is not common in the reserve. It occurs in low, swampy valleys, mostly in the interior areas, and is scattered among growths of great silver fir, Engelmann spruce, and western tamarack. It reaches a height of 75 to 120 feet, and a diameter up to 5 feet, with a clear trunk 40 to 90 feet in length, and age limit up to 275 years (Pl. CXXXIII, *B*).

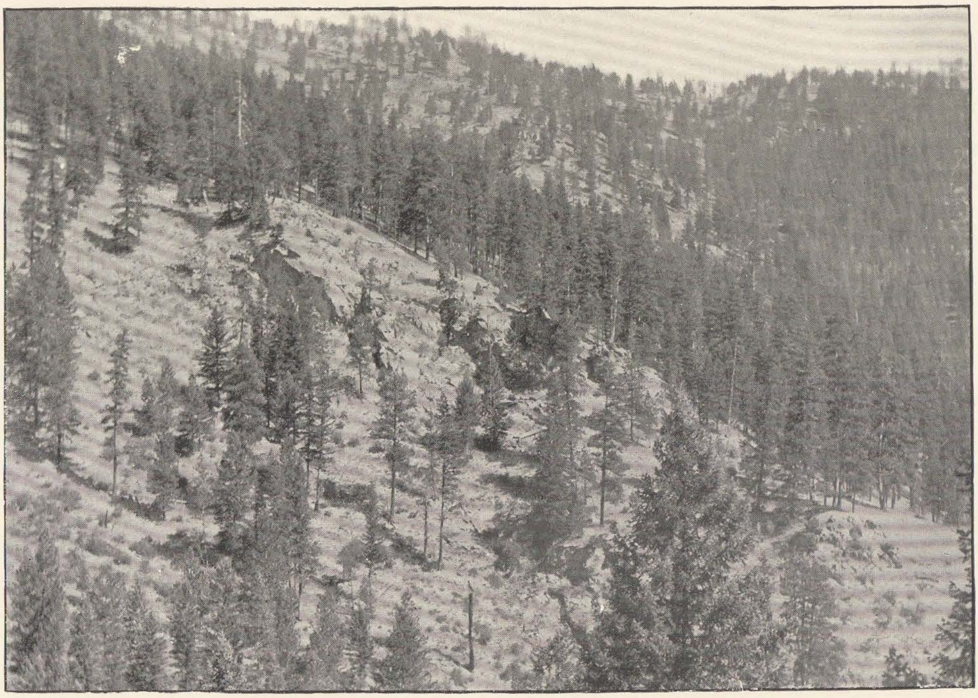
The red fir furnishes excellent timber where it attains sufficient dimensions. The smaller form is not generally utilized except for railroad ties, but the large trees are sawn for all purposes. The wood of trees grown on rocky soil is tough and stringy, while that grown on lowlands is soft, easily fissile, and much preferred for all purposes. The stands of the tree rarely consist of pure growths, unless on small areas among the yellow-pine tracts, where the ground is exceptionally moist. Ths largest tracts of nearly pure growths occur in the Upper Selway Basin and on the southern slopes of the Lochsa Valley. With age, however, the stands usually thin out and make room for various trees of other species. The tree is a rapid grower when well supplied with moisture, surpassing in this respect all the other species of commercially valuable conifers in the reserve.

The fire-resisting qualities of the red fir are second only to those of the yellow pine. Its thick, corky bark does not readily ignite, and the resin vesicles, which are plentiful in the young bark, do not contain a very inflammable balsam. The fires, however, develop resin cracks in the tree, longitudinal fissures filled with gum, which greatly injure the quality of its timber. The manner in which these gum cracks originate under the influence of fire is not clear, but it is a well-recognized fact that on tracts swept by forest fires all the red fir that escapes destruction invariably develops gum cracks in the basal portion of the trunk.

The red fir matures large quantities of cones, but is deficient in seed production. The cones are borne nearly throughout the entire length of the crown, the lowermost branches usually being barren, and mature in the latter part of July or August, the time depending on the altitude at which the tree grows. The cone scales open immediately upon maturity, and seed dispersion takes place rapidly while the cones are attached to the tree. A large percentage of the ovules fail to develop into seeds. In the reserve areas, and in general through-



A. SECOND-GROWTH WESTERN YELLOW PINE, SELWAY BASIN.



B. WESTERN YELLOW-PINE HILLSIDES, SELWAY BASIN.

out northern Idaho, not above 10 per cent of the ovules become seeds with germinating powers. Germination usually begins in the fall, but is sometimes delayed till the following spring.

The species is well rooted. There is a large, stout, short taproot and a well-balanced system of big laterals from the root crown. They penetrate 4 to 5 feet beneath the surface of the soil and give the tree a firm foundation. Reproduction of the species on the reserve areas is good; it comes next after the lodgepole pine in this respect. In many places it crowds the yellow-pine growths where fires have weakened the stands of that tree. In the Upper Selway Basin the lodgepole pine is slowly but surely giving way to extensions of the red fir types, and the same is true of portions of the Middle Lochsa Basin.

The species is not particularly subject to diseases. A species of mistletoe (*Razoumofskya abietina* or *douglasii*, one or both, perhaps) is of common occurrence on the limbs, where it causes big swellings and a bunchy proliferation of branches that sometimes assumes immense proportions. The peculiar bunched, and sometimes pendent, masses of branches which are such conspicuous features in the crown portion of the tree are always caused by the growth of this parasite.

The species forms 16 per cent of the forest growth in the reserve and the stand is 1,334,600,000 feet B. M.

THUYA PLICATA Don (Pacific arbor vitæ).

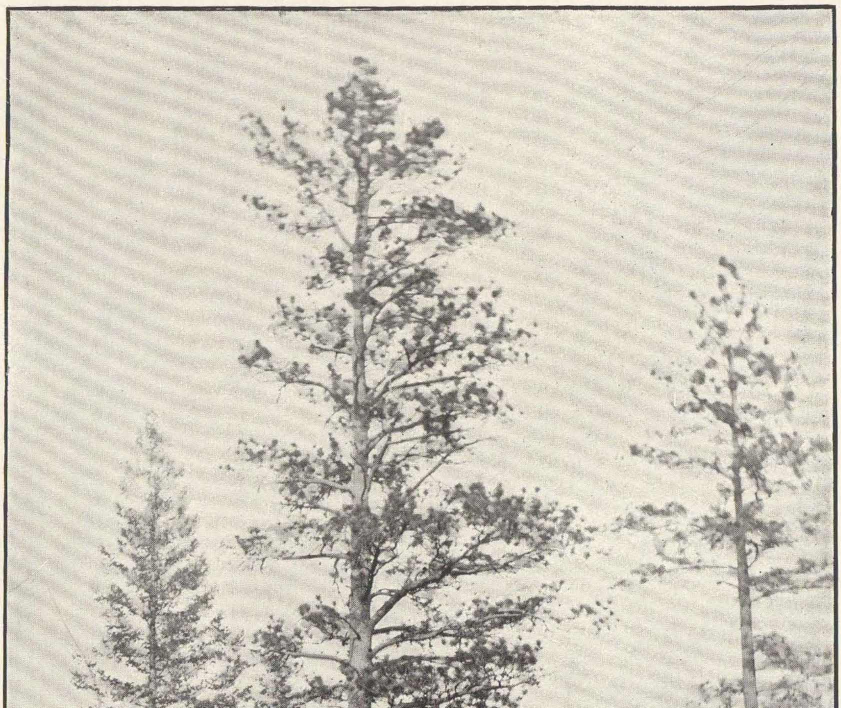
The arbor vitæ, commonly called cedar, ranks third in the list of commercially-valuable forest trees in the reserve. It occurs throughout the North Fork of Clearwater, in the Lochsa and the Lolo basins, and in the Selway Valley to its junction with Bear Creek. The species is not found in the reserve outside these tracts. It is a tree of the wet, swampy bottoms below 5,000 feet elevation, where it sometimes forms blocks of nearly pure growth, frequently with an immensely heavy stand. It also occurs on humid slopes, but then chiefly as a small tree of no great commercial value, and it occasionally ascends to elevations of 7,000 feet, when it becomes a mere bush in stature.

The character of its growth on the different areas varies considerably. In the Lolo and the Lochsa basins it is generally undersized; the trunks taper too rapidly, a common defect in the species as it grows in the Bitterroot Mountains, and the living branches of the crown begin near the ground, leaving no clear trunk. Most of the growth is rotten at the core, which in these localities is probably due to damage from fires in youth, as the trees are not overmature. The growth is sandwiched between blocks of mixed forest composed of Engelmann spruce and great silver fir, and is everywhere of small extent. The best stands exist in the bottoms of the canyons that open into the main Lochsa Valley from the south, and where the general conditions have been inimical to the run of ancient fires.

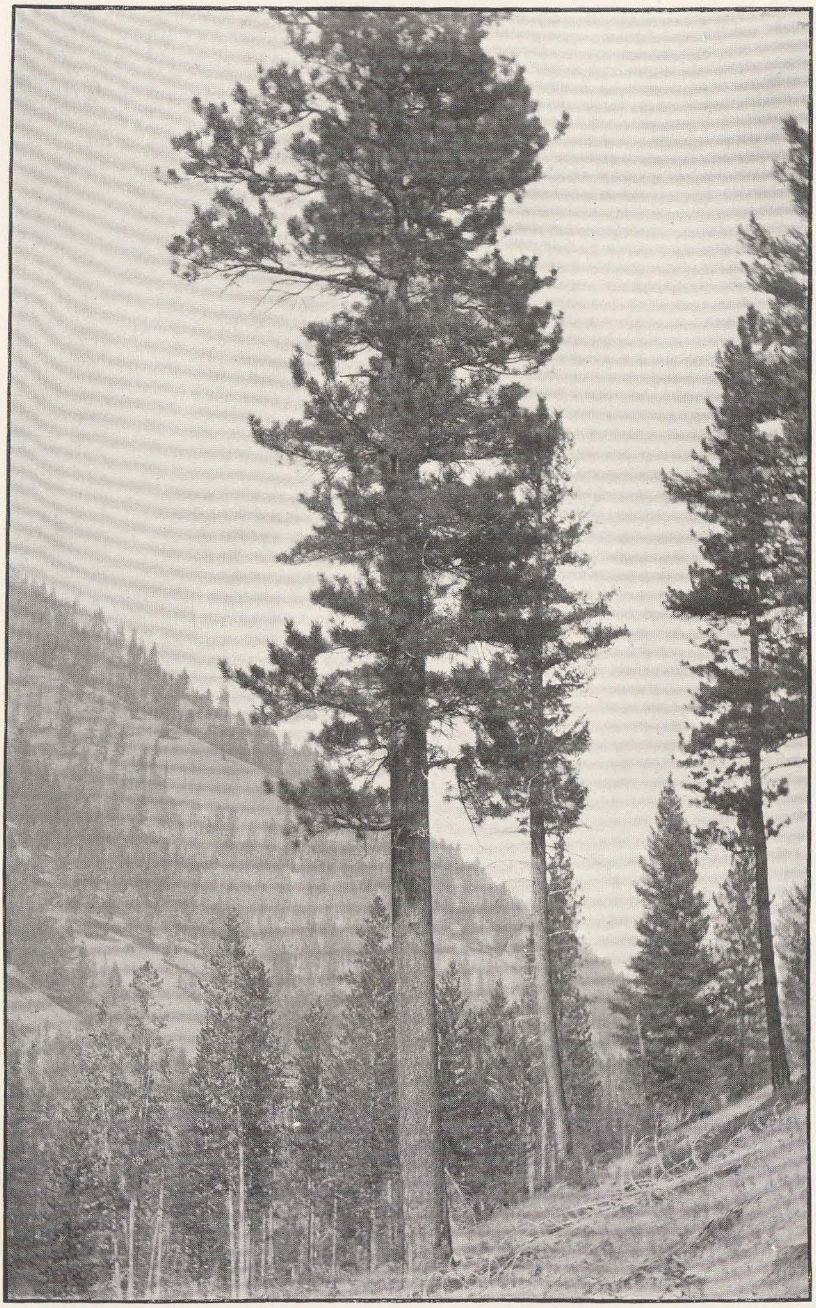
The heaviest growths of the species in the reserve occur in the Lower Selway Basin and particularly in the bottoms of Moose and Bear creeks, two tributaries of the Selway. Portions of these two creek bottoms have escaped the inroads of forest fires for periods of a thousand years and possibly more. The localities are circumscribed in area, the total for the reserve being about 9,000 acres. The cedar growth here is of advanced age, probably 700 to 800 years or more, but is not in prime condition, being overmature. A very large percentage is unsound, rotten at the core. The stands on these tracts sometimes run as high as 40,000 to 50,000 feet B. M. per acre. The trees are 50 to 120 feet in height and 2 to 8 feet in diameter, with clear trunks 10 to 100 feet in length, and are 150 to 700 years or more of age. The most common defect of the tree in its vegetative aspect is shortness of clear trunk and too rapid taper. In very heavy stands of pure growth the tree sometimes develops long, columnar trunks, when it becomes very valuable, much more so than the form with rapid taper. The type with long clear trunks, common enough west of the Cascades, is of rare occurrence in the reserve. So far as I know it only exists in the cedar groves of Moose and Bear Creek bottoms.

The wood of the tree is soft and very readily fissile. It is chiefly used for shingle making, but has also been sawn and used for interior finishings. The tree as it occurs in the reserve is not generally adapted for manufacture into lumber. The long, clear, columnar trunks found in the heavy stands of nearly pure growth are suitable for saw logs, but the quantity of such timber is very small. The common type in the reserve is marked by deficient trunk development, rapid taper from an enlarged, fluted base, many hard knots embedded in the wood and, in the case of large individuals, a zone of dry rot in the interior of the tree. For its best development the species requires a deep, rich, moist soil and a close, nearly pure, growth. Individuals standing alone in a mixed forest rarely reach the best development of which the species is capable.

The fire-resisting capacity of the tree is good in youth and middle age, but extremely deficient in advanced years. Its susceptibility to fire when old is due to the rot which then generally prevails in the interior of the trunk. If the flames gain an entrance to the zone of decay, destruction of the trunk is sure to follow. The habitat of the species in places where a deep deposit of humus has accumulated is exceptionally favorable to the spread of conflagrations and to the destruction of the trees that root in this deposit of decaying vegetable débris. In the heavy cedar swamps or groves the humus, or inflammable top layer, is sometimes 2 feet in depth and it burns or incinerates readily when once fired. After a fire has run through one of the heavy cedar growths one sees the roots standing out above ground, all soil and support



TYPES OF OLD-GROWTH WESTERN YELLOW PINE IN SELWAY BASIN.



TYPES OF OLD-GROWTH WESTERN YELLOW PINE IN SELWAY BASIN.

burned away from them. As a rule, where the humus exceeds 4 inches in depth, a fire running through it will work the destruction of every cedar tree in its path.

The species is a good cone producer, and matures great quantities of seeds. The cones ripen in August and September. The cone scales open very readily, and the slightest jarring of the boughs liberates the seeds. Germination takes place in the fall, and the young seedlings reach a height of 2 to 4 inches before winter sets in.

The root system is shallow, but spreads widely in all directions. There is no decided taproot, but many strong laterals stretch out and anchor the tree firmly. The large and important laterals of the root system have their rise in the trunk at some distance above the root crown and the ground, giving to the basal portion of the trunk a buttressed or fluted appearance, which becomes especially conspicuous in very aged individuals. The species is of indefinite duration. Rapid development in youth is followed by excessively slow peripheral growth as age comes on. The common, and about the only, disease that afflicts the tree is rot at the heart. It is, however, not generally a cause of death, except as it weakens the tree and prepares it for overthrow by strong winds. It is of common occurrence to find individuals in which the zone of decay has left nothing untouched in the interior of the tree but an inch or two next to the cambium layer. Yet the tree grows as vigorously as do the sound ones adjacent.

The reproduction of the species in the reserve is only moderately good. It is scarcely maintaining its stand. I observed no place where it was gaining ground or extending its range. On the contrary, old trees standing alone in a mixed forest growth in the bottoms of the Lochsa, Lolo, and Selway basins, with plenty of decaying cedar stumps scattered about on the adjacent tracts, prove a far wider extension and the existence of a more abundant growth in past times.

The species forms nearly 3 per cent of the forest growth in tne reserve, and the stand is 748 million feet B. M.

TSUGA PATTONII (Jeffrey) Coville (Alpine hemlock).

The alpine hemlock is one of the species of conifers whose southward extension in Idaho ceases in the northern areas of the reserve. Here it always occurs as a species belonging to the alpine-fir type of forest, rarely passing below elevations of 5,500 feet on northern slopes, or 6,500 feet on southern, with an extreme altitudinal limit of 8,000 to 9,000 feet, depending on direction of slope. The areas in the reserve upon which the tree occurs are as follows: The northern slopes and the summit of the North Fork–Lochsa divide from a point about 12 miles east of the western boundary of the reserve to the alpine regions of the main range of the Bitterroots at Lolo Pass, the valley of the Lochsa forming the boundary of its southward range (Pl. CXXXIV). It is a remarkable circumstance that this valley should have proven an insurmountable obstacle to the southward extension of the species. The subalpine regions of the Grave Mountains, beyond the Lochsa Basin, differ in no respect, either in soil or humidity conditions, from the summits and slopes of the North Fork–Lochsa divide, where the tree is of plentiful occurrence, yet on the Grave Mountains there is not to be found an individual of the species, nor are there any vestiges to show that it existed there in the near past.

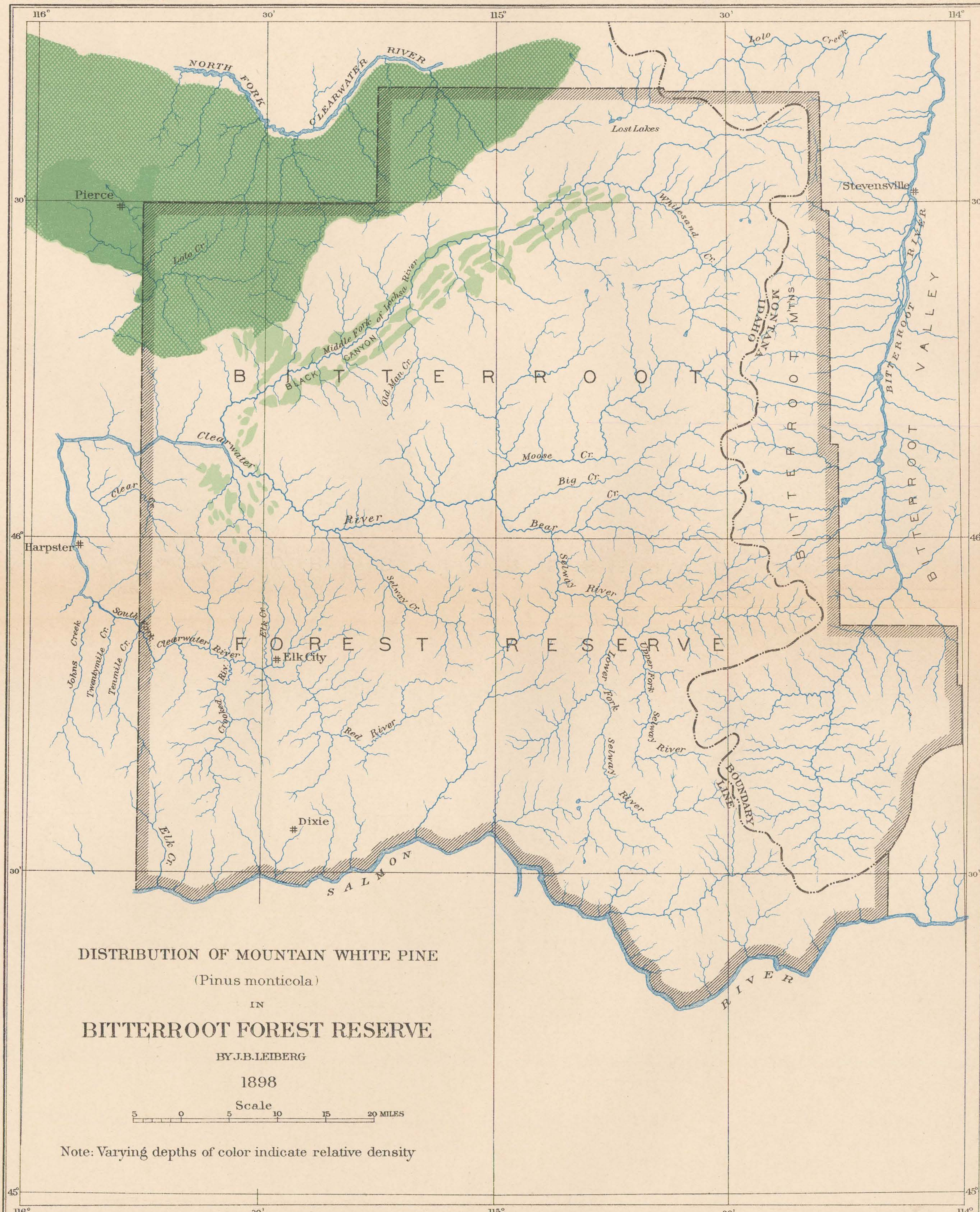
The alpine hemlock in the reserve occurs chiefly as an old growth; the second growth is small in quantity and the young growth is still less. The old growth is overmature, 30 per cent of it being rotten at the core; the second growth is in good condition; the young growth is bushy and thin, without any promise for the future. The dimensions for old growth are as follows: Sixty to 95 feet in height, 3 to 6 feet in diameter; clear trunks, 15 to 35 feet in length; age limits up to 600 years. For second growth they are 30 to 75 feet in height, 1 to 1½ feet in diameter; clear trunks, 15 to 30 feet in length; age limits 150 to 175 years (Pl. CXXXV).

In this region the species has not been sawn, therefore nothing is known regarding the quality of its wood and the lumber therefrom. In appearance the wood is fine grained and of greater density than that of the other nonresinous conifers in the reserve. It is not unlikely that the species would prove valuable for lumbering purposes if it grew in accessible places, but its habitat at high elevations places it beyond reach. The chief value of the tree at the present time is in the retarding influence it exerts upon the spring run-off. Owing to great development of crown it forms a deep shade wherever it grows. This screens the snow from the direct rays of the sun, resulting in its slow melting and a long retention of the water and soil humidity on the slopes under the trees.

The species succumbs easily to forest fires, having scarcely any higher ratio of resistance than the great silver fir. A slight scorching of the bark usually kills the tree. Cone and seed production are both low, many successive years passing without any cone growth taking place and a large percentage of the ovules are generally abortive. The cones mature in August, their scales open readily, but seed dispersion seems to be slow and uncertain.

Reproduction of the species within the reserve limits is deficient everywhere. The old stands are not maintaining their balance, but are giving way before encroachments of alpine fir and Engelmann spruce. Forest fires are chiefly responsible for this.

The species forms about 1.4 per cent of the forest growth in the reserve and the stand of merchantable timber is 132 million feet B. M.



DISTRIBUTION OF MOUNTAIN WHITE PINE

(Pinus monticola)

IN

BITTERROOT FOREST RESERVE

BY J.B. LEIBERG

1898

Scale

5 0 5 10 15 20 MILES

Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

TAXUS BREVIFOLIA Nutt. (Pacific yew).

The Pacific yew is a small tree in this region, more often a trailing shrub. Its amount is insignificant. As a shrub it sometimes forms a portion of the undergrowth in the heavy cedar groves or occurs as dense thickets on the higher slopes of the Grave Mountains, on the Salmon River divides and along the Lolo trail. As a tree it is found in the wetter and colder portions of the low-lying valleys. Its dimensions, when occurring in the arborescent form, are 20 to 30 feet high, with diameters up to 10 inches; clear trunks, none; age, 50 to 100 years.

OTHER TREES.

The deciduous-leaved trees form but a small portion of the forests of the reserve, less than 1 per cent; few of them are of any note, and none are of commercial value. The most noteworthy are the cottonwoods, the aspen, and the mountain mahogany.

The cottonwoods are found in the valleys of the streams up to elevations of 4,500 feet. Their average dimensions for mature trees are 40 to 60 feet high, 2 to 3 feet in diameter, clear trunks 10 to 25 feet.

The aspen is found throughout the reserve from the lowest altitudes to subalpine heights. It is a small tree, seldom over 20 feet high, or a shrub at high elevations, and occasionally forms circumscribed patches of nearly pure growth.

The mountain mahogany is found in the middle and upper portions of the Selway basins and on the southern slopes of the Salmon River divide. Its range here is an extension from the arid areas of the Rocky Mountains in the southeast, reaching the Clearwater basins by way of the Salmon River divides. It is commonly a mere shrub. When a tree, it is of low stature and scraggy in growth, rarely over 10 feet in height.

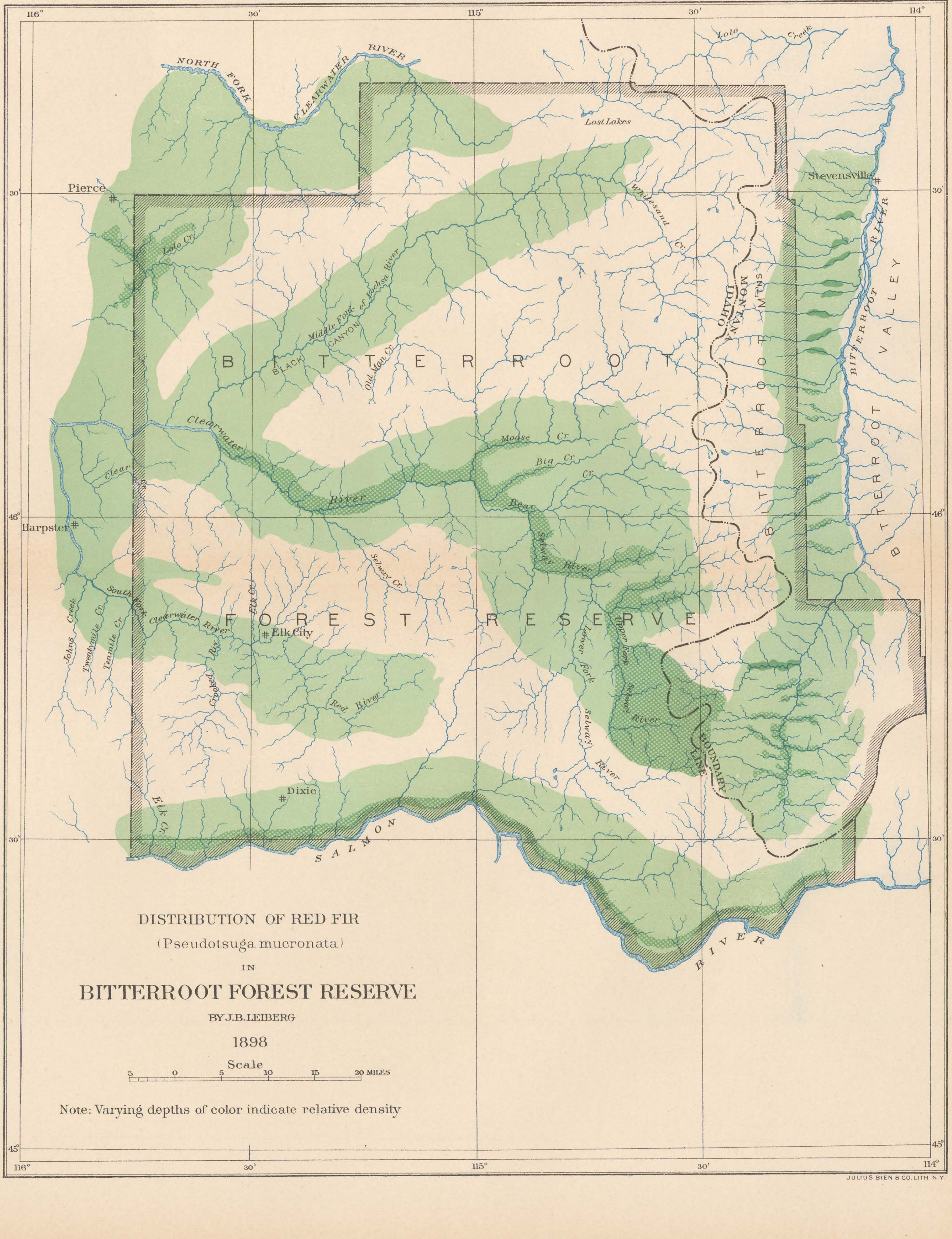
GENERAL FOREST CONDITIONS.

Much the larger percentage of forest as it now exists on the reserve owes its composition and aspect to the determining influences of widespread forest fires during the past 200 years, and for this reason the age limit affords by far the most convenient method of arranging the various stands in a general classification. Three divisions are here recognized, as follows: Young growths, where the general age of the trees is less than 75 years; second growths, where the prevailing ages of the forest components vary from 75 to 175 years; old growths, where the age exceeds 175 years.

Old growths occur as scattered stands in many places in the reserve. Collectively they occupy a lesser area than any of the others. Most of the species of conifers in the reserve are represented in them, and in the following order as regards their number and volume: Western yellow pine, Pacific arbor vitæ, Engelmann spruce, great silver fir, alpine hemlock, western tamarack, white-bark pine, archaic type of lodgepole pine and Lyall tamarack. The chief blocks of forest composed of this growth occur as follows: The white-bark pine and Lyall tamarack on the slopes of the main range of the Bitterroots and on the spurs adjacent thereto north of Nez Perces Pass, either in mixed or nearly pure stands; the white-bark pine on the Salmon River divides east of Little Salmon, and on a few of the high ridges in the Upper Selway Basin; the yellow pine in the Selway Basin from its upper forks to the junction of the Middle Fork of Clearwater and throughout the Salmon River slopes; the great silver fir on the ridges fronting on the Lower Selway Basin and on the divides west of Newsome Creek in the South Fork of Clearwater areas; the Pacific arbor vitæ in the Moose and Bear creek bottoms and along the banks of the Selway to the junction with the last-named creek; the western larch on the western portion of the Salmon River divides and on the ridges between Newsome and Elk Creeks; the archaic type of lodgepole pine and Engelmann spruce on the tracts between Grave Mountains and the main range of the Bitterroots, and the alpine fir on the North Fork–Lochsa divide. The total area covered by these old growths amounts to 450,000 acres in round numbers. In addition to these tracts there are many of lesser extent almost everywhere throughout the reserve. Some of them contain 5 or 10 acres, others but a few dozen trees, in other cases the growth consists merely of lone trees rising from the midst of dense second or young growths.

The old growths represent in every instance remains of an ancient forest, which has successfully resisted the fires that laid waste the adjacent timber long anterior to the advent of the white man in these parts. The stand of commercially-valuable timber in the old growths far surpasses in volume, acre for acre, that of the best portions of the second growths. In the yellow-pine areas it may run as high as 30,000 feet B. M. per acre; in the tracts covered with the Pacific arbor vitæ, as much as 100,000 feet B. M. per acre; in the great silver-fir growths it may reach 20,000 to 30,000 feet B. M. per acre, and fully as much in some of the stands of Engelmann spruce. It does not, however, always contain the choicest timber, much of it being overmature and rotten at the core. This is particularly the case with the stands of Pacific arbor vitæ, great silver fir, and alpine hemlock, where fully 25 per cent of the timber is worthless from this cause. The western yellow pine, Engelmann spruce, and the archaic form of the lodgepole pine are in better condition, because none of these species are especially subject to rot at the center.

The old-growth stands have a noticeable tendency to form pure growths. This is particularly well marked in the growths of western



DISTRIBUTION OF RED FIR
(Pseudotsuga mucronata)
IN
BITTERROOT FOREST RESERVE
BY J.B.LEIBERG
1898
Scale
5 0 5 10 15 20 MILES
Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

yellow pine, Pacific arbor vitæ, and alpine hemlock, less so in those of Engelmann spruce and the great silver fir. In second growths these trees, with the exception of the western yellow pine, nearly always grow in a mixed forest, but in the old-growth areas in the reserve the stands are from 75 to 80 per cent pure.

Reproduction in the old growths is conspicuously deficient. The deep shade cast by the dense stands of trees is inimical to germination of seeds and growth of the saplings. It is a noteworthy fact that, with the exception of the Pacific arbor vitæ, saplings springing up in the old growths are mostly of species different from those that compose the large growth. Thus in the stands of Engelmann spruce lodgepole pine is coming in; in the areas of great silver fir, red and alpine firs and Engelmann spruce. Nor are the growths of Pacific arbor vitæ wholly exempt, for while young cedar trees are not uncommon, the Pacific yew and various other trees are disposed to form the new forest. It appears as though there existed for some species a sort of cycle with reference to their growth upon any particular area.

In the old-growth areas humus is abundant and is the chief ingredient in the top layer of the soil. It varies from 3 to 8 or 14 inches in depth and is composed of rotting leaves, twigs, flakes of bark, etc. It is a nidus for the growth of many kinds of fungi, possibly for bacterial species as well, which more or less influence the development of the trees. Certain it is that all trees, not excepting the yellow pine which will grow in pure granitic gravel, thrive much better if there is a heavy top-dressing of humus over their roots than they do when this layer is lacking. If the old growth was accessible it could be logged in toto with profit to the tracts it occupies. The humus is an excellent seed bed and the removal or at least the thinning of the heavy growth would render possible rapid propagation and growth of the better species of timber trees on these areas. The undergrowth is not abundant, as the heavy shade is no less inimical to the reproduction and growth of shrubs than to the arborescent flora. As a rule the stands of old growth present an open, park-like appearance between the trunks of the trees, because the litter of decaying and uprooted trees which is such a marked feature of second-growth stands, is here lacking.

That any considerable blocks of old growth exist on the reserve areas, or anywhere else in Idaho for that matter, is due to the circumstance that most of the present stands are on wet, swampy tracts, where fires could not run. In the case of the western yellow pine, its safety has been in its natural fire-resisting capacity and in the absence of much litter on the tracts it occupies. There is, however, no probability that any of the old growth occupies tracts never swept by fires. I have as yet to see any large acreage in the north Idaho forests where charred wood, proving the prevalence of ancient fires, can not be found at varying depths in the soil. In the instances of old growth in the reserve it merely proves the absence of fires during the age of the forest.

There is another form of old growth in the reserve. This consists of large trees, of great age, standing solitary or in small groups in a mixed forest. All types are met with; mountain white pine in dense stands of lodgepole pine in the central portion of the Lolo Basin; the same species among thick masses of red fir in the Upper Lochsa Valley; old individuals of white-bark pine in young Engelmann spruce or lodgepole growth; great silver fir among growths of red fir or lodgepole pine; and yellow pine in dense stands of red fir. These solitary individuals or small groups of old growth are the residue of much larger blocks of old forest swept out of existence long ago by fires.

Another type of old growth consists of mature lodgepole pine. Except in the form I have designated archaic, the tree does not commonly reach the age limit of the old growth proper, death through decay or uprooting interfering. Its old-growth limit is from 120 to 180 years. Blocks of mature lodgepole pine exist in many localities, but especially in the basin of the South Fork of Clearwater. The lodgepole pine, when fully mature, shows exactly the same peculiarity of deficient seedling reproduction on the areas it occupies as do the other species of conifers in the old growth. A striking example of this occurs on the divides west of Newsome Creek, where there are many blocks of mature lodgepole-pine growths. These have arrived at the stage where the original forest of Engelmann spruce and alpine fir begins to assert itself. Though the old trees of lodgepole pine bear an abundance of cones and seeds, yet its seedlings or saplings are practically absent among the growth of new species that are crowding out the lodgepole pine. But on areas of this character that have been burned within the past twenty or thirty years the young forest growth is composed almost wholly of lodgepole pine, seedlings derived from the trees that do not reproduce themselves in the mixed forest on the surrounding areas where they grow.

The second growth, composed of trees varying in age from 75 to 175 years, comprises the largest percentage of forest growth in the reserve. It occurs in very large blocks, or as small isolated stands where modern fires have cut into it. It is either a mixed forest or one of nearly pure growth of some particular species. In the latter case either the lodgepole pine, the mountain white pine, or red fir are the species that compose it. The largest stands of the second growth, of which lodgepole pine forms the chief component, exist in the Upper South Fork of Clearwater Basin, where extensive tracts of mountain slope and valley are covered with it. The heavy stands of second-growth mountain white pine are confined to the northwestern areas of the reserve while the clearer stands of red fir exist in the Upper Selway Basin. As a rule,

WESTERN MONTANA TYPE OF RED FIR.

A. WESTERN MONTANA TYPE OF RED FIR.

B. CEDAR GROVE ON BEAR CREEK.

however, outside the lodgepole pine, second growths in the reserve consist of a mixed forest. The composition, extent, and merchantable value of the growth depend wholly upon the fires that swept this region previous to the white man's coming. Much of it is worthless because composed of such kinds as alpine fir, lodgepole pine, and white-bark pine, or owing to insufficient age and growth. The species in the second growths which are commercially valuable and have arrived at sufficient age and size are red fir, western tamarack, alpine hemlock, and western yellow pine. The mountain white pine, Pacific arbor vitæ, and Engelmann spruce are generally of too slender growth to be of any value.

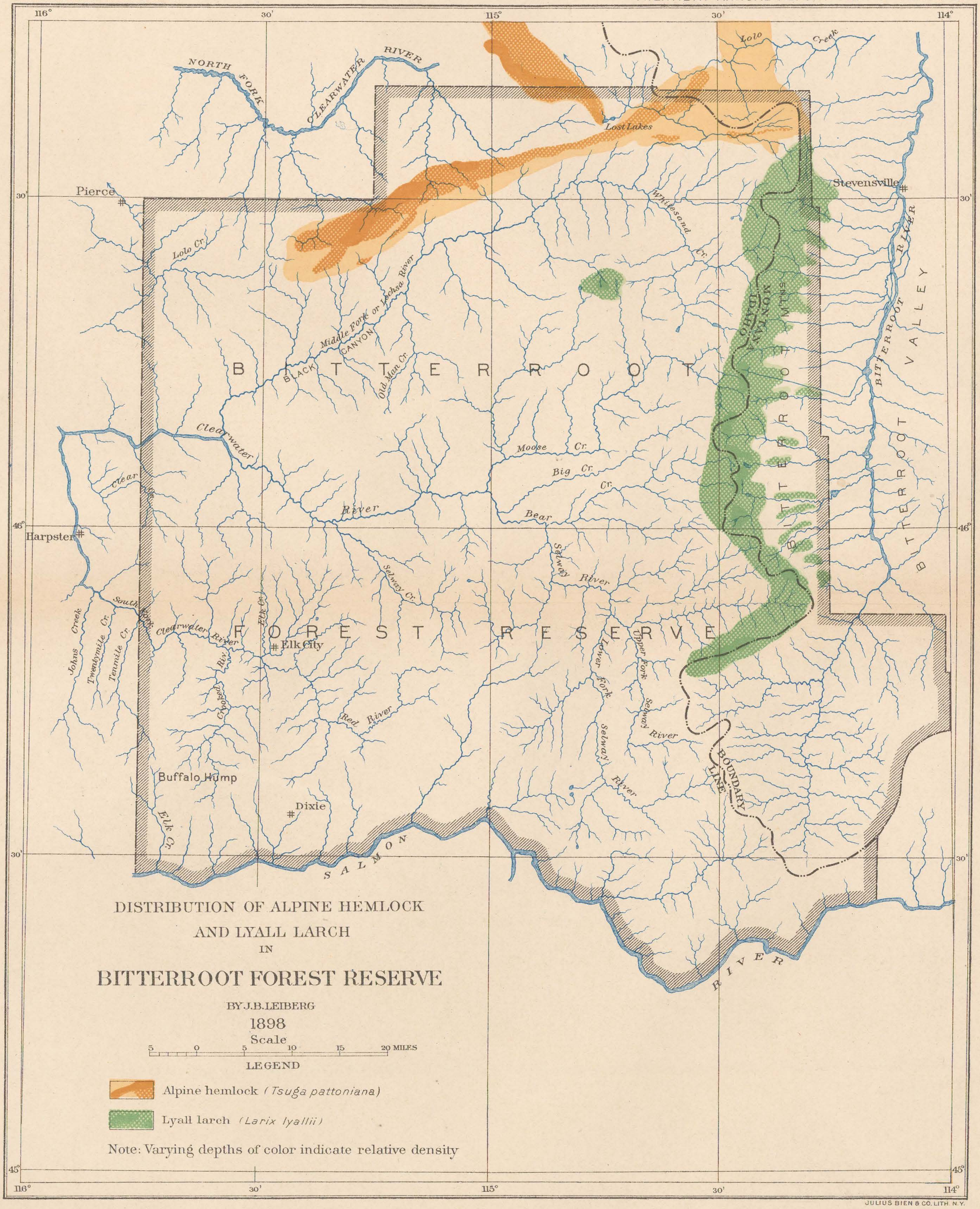
The present complexion of this kind of forest is very different from the ancient type which it replaced. Whether this is due to climatic changes or to other factors there is no way of deciding with certainty, but it is evident that there now is a general tendency toward the replacement of species requiring a great degree of humidity with kinds requiring less. Leaving aside the lodgepole pine, which covers nearly all areas alike as the first arborescent growth after fires, we find that throughout the Oro Fino Basin adjacent to the northwest corner of the reserve, heavy stands of mountain white pine or western tamarack, principally the former, have replaced an old growth of Pacific arbor vitæ and great silver fir. In the Lochsa Basin red fir and Pacific arbor vitæ have occupied ground formerly covered with a stand of old forest, of which the mountain white pine formed the chief component; the red fir alone has crowded out the ancient yellow-pine growth on large tracts of both the northern and southern slopes, and Engelmann spruce has replaced older growths of western tamarack, which in its turn has crowded out growths of Pacific arbor vitæ. In the Upper Selway Basin second growths of red fir have occupied areas formerly covered with western yellow pine, and are now replacing large tracts upon which second growths of lodgepole pine have been destroyed by recent fires. In the subalpine areas the second growth shows a tendency to more extensive stands of Engelmann spruce and alpine hemlock at the expense of alpine fir, white-bark pine, and Lyall tamarack. The suppression of white-bark pine in this case is due to its low ratio of cone and seed production, and this is, to some extent, also the case with the Lyall tamarack, though the exclusively alpine habit of the latter tree would here in any event preclude its existence except on limited areas.

The ratios in which the various species occur that compose the mixed forests of the second growths in any particular locality are subject to infinite variations when small tracts are in question, but there is generally a sort of balance throughout the areas of an entire district, depending on the average altitude, age of the burns, and the humidity conditions that prevail. In the Upper Selway Basin, where the precipitation is evidently less than on tracts farther westward, many of the second-growth stands ars composed of red fir to the extent of 70 per cent. In other parts of the basin, where humidity conditions are different, red and great silver firs occur in equal proportions. In the Lolo Basin, on the Brown and Musselshell creek bottoms, Engelmann spruce or western tamarack frequently form 30 to 40 per cent of the growth. The alpine hemlock sometimes occurs in nearly pure stands of second growth along the North Fork–Lochsa divide, but is more commonly mixed with Engelmann spruce and alpine fir in varying proportions. The Pacific arbor vitæ rarely furnishes any pure stands in the second growths, even on tracts limited in extent. So far as I am aware, there is no locality in the reserve where a second growth of this species occurs that ever promises to develop into such mammoth stands of pure growth as the "cedar groves" in Moose and Bear creek canyons.

The second growths of lodgepole pine are of many aspects, owing to its diverse ages. As this tree occupies deforested ground merely while it is becoming reforested with the original forest growth, it follows that as time goes on the proportion of lodgepole pine becomes continuously less. If not interrupted by fires, a lodgepole-pine stand 50 or 60 years old will show small proportions of the forest which eventually will replace it.

The chief value of the forest in the reserve during the next century will lie in the second-growth stands that it carries. The areas occupied by them in the reserve comprise in the aggregate 1,110,000 acres, of which amount about 40 per cent or 444,000 acres are pure lodgepole-pine stands, mature or rapidly arriving at the age of maturity. The balance are mixed stands, situated mostly in the merchantable timber-producing zones—that is, below the subalpine tracts. The capacities for reproduction of the second growths are generally good; they are so at least on 80 per cent of the areas. The exceptions occur mainly in certain stands situated in the upper limits of the mountain white-pine type of forest. In some of these localities, where heavy growths of Engelmann spruce, 80 to 110 years old, prevail, the forest is lacking in reproductive vigor; is even far from maintaining its stand. The primary cause lies in the attack of a fungus which causes death of the foliage. It sometimes affects 90 per cent of all Engelmann spruce on areas embracing 1,000 to 3,000 acres each. The result is the destruction of the species on these tracts and a period of brush growth in place of the forest. The alpine fir in the lower limits of its zone of growth is sometimes similarly affected. It is not difficult to understand the destruction of these trees when denuded of their foliage by the development of the fungus, but it is not clear why such tracts should become brush covered and remain so for many years with no young forest growth springing up to replace the one destroyed.

The number of trees per acre in the second growths is usually high



DISTRIBUTION OF ALPINE HEMLOCK AND LYALL LARCH IN

BITTERROOT FOREST RESERVE

BY J. B. LEIBERG

1898

Scale

5 0 5 10 15 20 MILES

LEGEND

Alpine hemlock (*Tsuga pattoniana*)

Lyall larch (*Larix lyallii*)

Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

for areas below the subalpine tracts. It is greatest in the lodgepole-pine growth, where it varies from 1,000 to 2,000 per acre in stands 60 to 80 years old. In those of red fir and mountain white pine the number runs from 800 to 1,500 trees per acre; in growths of western tamarack, 1,200 to 1,500; while in those of alpine fir and white-bark pine 500 to 800 trees, or even less, is the usual number. The stands of western yellow pine, when nearly pure, are always low in the number of trees per acre, not often exceeding 200 to 300. In these estimates only trees with basal diameters above 4 inches are considered. In comparison with stands composed of the same species of trees in growths of equal age, the Clearwater areas are much below those of the State farther north.

The underbrush on second-growth areas varies with the different forest types. In the mountain white-pine type the undergrowth is always heavy, often extremely so, the *Menziesia* and various species of huckleberry shrubs predominating. In the yellow-pine type the brush growth is mostly thin, and is composed of *Opulaster malvaceus*, *Philadelphus lewisii*, *Ceanothus sanguineus*, and masses of young growth of red and great silver firs, of which the majority never progress beyond their sapling state. In the alpine-fir type the undergrowth is usually scanty, *Vaccinium scoparium* being by far the most abundant. In the lodgepole-pine growth, during the early stages of its existence, there is practically no underbrush except the immense number of young saplings that spring up under the protecting shade of the older trees. With age most of them die, the growth becomes open and *Vaccinium scoparium* comes in as the chief component of a low, thin undergrowth. Of litter there is always a great quantity in the second-growth areas, especially in the mountain white-pine type of forest. The litter is composed of broken tree tops, uprooted trees, and the half-burned, decaying logs that have remained after the previously existing and burned old growths. Humus is not abundant. A very long time is required for it to accumulate in large quantities, and the age of the second growths has not been sufficient for its production to a greater depth than 2 or 3 inches.

The young growth, where it forms large solid blocks, is practically all lodgepole pine. There are small stands of it, composed of most of the other conifers in the reserve, scattered between bodies of second and old growths. It is principally a reforestation of burned areas antedating the advent of the white man. As such it is more abundant in the white-pine zone than elsewhere, and shows the highest percentage of deficiency in the areas of the alpine fir, due, in the latter case, to the low ratio of cone and seed production of the trees which form the bulk of the forests of the zone. The species least represented in the young growth are the white-bark pine and Lyall larch, and those occurring in the greatest quantity are the lodgepole pine and red fir, in the order mentioned.

The areas of young growth in the reserve amount in the aggregate to 400,000 acres. In this there are included some of the areas elsewhere classed under recent burns, that is, 35 to 40 years old, which in some instances have become covered with a sapling or seedling growth of various species of coniferous trees.

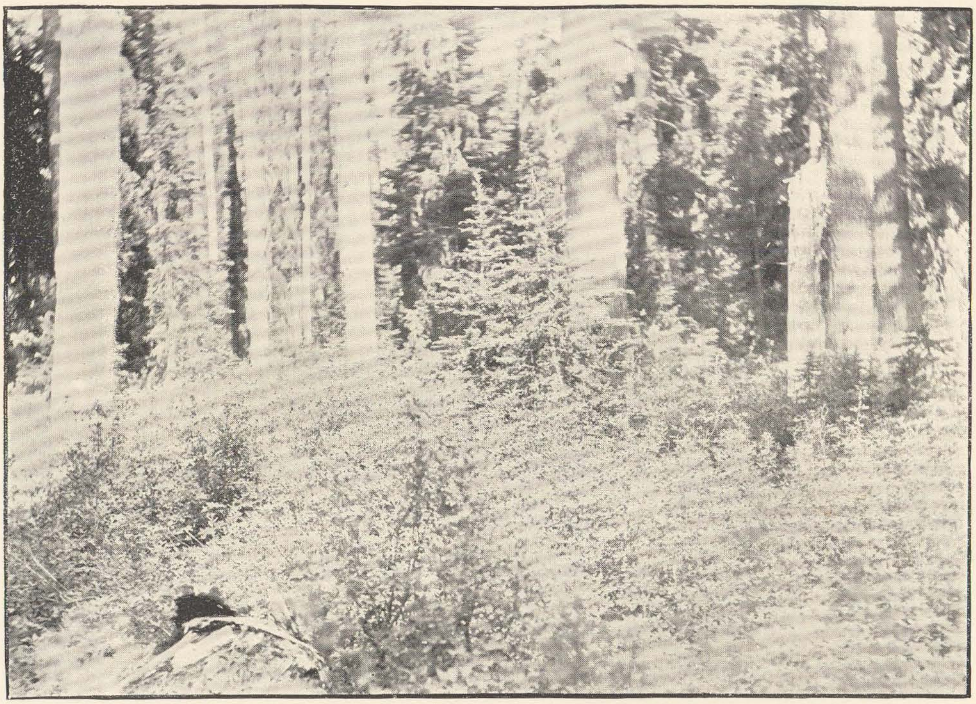
In the natural groupings of the different kinds of trees which compose the arborescent flora of the reserve there are observable aggregations of various species forming types of forest. The composition of these types depends upon three essentials—altitude, temperature, and moisture. As the two latter factors are usually governed by the one of altitude, and as, in the areas in the State north of the Clearwater, the grouping of the trees corresponds in a general way with definite elevational limits, certain types collectively have been regarded as forming zones of forest growth, and have been designated by the name of the tree which forms the chief or most important component of the aggregation. We have thus in Idaho three chief zones, or general types of forest growth, viz: (1) The zone of alpine fir; (2) the zone of mountain white pine; (3) the zone of western yellow pine.

In the northern portions of the State these zones are definable in their altitudinal relations with a considerable degree of exactness. They also are fairly well differentiated in the areas adjacent to the main range of the Bitterroots north of Nez Perces Pass, but elsewhere in the reserve their elevational limits are indefinite and subject to great variations upon different areas.

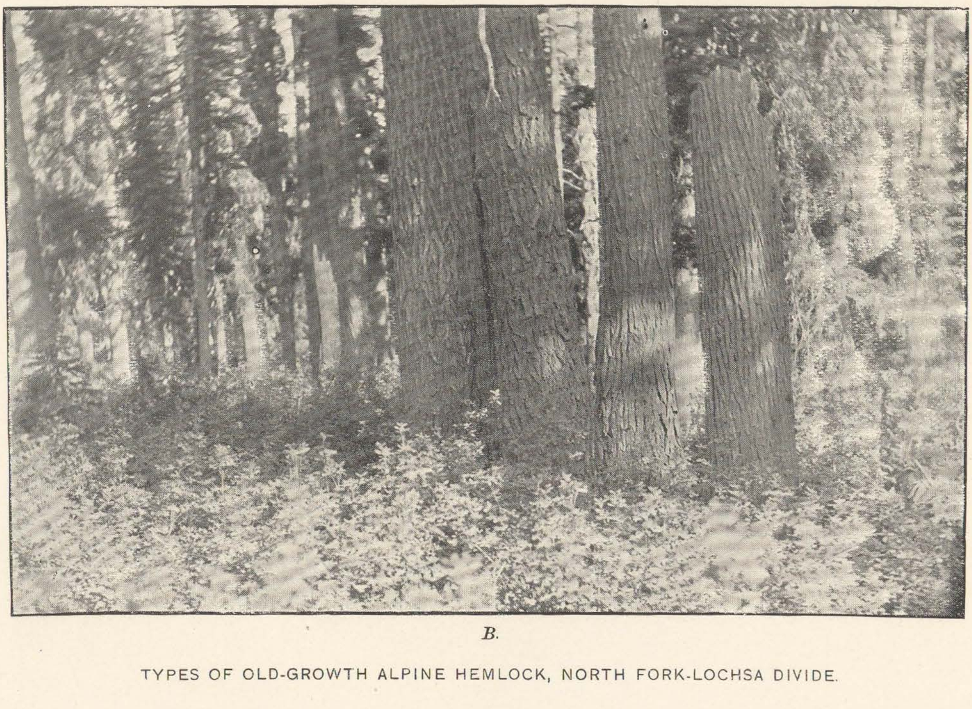
The zone of alpine fir is, on the whole, the one whose upward and downward extensions present the sharpest lines of demarkation. This is owing to the presence of a large percentage of those species whose lines of lowest range are closely drawn along the 6,000-foot contour, such as the white-bark pine, Lyall tamarack, and alpine hemlock. The species that compose the general zone or type are:

Pinus murrayana	Lodgepole pine.
Picea engelmanni	Engelmann spruce.
Larix lyallii	Lyall larch.
Abies lasiocarpa	Alpine fir.
Tsuga pattonii	Alpine hemlock.

A great variety of combinations or subtypes are formed by these trees, according to the prevalence of one or more of them in any particular stand, but, as a rule, the alpine fir is everywhere the predominating factor in point of number of individuals. The general altitudinal limits of the zone are from the crests of the highest ridges of the main range of the Bitterroots to elevations of 5,800 feet on northern slopes and in canyon bottoms, but it may go much lower. In the areas adjoining Brown and Musselshell creeks, in the Lochsa Basin, it descends to elevations of 3,300 feet. In the South Fork of Clear-



A.



B.

TYPES OF OLD-GROWTH ALPINE HEMLOCK, NORTH FORK-LOCHSA DIVIDE.

water district it occurs at fully as low an altitude. In the valley of Little Salmon it is found at the 5,000-foot contour. When the zone extends to these levels its components are lodgepole pine, Engelmann spruce, and alpine fir. It forms then a sort of transition to the mountain white-pine zone, but the abundance of alpine fir, which always characterizes it at all elevations, leaves no doubt as to the relationship of these outlying subtypes. The downward extensions of the zone depend upon soil moisture and temperature as the chief factors, air temperature during the growing season as the second one. In the areas where it descends to altitudes below 5,000 feet there is always present much water in the top or subsoil at a low temperature during the growing season.

The lowest part of the zone usually furnishes merchantable timber, principally composed of Engelmann spruce. In favorable localities the species may attain commercial sizes in the higher areas of the zone, as near the head of the Upper Lochsa Fork, at 7,000 feet elevation. The aggregate acreage in the reserve covered with subtypes of forest growth that collectively form the zone of the alpine fir amounts to 1,371,392 acres, or nearly 38 per cent.

The zone of mountain white pine occupies northern and eastern slopes below 5,800 feet and follows the canyon bottoms from this altitude down to 2,000 feet. For a large development of the trees that compose it, a deep soil, ample soil humidity, and higher temperatures are required than are necessary for the species of alpine-fir type. The zone comprises the following species:

Pinus monticola	Mountain white pine.
Pinus murrayana	Lodgepole pine.
Abies grandis	Great silver fir.
Larix occidentalis	Western larch.
Picea engelmanni	Engelmann spruce.
Thuja plicata	Pacific arbor vitæ.
Taxus brevifolia	Pacific yew.

Some of the subtypes of the zone show as great variations in their upward range as do the types belonging to the areas of the alpine fir in their downward extensions. Such are the stands of western tamarack in the South Fork of Clearwater district, which attain elevations of 7,000 feet. A very large proportion of the merchantable timber in the reserve occurs in this zone. It contains 1,091,072 acres, or about 30 per cent.

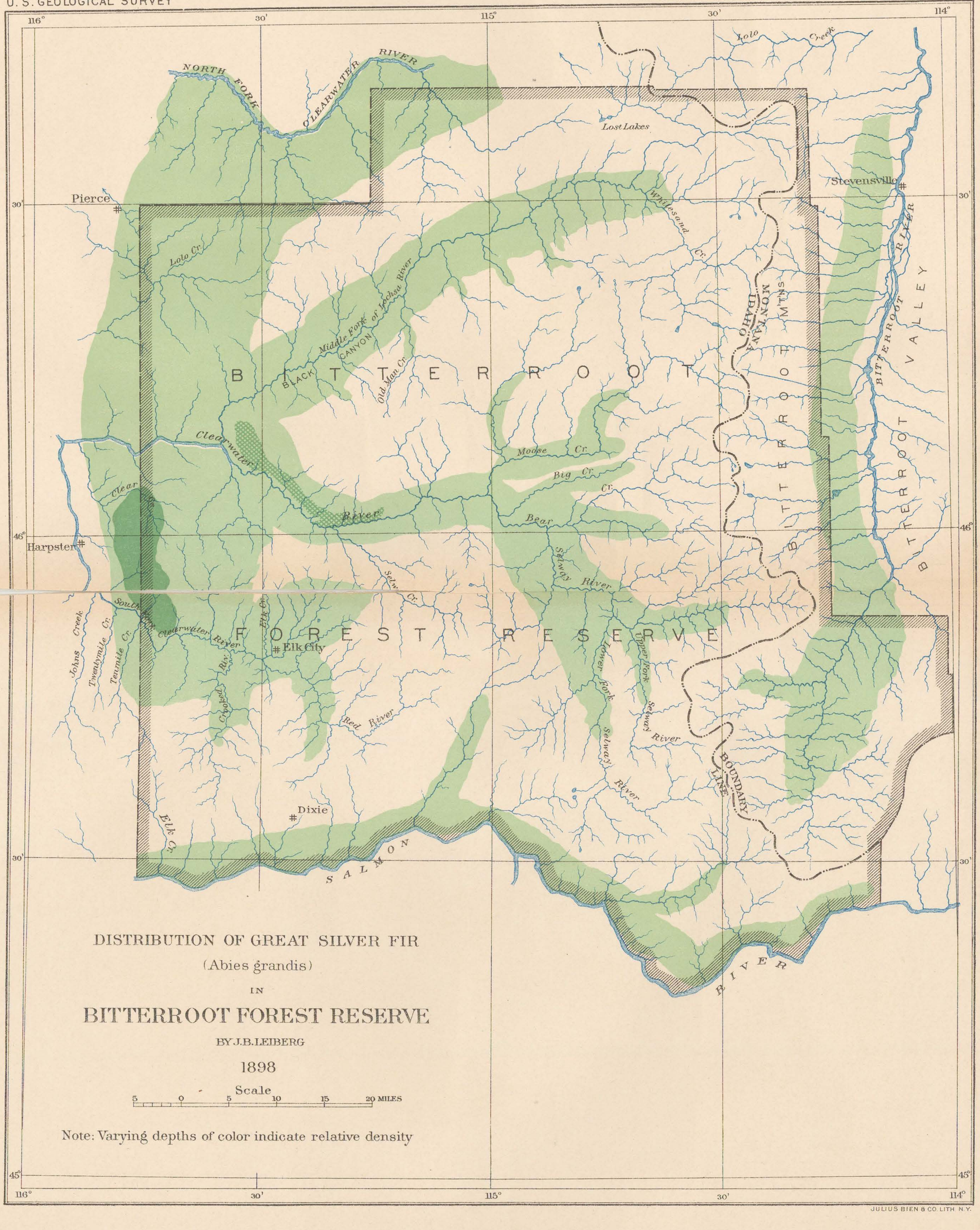
The zone of the western yellow pine extends to all areas below the 5,800-foot contour, where sufficiently high temperature conditions prevail. The species of conifers that compose it are such as prefer well-drained slopes for their habitat. Its upward range extends from the lowest altitudes of the valleys to elevations of 6,000 feet on the drier west- and south-facing slopes, and approximately to 4,000 or 4,500 feet on northern and western declivities. Sometimes it attains elevations of 7,000 feet, as on the rocky slopes of Grave Mountains, but this is merely due to local temperature conditions. A large percentage of the most valuable timber in the reserve occurs in this zone, and the areas covered by it are usually the most accessible of any in the Clearwater basins. It contains 1,149,696 acres, or about 32 per cent. The following are the principal species of trees which compose the forest growths in the zone:

Pinus ponderosa	Western yellow pine.
Abies grandis	Great silver fir.
Pseudotsuga mucronata	Red fir.
Pinus murrayana	Lodgepole pine.
Betula occidentalis	Western birch.
Betula papyrifera	Paper birch.
Populus trichocarpa Populus balsamifera	Cottonwood.
Populus tremuloides	Aspen.

This zone also contains small percentages of various semiarborescent willows and alders. There are clear indications that the relative altitudinal balance between the various zones is not constant. It fluctuates, gaining or losing in acreage accordingly. The changes occur slowly, extending over centuries, and result in profound modifications of the forest upon the areas affected. It is highly probable that climatic changes are at the foundation of the shifting of these forest types, but this is mostly a matter of conjecture; yet there are many indications pointing to some such cause. Forest fires also play a part in it, but their effects are at the best transitory. The changes that are taking place at the present day on these areas are: (1) An extension of the western yellow-pine zone through its red fir-yellow pine subtype into areas formerly occupied by subtypes belonging to both the zones of alpine fir and mountain white pine; this is the case in all of the Upper Selway Basin and in the Lochsa Valley; (2) an extension of alpine-fir types into tracts previously occupied by subtypes belonging to the mountain white-pine zone, which occurs in the basin of the South Fork of Clearwater; (3) a gradual elimination of certain subtypes of growth in the alpine-fir and mountain white-pine zones, which is here accomplished by the slow extinction of various species, of which the following kinds, which find their southern limit in the State on the reserve areas, are the most important. The species are:

Western tamarack.	Pacific arbor vitæ.
Lyall tamarack.	Mountain white pine.
Alpine hemlock.	

There is the clearest evidence that the western tamarack, mountain white pine, and Pacific arbor vitæ extended south of their present



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limits within comparatively recent times. In the case of the other species the evidence is not so clear. The former present a ragged line of termination from east to west across the reserve. Along this line are: (1) Old growths almost lacking the power of reproduction; (2) second growths scattered in isolated blocks among stands of the more vigorous species that are crowding them out; (3) isolated trees, remnants of the more abundant and vigorous growths that flourished here in the past. The general conclusions to be drawn from the limitations of the zones as they now exist are that all the subtypes of the yellow-pine and alpine-fir zones are gaining ground, while the mountain white-pine zone is constantly losing.

The undergrowth in the upper areas of the alpine-fir zone is usually scanty; sometimes there is none at all, or a dense, close sward of bear grass (*Xerophyllum tenax*), mixed with *Vaccinium scoparium*, covers the ground. In the lower edges of the zone, especially in the upper bottoms of the canyons, the undergrowth is often excessively thick, consisting of young trees of the various species of conifers, *Alnus alnobetula*, *Sorbus occidentalis*, *Menziesia ferruginea*, *M. glabella*, *Ledum glandulosum*, *Azalea albiflora*, and in the edges of the subalpine meadows matted growths of *Vaccinium occidentale*, and occasionally *Betula glandulosa*. The mountain white-pine zone is the richest of any in undergrowth. In subtypes of mixed forest stands it is always dense. In subtypes of pure growths, as in the blocks of Pacific arbor vitæ, it is often nearly absent or is composed of trailing Pacific yew. The more common and abundant shrubs in the zone are *Acer glabrum*, *Sambucus glauca*, *S. melanocarpa*, various species of alders and wild roses, *Ceanothus sanguineus*, *C. velutinus*, *Cornus stolonifera*, *Rhamnus purshiana*, and *Rubus parviflorus*. The upper areas, where they join the zone of alpine fir, carry the densest undergrowth, which is composed of 80 per cent of *Menziesia ferruginea* and *M. glabella*. These two shrubs, as to bulk, form together fully 50 per cent of the undergrowth in the entire reserve. The undergrowth in the zone of western yellow pine is nearly the same as in that of the mountain white pine, except that the *Menziesia* are always lacking. In subtypes of the zone composed of pure growths of yellow pine the underbrush sometimes consists of dense thickets of *Opulaster malvaceus*; at other times there is no shrubby undergrowth, the ground being covered by a sward of grass or sedge, and sometimes the undergrowth is a mass of saplings of red and great silver firs.

FOREST CONDITIONS OF THE RESERVE IN DETAIL.

For convenience, in a more detailed statement of the forest conditions in the reserve, the entire area is here divided into districts corresponding in a general way with the drainage basins.

The divisions are as follows:

I. North Fork of Clearwater Basin.

II. Lochsa Basin, including Lolo Fork and the Middle Fork of Clearwater Basin.

III. Selway Basin.

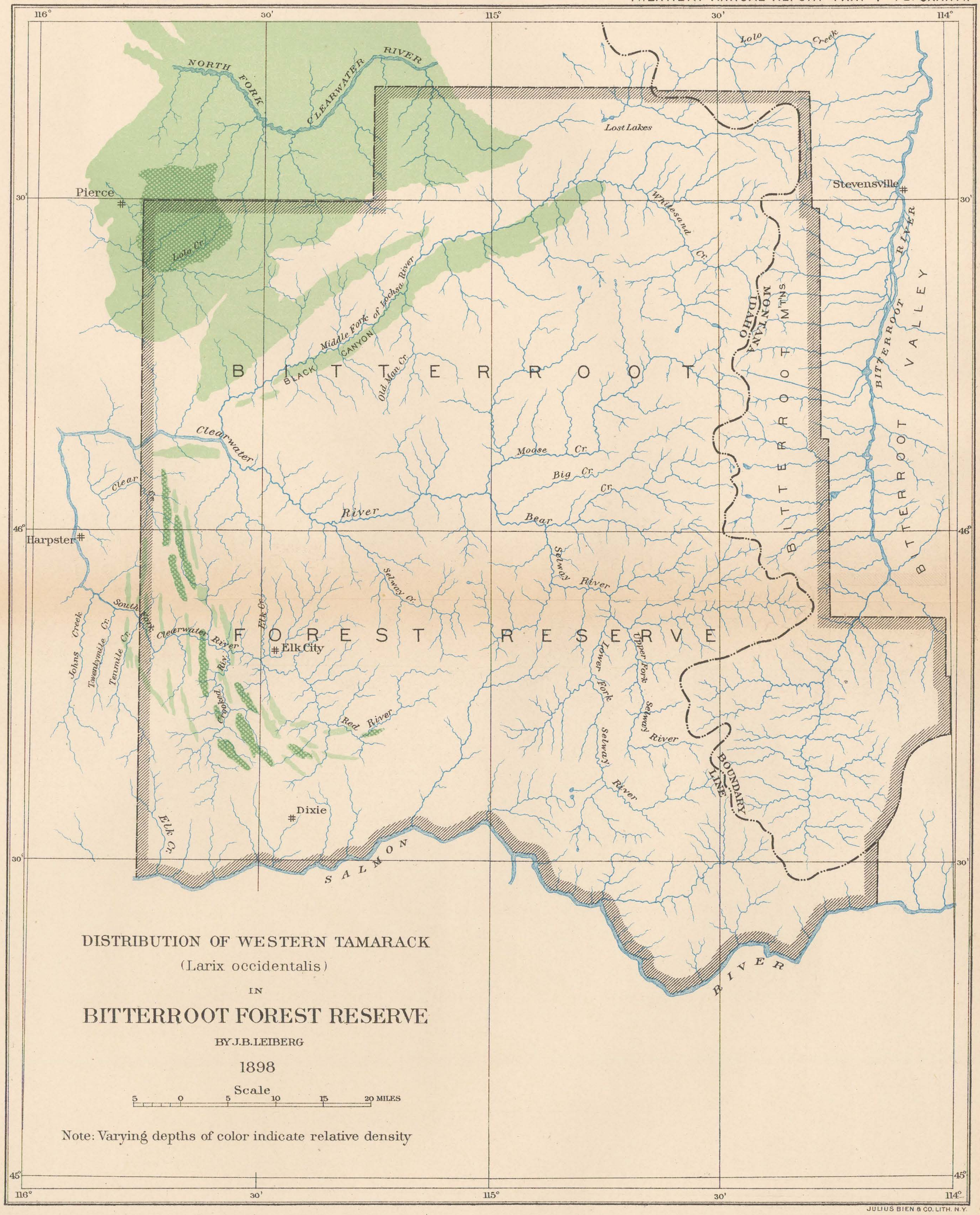
IV. South Fork of Clearwater Basin.

V. Salmon River slopes.

The areas included within these districts constitute the Idaho portion of the reserve.

NORTH FORK OF CLEARWATER BASIN.

This district contains tracts lying north of the Lolo trail. It is here made to include some portions around Pierce not properly within the reserve limit, but examined in connection with the general work on the other areas. The area of the district can not be stated with accuracy, owing to the absence of definite surveys to fix the northern boundary of the reserve. There were examined in it 400 square miles, or 256,000 acres. The region forms the southern portion of the drainage basin of the North Fork of Clearwater River, and has an altitude varying from 3,000 feet above sea level in the valleys to 8,000 or 8,500 feet on the summit of the inclosing ridges. The highest elevations occur in the southeastern portion and along the Lolo trail, on the North Fork–Lochsa divide. By far the greater portion has an altitude less than 5,000 feet. In general it is not a very rocky region, the ridges being well covered with soil and supporting an abundant forest growth where not destroyed by past fires. The slopes are not abrupt below the 6,000-foot contour, becoming rocky and precipitous only above this elevation. The areas that lie contiguous to the Lolo trail and the North Fork–Lochsa divide, with an altitude of 5,500 feet and upwards, have at the head of their streams the common wet and springy meadows, with now and then a small lake resulting from past glacial erosion, and slope down into low, well-timbered valleys. As the region lies mostly on northern slopes, grassy hillsides, the result of old burns, are almost entirely absent. West of Pierce, between it and Weippe, the country is made up of a series of low hills and divides scarcely rising above 4,500 feet. Between these hills lie numerous marshy sedge meadows. The aspect of the country here indicates that it once upon a time formed the shore line of a large lake that covered the plains to the west and existed within a comparatively recent geologic period. The soil and comminuted granitic débris of the underlying country rock cover these hills deeply and make possible a heavy forest growth. East and southeast of Pierce the mountain spurs rise rather steeply to elevations of 5,000 feet and form the divide between Oro Fino Creek and the tributaries of the Lolo Fork of Clearwater. The forest presents the common three chief forest types of northern Idaho, viz, the western yellow-pine type, the mountain white-pine type, and



DISTRIBUTION OF WESTERN TAMARACK
(Larix occidentalis)
IN
BITTERROOT FOREST RESERVE
BY J.B. LEIBERG
1898

Scale
5 0 5 10 15 20 MILES

Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

the alpine fir type. The different types have somewhat of a zonal arrangement, but are not well differentiated as to species of trees belonging to each except in the middle and upper portion of the alpine-fir type of forest. The areal extent of the forest belonging to each of the types so far as they may be separated is as follows:

Principal forest types in North Fork of Clearwater Basin.

Species.	Per cent.	Acres.
Western yellow-pine type	10	25,600
Mountain white-pine type	75	192,000
Alpine-fir type	15	38,400

Thus, of the entire district 85 per cent, or 217,600 acres, is below the 5,800-foot contour, which elevation is here the approximate altitudinal limit for the upper portion of the mountain white-pine type of forest.

The stand of timber in the district is good, except where recent fires have devastated the country. The greater portion is a second growth less than 120 years old, therefore, except in the case of red fir and tamarack stands, not yet to be classed as strictly commercial timber. Seventy per cent of the forest is of this immature growth and only 30 per cent is old growth of various ages up to 500 or 600 years. The old growth consists principally of mountain white pine, Engelmann spruce, great silver fir, and alpine hemlock. Trees of other species occur also, but mostly as scattered individuals. The largest bodies of the old growth are found adjacent to the North Fork–Lochsa divide, and are of the alpine hemlock species. The next largest are in the gulches near Pierce, mostly on French Creek, and consist of the mountain white pine. The second growth is scattered over the district. It invariably occurs as a reforestation of burned-over areas, as shown by charred stumps of the older forest. The heaviest stand of the growth is in the region west and southwest from Pierce, and is formed by the mountain white-pine species. Large tracts occur here that carry from 2,000 to 4,000 trees per acre, from 8 inches basal diameter up. This heavy second growth is not a first-class stand. The trees are full of dead and living limbs from base to summit, and show a large percentage of rot. A stand of this kind, estimated by taking all trees having basal diameters of 10 inches and upward and scaling them to top diameters of 8 inches, may give as much as 500,000 feet B. M. as the quantity on an acre, while scaled by commercial methods it may not run above 6,000 or 7,000 feet B. M. The next heaviest stand of second growth consists of lodgepole pine, and occurs in many places in the district; and, although the number of trees per acre may be much greater than in the stands of the mountain white pine, the actual timber volume is at all times much less, owing to shortness of trunks and small diameters. The reforestation process represented by the second growth has proceeded with great inequality as regards the species that have taken possession of the burned-over areas. The previously-existing forest in the region around Pierce appears to have consisted of gigantic cedars, tamaracks, and silver firs. It is now covered with mountain white pine, lodgepole pine, and red fir as the principal components. The burned-over subalpine areas have grown up in some places to lodgepole pine where the former forest was white-bark pine, Engelmann spruce, and alpine fir. In other localities thick growths of alpine hemlock have replaced the alpine fir.

Fires of recent date have laid waste large tracts of the district. They have been especially destructive in the region around Pierce and in the subalpine regions along the Lolo trail, in the southeastern areas. The tracts that are best preserved and contain the largest body of living timber are in the central portion of the district, where the forest appears to have been too wet to burn readily, but there are no very large tracts anywhere that do not show the effects of recent fires. Pierce being a mining settlement, and the country thereabouts containing auriferous gravel in many localities, forest fires could be expected to follow as a natural sequence to the development of the mineral resources. Of the 256,000 acres included in the area under consideration, the forest on 30 per cent, or 76,800 acres, has been totally destroyed or so badly burned or scorched that its destruction by rot, induced thereby, or high winds is merely a matter of a few years.

Reforestation of the modern burns is fairly rapid in the region around Pierce, but is slow and deficient in the areas lying in the eastern sections. The tendency here is toward densely brush-covered slopes with the *Menziesia* shrub as the chief component.

The composition of the coniferous forest in the district is as follows:

	Per cent.		Per cent.
Western yellow pine	.005	Engelmann spruce	19
Mountain white pine	12	Red fir	14
Lodgepole pine	25	Pacific arbor vitæ	4.5
White-bark pine	.005	Alpine hemlock	7.5
Great silver fir	9	Alpine fir	3
Western larch	6		

The stand of commercial timber in the district is as follows:

	Feet B. M.
Western yellow pine	6,000,000
Mountain white pine	250,000,000
Great silver fir	85,000,000
Western larch	75,000,000
Engelmann spruce	180,000,000
Red fir	110,000,000
Pacific arbor vitæ	48,000,000
Alpine hemlock	122,000,000
Total	876,000,000

In this table are included trees of the species enumerated having diameters of 12 inches at the base and upward. The alpine hemlock is here regarded as commercial timber, as I believe it to be in every way equal if not superior to the western larch, which is commonly taken as such in this region. About 30 per cent of the old growth of alpine hemlock and Engelmann spruce, and about 5 per cent of great silver fir is rotten at the core. This is excluded from the estimates in the table.

LOCHSA AND MIDDLE FORK AREAS.

This district contains 2,200 square miles, or 1,408,000 acres. It forms the drainage basin of the Middle Fork of the Clearwater and its largest affluent, the Lochsa, which is reckoned the proper continuation of the Middle Fork. It is a rough and broken region, with the highest ridges and peaks that exist in the interior of the reserve. The Grave Mountains, which constitute the Lochsa–Selway divide, inclose the basin on the south, extending from the main range of the Bitterroots to the mouth of Selway Fork. West of this point the divide between the Middle Fork and the northern tributaries of the South Fork of Clearwater becomes the southern boundary of the district. At the north the basin is bounded by the divide between the North and the Lochsa forks of Clearwater. About midway between the two inclosing ridges lies the main valley, sunk from 4,000 to 5,500 feet below their crest lines, with a great canyon system cutting back on either side from the main stream into the inclosing ridges. The chief topographic features of the Lochsa portion of the district are high, rocky crest lines, narrow canyons, and extremely steep slopes. One of the principal tributaries of the Middle Fork of Clearwater is the Lolo Fork. Its drainage basin occupies the northwestern areas of the district. In its lower sections, which are outside the reserve areas, the stream has excavated a deep and narrow canyon through basaltic formations. The upper portions of the stream, dividing into many forks, form valleys of shallow depth, sometimes one-half to three-quarters mile wide, often with marshy and sedgy meadows along the extreme western border of the reserve. Where the tributaries of the Lolo begin to lengthen toward the east the valleys undergo a gradual transition to the canyon formation of the Lochsa, until finally they assume the same general features that characterize those valleys.

All three of the leading Idaho forest types or zones are represented in the district. The alpine-fir type is more abundant than either of the others, owing to the great height of the primary divides and their laterals. The true alpine-fir type, pure or mixed growths of alpine fir, white-bark pine, Lyall larch, and alpine hemlock, occurs on the main range of the Bitterroots, on the Grave Mountains, and in scattered localities on the North Fork–Lochsa divide, at 7,000 to 9,000 feet altitude, rarely in large bodies. Usually it is more or less mixed with Engelmann spruce and lodgepole pine, and in this form covers all crests and slopes above 6,000 feet elevation, often descending on northern declivities to the 5,000-foot contour. The growth, even at its maximum stand, is everywhere of inferior quality. The alpine hemlock, which is a conspicuous member in the alpine-fir type of forest in the district north of the Lolo trail, comes into the Lochsa areas only along the crests of the North Fork–Lochsa divide, and is seldom much more than a sapling in stature. Most of the Engelmann spruce is likewise small and dwarfed throughout the areas where the above forest type prevails.

The mountain white-pine type is best developed in the basin of the Lolo Fork. In the swampy areas of the extreme western portion bordering Brown and Musselshell creeks and their tributaries the stand of timber of this type is very dense. It consists chiefly of Engelmann spruce, mountain white pine, and alpine fir, the latter descending to levels of 3,000 feet. In the eastern and central portions of the basin, mountain white pine and western tamarack form the chief components of the type. In the valley of the Lochsa the white-pine type of forest generally occurs on the northern and eastern slopes of the mountains below the 6,000-foot contour and in the bottoms of the canyons. It is composed of western tamarack, Pacific arbor vitæ, great silver fir, lodgepole pine, and Engelmann spruce as the principal trees. The mountain white pine, here at the limit of its southward range in the reserve, is found in very small bodies, or as scattered trees in the bottoms and on the lower slopes, and the Pacific arbor vitæ occurs as pure growths in the swampy canyon bottoms or as small trees on the slopes, forming there a sort of undergrowth. The stand of timber in this zone, throughout the middle portion of the Lochsa Valley and along its tributaries, is mostly thin and deficient in commercially-valuable timber, but in the upper portion are tracts where it is heavier. This is due to the occurrence of areas covered with old growths of Engelmann spruce and lodgepole pine, of which the most extensive is situated in the region of the two principal upper Lochsa forks, west of the alpine regions of the main range of the Bitterroots and east by north of Grave Peak. It covers an area of, approximately, 250,000 acres, and consists of alternating blocks of Engelmann spruce, 150 to 300 years old, and of the archaic type of lodgepole pine, 200 to 350 years old, mixed with strips of the common mountain type of the species of various ages.

The western yellow-pine zone or type of forest is common throughout the district at altitudes below 5,800 feet. It is found in the Lolo Basin at various elevations. The dry and warm southern slopes in the Lochsa Basin below contours of 5,800 feet are mostly covered with growths of this type. On the northern slopes it is uniformly found below altitudes of 5,000 feet where the slope is warm and dry. Yellow pine, red fir, and great silver fir are the principal trees that constitute the type. The yellow pine is mostly confined to the Lolo Basin and the southern slopes in the Lochsa Valley. It extends to the main forks of the latter stream, ceasing only with the near approach to the subalpine areas of the main range of the Bitterroots. Outside of the Lolo Basin and the lower portion of the Lochsa Valley it is of small size and comparatively worthless as commercial timber. The red fir is abundant throughout the zone. In the Lolo Basin it is of fair quality, and occurs in commercial sizes. On the southern slopes in the Lochsa Valley it is commonly of small dimensions, but on the northern slopes it is frequently found of large size.

Immense fires have ravaged the district both in the past and in recent times. The only areas containing any considerable quantities of old growth are the ones previously mentioned as existing northeast of Grave Mountains and the yellow-pine tracts in the Lower Lochsa and the Lolo basins. Small bodies of the alpine-fir type of forest of this age situated on isolated, rocky knolls on the high divides are also found here and there untouched by fires. But the bulk of the forest in the district is, or was, a second growth after ancient fires. Modern fires have burned the growth over the greater portion of the district; in fact, the only tracts on which forest fires have not run through the timber are those containing old growths of Engelmann spruce, archaic type of lodgepole pine, and small areas with a nearly pure growth of alpine fir. The fires of modern date, none earlier than 1862, most of them much later, have practically destroyed the timber on 701,000 out of the 1,408,000 acres in the district, or nearly 50 per cent. When I say "practically destroyed," I mean that though not entirely burned up, the unconsumed forest has been so severely damaged by the fires that the remaining timber is practically valueless. The destruction has been the greatest in the alpine-fir type of forest, owing to its greater extent, less so in the white-pine tracts, at least in those carrying the yellow-pine type of forest. For many years the Lochsa Basin has been a favorite field with prospectors hunting "lost mines," concerning which all sorts of wild and fabulous tales are extant. In the search for imaginary treasures the timber has suffered enormously from fires that have been set for the purpose of destroying the forest covering of the mountains to facilitate the search. The results of the fires are bare or brush-covered mountain slopes, as the forest does not rehabilitate itself very readily in the Lochsa Basin. The ancient fires created large open hillsides covered with grass, sedges, or bear grass. Hundreds of years have passed since some of these slopes were deforested, and they have not yet even begun to show a return to the ancient condition. The same result accompanies modern fires. There is a decided tendency to grassy or sedgy slopes, instead of forested ones. A good illustration of this is to be seen along Hoodoo or Elk Summit Creek. Burned 20 or 25 years ago, the slopes are now grassy fields, or they are covered with a low growth of huckleberry bushes. Neither the grass nor the brush growth is of any value whatever here, and of reforestation there is no sign yet. On the Lochsa–Selway divide, between Fish Lake and Oldman Creek, are miles of slopes with fire-killed timber and no young growth springing up to take its place. Similar conditions prevail north of Grave Mountains, on the North Fork–Lochsa divide, and in many other localities. Where the reforestation process is asserting itself, the species coming in as the first growth on the denuded areas is mostly the lodgepole pine of the common mountain type, a tree of no commercial value in this section. In the Lolo Basin the reforestation process is proceeding more rapidly, due to deeper soil and more gentle slopes that do not shed water so rapidly as do the Lochsa slopes. In the areas of this basin the lodgepole pine is not always the first tree in the reforestation process. Quite frequently the western tamarack or the great silver fir forms the first tree growth after a fire.

The areal extent covered by the principal forest types is as follows:

Principal forest types in Lochsa and Middle Fork areas.

Species.	Per cent.	Acres.
Western yellow-pine type	15	211, 200
Mountain white-pine type	30	422, 400
Alpine-fir type	55	774, 400

About 40 per cent, or 563,200 acres, are situated below the 5,800-foot contour.

The composition of the coniferous forest in the district is as follows:

	Per cent.		Per cent.
Western yellow pine	8	Mountain white pine	1
Lodgepole pine	35	White bark pine	0. 05
Great silver fir	5	Alpine fir	10
Western larch	3	Lyall larch	0. 0005
Engelmann spruce	20	Red fir	10
Pacific arbor vitæ	6. 5		

The stand of timber in the district, with reference to commercial sizes, is as follows:

	Feet B. M.		Feet B. M.
Western yellow pine	150, 000, 000	Mountain white pine	30, 000, 000
Great silver fir	20, 000, 000	Western larch	90, 000, 000
Engelmann spruce	220, 000, 000	Red fir	200, 000, 000
Pacific arbor vitæ	150, 000, 000	Alpine hemlock	10, 000, 000
Archaic type of lodgepole pine	38, 000, 000		908, 000, 000

In this estimate the archaic type of lodgepole pine is introduced because its timber is so widely different from all other forms of the species that it probably possesses commercial value. In the Bitterroot reserve the type is rigidly confined to the area east of the Grave Mountains. It will be noticed that Engelmann spruce leads all the other species. This is due to the heavy stands of this species in the old growth.

SELWAY BASIN.

The Selway is, next to the Lochsa, the largest of the Middle Fork tributaries. Its eastern affluents drain the western slope of the Bitterroot main range from Lost Horse Pass on the north to Mineral Hill on the south, a distance of 60 miles. From this source is received most of the volume of the stream, the drainage reaching the river through long gorge-like canyons north of Nez Perces Pass and through an intricate system of shorter, more tortuous ones south of that point. The drainage received into the stream from the west originates in the divides that cut off the basin from those of the South Fork of the Clearwater and Little Salmon, and is unimportant in volume. The area of the basin is 1,320 square miles, or 844,800 acres. The general trend of the main valley is from south to north. The bed of the river lies in stretches of a deep canyon or gorge formation, alternating with small widenings, where the canyon walls recede. The bottom of the valley varies in elevation from 2,000 to 4,000 feet above sea level, whilst the summits of the inclosing ridges rise to an altitude of 9,000 feet in the main range of the Bitterroots, to 7,500 feet in the Selway–South Fork divide, and to 8,000 feet in the Salmon–Selway divide at the head of the stream. Owing to the height of the inclosing ridges and the steep slopes some of the smaller tributaries have very rapid descents. A few of the creeks heading in the main range of the Bitterroots south of Lost Horse Pass, for example, fall 7,000 feet in a distance of 20 miles, or an average of 350 feet to the mile.

The Selway Basin is a region of rocky and very steep slopes. Much the larger portion presents clear evidence of extensive glacial erosion in the past, especially so along the main range of the Bitterroots, along the Lochsa–Selway divide, and at the head of the basin in the Salmon River divide; less so in the Selway–South Fork divide. The areas of glacial erosion are extremely precipitous in the subalpine tracts, where the canyons and slopes are strewn with big bowlders and the soil covering is very light and thin, or where frequently there is none at all.

The stand of timber in the basin is large, owing to the great amount of old growth on the yellow-pine areas, but is not generally dense. The western yellow-pine type and the alpine-fir type are much better represented than that of the mountain white pine and cover a far greater area, the three chief types of the forest growth being represented in the following proportions:

Principal forest types in Selway Basin.

Species.	Per cent.	Acres.
Western yellow-pine type	54	456,192
Mountain white-pine type	6	50,688
Alpine-fir type	40	337,920

The yellow-pine type extends throughout the entire valley of the Selway, from its mouth to its head in the Salmon River divides, where it crosses the ridges and joins the yellow-pine areas in the Bitterroot and Salmon river valleys. Yellow pine also occurs in the lower portion of the long canyons that have their origin in the main range of the Bitterroots and follows to their heads many of the valleys of the tributaries heading in the Selway–South Fork divide. The basin along the main valley, and for several miles back both east and west, appears to have an exceptionally high annual temperature as compared with the other regions of the Clearwater country. To this must be attributed the large percentage of its area that is covered with the western yellow-pine type of forest. The trees that here form the bulk of the yellow-pine type are the western yellow pine and the red fir. The chief growth of yellow pine occurs on the western slopes of ridges, in proximity to the main valley, and on the southern slopes of the tributary streams that enter it from the east and west. Scattered tracts are also found on the eastern slopes facing the valley. The stand is the average for dry areas in northern Idaho; that is, 2,000 to 5,000 feet merchantable timber per acre, but occasionally it rises to 15,000 feet per acre for small tracts. Above the junction of the two upper forks, about 45 miles above the mouth of the stream, the yellow pine thins out and occurs only in scattered bodies of limited extent.

The red fir is the most abundant of the two trees that constitute the chief components of the type, but it lacks the volume of the yellow pine, acre for acre, being mostly of the small western Montana form. Its range is throughout the basin at all elevations below 7,000 feet, except in proximity to the main range of the Bitterroots, where it scarcely ascends beyond 6,000 feet elevation. Above the upper forks of the Selway it forms the principal portion of the western yellow-pine type of forest, occurring abundantly on all the slopes.

The mountain white pine type is sparsely represented in the district with reference to the acreage it occupies, but it contains by far the heaviest stands of timber of any type in the basin. Pacific arbor vitæ is its chief component, the mountain white pine and the western tamarack having practically ceased within the areas belonging to the

Middle Fork–Lochsa district. The arbor vitæ, or cedar, as it is commonly called, occurs in the canyons below the Upper Selway forks. It is especially abundant in Moose and Bear creek canyons and in those of their larger tributaries. The canyons of these streams widen at various places and form marshy expanses where is found the heavy, nearly pure, old growths of the species, which are commonly known as the cedar groves of the Middle Fork. They are noteworthy as representing the oldest living forest in the reserve. This growth, in some cases probably above 1,000 years old, shows the tree with the greatest dimensions that it attains in the reserve. Specimens occur as much as 12 feet in diameter and with clear trunks 100 feet in length, and the stand in some places is as high as 40,000 feet per acre. A large percentage of the growth is unsound, being overmature and rotten at the core. In the canyons above Bear Creek the tree is found in scattered, small bodies, and ceases altogether at the junction of the upper forks of the stream. Engelmann spruce and great silver fir are plentiful in the mountain white-pine type of forest, alternating in more or less compact stands with the arbor vitæ, but the trees are generally small in stature, or, when large, are rotten at the core owing to past fires, or they have insufficient development of trunk to make them of commercial value.

The alpine-fir type of forest covers next to the largest acreage in the district. The species of conifers comprising the bulk of the stand are Lyall larch, lodgepole pine, Engelmann spruce, white-bark pine, and alpine fir. The alpine fir and Engelmann spruce are most abundant. The forest, as a rule, is thin throughout the zone. None of the trees reach merchantable size. On the areas that slope directly away from the main range of the Bitterroots the forest occurs in patches separated by rocky combs or slides, or areas denuded of all soil covering, upon which nothing grows. Similar conditions present themselves on the Lochsa–Selway divide and on the higher elevations near and at the Salmon divides.

Forest fires, ancient and modern, have everywhere devastated the basin. None of the zones have escaped. Fires in the yellow-pine areas have destroyed much of the red fir, sparing only the yellow pine by reason of its superior fire resisting qualities. In the southern portion of the district 60 per cent of the red fir has been destroyed. In the mountain white-pine type of forest large blocks of the heavy cedar growths have been so thoroughly burned out, both timber and soil, that there remains not a vestige of forest growth. The lodgepole-pine growth over thousands of acres near the Salmon divide at the head of the basin, where it represents the alpine-fir type of forest, has been fire killed at the root and thrown down by wind and snow. In the subalpine areas of the main range the destruction has been in circumscribed patches, the bare expanses of rocks and wet meadows that break the continuity of the forest in these regions having prevented any one conflagration from spreading over a very large territory.

The after effects of the fires do not here differ materially from those observable in other localities. The ancient fires created large openings on the hillsides sloping southward on the Lochsa–Selway divide. These openings are now grassed over and show little sign of reforesting. The grass growth on them is a continual menace to the life of the adjacent forest, as the dry grass furnishes an excellent medium for the starting point of big conflagrations. The yellow-pine forest at lower elevations is open, and the forest floor is grass or sedge covered. Here, likewise, the grass assists in spreading the fires, which in this type of forest kill the yellow-pine saplings, but appear to promote the spread of the red fir, a tree that everywhere in this zone crowds the growth of the yellow pine on the fire-swept areas. The red fir is here, however, of much less value than the yellow pine, owing to its deficient trunk development. In the humid, subalpine tracts lodgepole pine covers the burned areas almost everywhere, to the exclusion of all other species, but south of Nez Perces Pass the persistent fires to which the forest has been subjected seems to favor the growth of red fir at the expense of the lodgepole-pine areas. This is the only instance known to me where a tree of superior value replaces one of inferior on burned-over forest ground.

The burned area in the district is reckoned at about 35 per cent of the whole, or 300,000 acres.

The composition of the coniferous forest in the basin is as follows:

	Per cent.		Per cent.
Western yellow pine	21	Lodgepole pine	17
White-bark pine	.05	Great silver fir	3.5
Alpine fir	7	Lyall larch	.0005
Engelmann spruce	11	Red fir	34
Pacific arbor vitæ	5		

The stand of timber is as follows:

	Feet B. M.
Western yellow pine	700,000,000
Great silver fir	90,000,000
Engelmann spruce	85,000,000
Red fir	900,000,000
Pacific arbor vitæ	550,000,000
Total	2,325,000,000

SOUTH FORK OF CLEARWATER BASIN.

This district forms the southwest portion of the reserve and contains 1,024 square miles, or 655,360 acres. It differs considerably in its topographic features from the other districts in the reserve in that the region is less broken, the divides are not uniformly so high, the slopes not so rocky or precipitous, and that the valleys in many places contain broad and nearly level areas.

The district is formed by the upper basin of the South Fork of Clearwater River, which splits up into three principal forks, viz: American, Red, and Crooked rivers. The larger portion of the main stream lies outside of the reserve. The forks of the stream have their courses through valleys that occasionally widen into broad expanses or contract into narrow canyons. Collectively, the American and Red rivers form a rather wide, open basin with many low, broad, transverse or longitudinal ridges separating the lesser tributaries, while Crooked River flows, principally, in a narrow canyon. The course of the main stream lies, as already remarked, mostly outside the reserve through a deep canyon in basaltic formation, its slopes presenting the ordinary, more or less completely-terraced appearance peculiar to such rock. The divides which inclose the basin vary in elevation from 5,800 to 9,000 feet. The highest summits as well as the most rocky and precipitous ones are at Buffalo Hump, in the angle formed by the Salmon River divides near the head of Crooked River. This district does not appear to have been subjected to such intensive glaciation as mark some of the other areas in the reserve. The effects of glacial erosion are mostly confined to the ridges bordering Newsome Creek and Crooked River.

The district shows clearer than any other in the reserve the result of ancient fires. About 80 per cent of it is covered with lodgepole pine, the growth of which is directly traceable to the effects of fires that ravaged the section a century or more ago. This growth is very often 90 per cent pure, and is the most conspicuous feature in the forest cover of the basin. The lodgepole pine is not of uniform age. It varies from 90 to 120 years. Some of its stands are in full vigor, others are overmature and are beginning to give way to a young growth of the original forest that the lodgepole pine has replaced. Between the two extremes of lodgepole-pine growths are all gradations in age, showing that the ancient fires did not lay waste the basin in one or several seasons, but that it was the work of many years. The early settlers, or rather the prospectors that discovered the Elk City placers in 1860 and 1861, did not spare the lodgepole-pine growth that they found covering the country, but fired it in many places. The conflagrations have continued to this day and are slowly but surely destroying the lodgepole pine and other types of forest growths in the basin.

The chief forest types of the reserve occur in the district as follows: The western yellow-pine type is found on the western slopes of the ridges that form the divide between the main South Fork and Newsome Creek; also to a limited extent on the eastern slopes of the same and on the warmer and drier south, east, and west slopes of the ridges that separate the American, Red, and Crooked river forks. It is limited in extent wherever it grows. On the western slope of the ridges between Newsome Creek and the main South Fork and in the interior portions of the basin most of the type consists of western yellow pine in 40 to 60 per cent pure growths. Elsewhere the stand is chiefly composed of red fir of small size. The altitudinal limit of the type is about 5,000 feet on the ridges west of Newsome and 4,000 to 4,500 in the interior of the district. They are thus considerably lower here than in the districts farther north. A higher rate of precipitation appears to be the cause of it, possibly a lower mean annual temperature as well; for it is an incontrovertible fact, as shown by the forest and the herbaceous flora and the cultivated garden vegetables, that a higher spring, summer, and fall temperature prevails in the Lochsa Basin than in that of the South Fork at similar elevations.

In times antedating the century-old burns the mountain white-pine type of forest covered most of the areas in the district. The dead remains of the ancient growth prove this. The great silver fir and the western tamarack were the trees that then formed the bulk of the forest of this type. At the present time the lodgepole pine covers most of the areas of the white-pine zone. The heaviest stands of timber in the district are composed of great silver firs. The species is found throughout the basin, but the most extensive stands of it occur on the ridges west of Newsome Creek. Here it is an old growth and the trees that compose it far surpass in size and numbers any similar growth of the species in Idaho north of Salmon River. The stand of this one species in many of the blocks runs from 20,000 to 40,000 feet B. M. per acre. The growth is coarse and overmature and is badly spotted with decay incident to its great age. The other component of the mountain white-pine type, the western tamarack, grows on the ridges west of Elk Creek between elevations of 5,000 and 7,000 feet, extending from the Middle Fork–South Fork divide, where it connects with the range of the species in the Middle Fork–Lochsa Basin, around the head of Crooked River east of Buffalo Hump, and thence eastward along the Salmon River divides to a point about 15 miles west of Little Salmon. In past times, that is within the last two centuries, the species extended east to the Little Salmon Valley, as shown by stumps found in the heavy lodgepole-pine forest along the main Salmon divide, between Mountain Meadows and the Little Salmon breaks. Its extinction is due wholly to forest fires, and unless some way is found to prevent the annually-recurring conflagrations in the district it is a mere question of time when the species will have been entirely exterminated in the South Fork Basin. The bulk of the stand in the district was an old growth of magnificent proportions. Many of the remaining trees are 4 feet in diameter at the base with trunks of a most remarkable symmetry, sometimes 80 to 90 feet in clear lengths. These tamarack stands were by far the most valuable forest in the district at the time settlements began. It is not possible to state with any great degree of accuracy the amount of tamarack that has been consumed by modern forest fires, but to judge from the present stand and the dead and half-burned remains which form immense heaps of litter on the ridges where it once grew, the quantity can not be much below 1,000 million feet B. M. The tamarack grown here has remarkably fissile wood and is much used for shakes and handmade shingles, no cedar being found in the district.

The alpine-fir type of forest exists here chiefly as a lodgepole-pine growth. The true type, consisting of alpine fir, white-bark pine, and Engelmann spruce, is very nearly obliterated except west of Newsome, at the head of Elk Creek, and around the margins of wet, subalpine meadows scattered here and there throughout the district. It is beginning to reassert itself in some places where the lodgepole-pine growth has arrived at maturity, and, if forest fires are kept out, will eventually reoccupy the old areas.

The great extent of forest fires, past and present, in the district has already been mentioned. The after effects vary somewhat from those observable elsewhere. The most obvious difference consists in the almost total obliteration of the forest types that essentially belong to the various altitudinal zones, and the substitution therefor of a uniform, nearly pure, lodgepole-pine growth. The reason for this is to be found in the prevalence of the great silver fir as a principal component of the original growth in all the zones. This species is notoriously deficient in fire-resisting qualities, and a conflagration that would spare a certain percentage of trees like the red fir or western tamarack would exterminate every individual of the great silver fir on the fire-swept area. Modern fires in the lodgepole-pine timber have created deforested hillsides, now covered with a scattered growth of sedge or grass. These hillsides are different in character from those in the subalpine areas in other portions of the reserve deforested from like causes. The latter sometimes furnish a fair quality of pasturage, and will not be reforested for centuries to come unless by the agency of man; the former, as found in this district, are worthless for any purpose, but will be covered with a lodgepole-pine growth within the next 20 or 30 years.

It is difficult to estimate accurately the acreage belonging to the different forest types or zones in the district, as the extensive lodgepole-pine growth has nearly obliterated the line of demarcation between the various zones. The table below gives the probable extent of each:

Principal forest types in South Fork of Clearwater Basin.

Species.	Per cent.	Acres.
Western yellow-pine type	15	98,304
Mountain white-pine type	65	425,984
Alpine-fir type	20	131,072

The composition of the present forest in the district is as follows:

	Per cent.		Per cent.
Western yellow pine	2	Alpine fir	0.5
White-bark pine	.005	Western larch	.005
Lodgepole pine	82	Engelmann spruce	2
Great silver fir	8	Red fir	5

Modern burns cover 40 per cent, or 262,144 acres, of the district.

The quantity of timber in commercially valuable sizes is as follows:

	Feet B. M.
Western yellow pine	80,000,000
Great silver fir	222,200,000
Western larch	85,000,000
Engelmann spruce	20,000,000
Red fir	35,000,000
Total	442,200,000

The great silver fir in commercial sizes is defective to the extent of 30 per cent, which is deducted from above estimates.

SALMON RIVER DIVIDE AND SLOPES.

This district includes the summit and southern slopes of the Salmon River divide, from the southwest portion of the reserve nearly to its eastern limit, where the divide coalesces with the main range of the Bitterroot and the Rocky mountains. It contains, approximately, an area of 700 square miles, or 448,000 acres. The topography of the district, in its largest aspect, consists of the summit of a long, somewhat tortuous ridge and its extremely steep southern slopes, which lead directly into the great gorge at the bottom of which flows the Salmon River. The Salmon River divide presents two divisions with respect to its topographic features, which coincide in their situation with the limits of the South Fork of Clearwater and Selway basins. Between Buffalo Hump and Little Salmon the divide forms the southern boundary of the South Fork of Clearwater Basin, and is here a broad, somewhat flat, summit, flanked on the Salmon River slope by peculiarly wide basins; in other words, the Salmon River divide betweeen Buffalo Hump and Little Salmon consists of a ridge that shows a much less degree of erosion than does any other section of the reserve areas. The appearance of the ridge and its flanking basins suggests nonglaciation as the reason for the small amount of sculpturing exhibited. East of Little Salmon the divide is a narrow, rocky crest, cut and eroded by past glaciation in a manner similar to glaciated regions elsewhere in the Clearwater basins. The elevation of the divide varies from 6,500 to 9,000 feet. The descent to the Salmon River is generally very abrupt, in many localities precipitous, but rarely is there an uninterrupted slope from the crest of the divide to the valley. There are usually terraces that break the direct descent in the upper portions of the slope, but sooner or later these terraces end, and the final declivity becomes excessively steep, often to such a degree as to become entirely impassable. Here and there, where the crest of the divide recedes from the river to a considerable distance, long spurs project into the Salmon Basin. The summit of these spurs may fall but little below the general level of the main divide for distances of 2 or 3 miles, but where they eventually break away to the gorge below the descent is much too steep for man or beast.

The drainage on the direct slope is excessively rapid. This results in semiarid conditions all along the sides of the gorge, and they are especially well marked below the 5,500-foot contour. The aridity due to a too rapid drainage is aggravated by the intensely hot and dry air in the gorge during a large portion of the year.

There is nothing that can be called bottom lands in the Salmon River Canyon. Throughout its length most of the mountain slopes end directly in the bed of the river, without any intervening bench lands of any sort. At the opening of cross canyons gravel bars of limited extent sometimes occur. They are the bottom lands of the gorge.

The timber growth exhibits two of the Idaho forest types in good proportions. They are the western yellow-pine type and the subalpine-fir type. The intermediate one, or the mountain white-pine type, is poorly represented. This is due to the hot air of the gorge and the rapid drainage, causing semiarid conditions that are inimical to the development of the type. The western yellow-pine and the alpine-fir types meet and mingle at elevations of 6,000 to 6,500 feet. The only evidence of a transition zone between the two types consists in a thinning out of the pure or dominant yellow-pine growth of the lower levels as it ascends to higher elevations, and a preponderance of the red fir. The principal trees of the yellow-pine type are the western yellow pine and the red fir. The great silver fir is not lacking, but it is not very plentiful. Numerically, the yellow pine and the red fir are about equal, the preponderance, if any, being with the red fir, but in bulk the yellow pine is vastly greater. Considering the aridity and rockiness of the slope the stand of timber is fair. Often it is very heavy, the yellow pine reaching stands of 15,000 to 20,000 feet B. M. to the acre on those terraces where soil and moisture conditions are favorable. In such localities individuals of the species are found which are fine examples of the best development that the tree is capable of attaining in this region, many of them having diameters of 5 to 6 feet, with clear trunks 75 to 85 feet in length. In proximity to the river the trees are small, much scattered, and mostly valueless for lumber.

The red fir is chiefly of the western Montana form owing to the rocky soil and deficient supply of moisture. Below 6,000 feet it forms slender trees 50 to 90 feet high. Above the 6,000-foot contour the species is dwarfed in stature and deficient in clear trunk development, but often with much increased diameters over the tree at lower elevations. The localities in the district where the red fir becomes of sufficient size to be a commercially-valuable tree are the valleys of the Little Salmon and Horse Creek, especially the former. These valleys head so far north that a large proportion of their slopes and bottoms lie beyond the influence of the semiarid conditions that prevail in the Salmon River Gorge, thereby insuring sufficient humidity for a larger development of the tree.

The stand of timber of the western yellow-pine type on the Salmon River slopes, though heavy in some places, can not be considered as anything but light if taken in its entirety and compared with stands of this type elsewhere in the reserve. The cause of this lies in the numerous barren, rocky combs and treeless slopes that here break the continuity of the forest of this type.

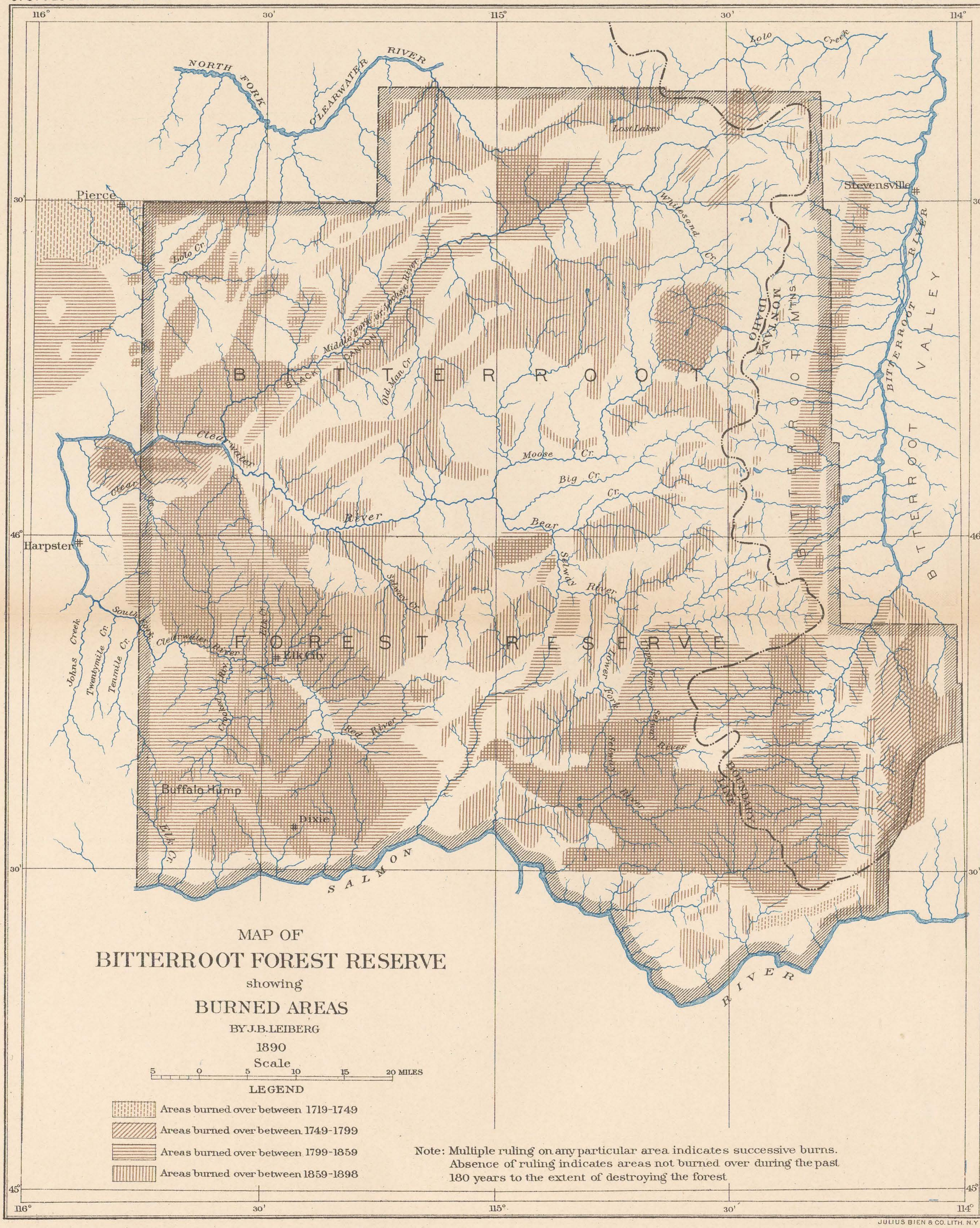
The alpine-fir type of forest is chiefly represented by the white-bark pine and the lodgepole pine. West of the Little Salmon Valley the lodgepole pine is the more common; to the east the white-bark pine predominates. The alpine fir and Engelmann spruce are not plentiful, except in the valleys of the larger tributary canyons. None of the trees of the alpine-fir type grow to commercial size in this district.

The mountain white-pine type of forest is represented by the western tamarack. It occurs on the main Salmon divide, around the head of Crooked River, and extends thence eastward a distance of 10 or 12 miles. The acreage occupied by the western tama ack in the district is insignificant.

The areal exent of the two dominant forest types is as follows: Western yellow-pine type 80 per cent, or 358,400 acres; alpine-fir type 20 per cent, or 89,600 acres.

The forest fires have been nearly as extensive in this district as in the others, but less destructive to the commercially-valuable timber, owing to the large stands of western yellow pine. In the upper areas of this type of forest, where the red fir predominates, the destruction has been the most severe. The fires that have run through the alpine-fir areas have done more damage to the tracts west of the Little Salmon than east of this valley. Ancient fires in the district were fully as widespread and destructive as have been the modern ones. The large tracts covered with the lodgepole pine attest this.

The reproduction of the western yellow pine and red fir in the district is sufficient to maintain a stand of the present density. The lodgepole pine does not encroach upon the yellow-pine areas to any great extent. When they are burned over, red fir and western yellow pine are the first trees in the reforesting process. In the alpine-fir areas the lodgepole pine comes as the primary forest growth after fires. Brush-covered slopes occur, but are rare. Grassy slopes are common, caused by the arid or semiarid conditions of the gorge, not



MAP OF BITTERROOT FOREST RESERVE showing BURNED AREAS

BY J.B. LEIBERG

1890

Scale

5 0 5 10 15 20 MILES

LEGEND

- Areas burned over between 1719-1749
- Areas burned over between 1749-1799
- Areas burned over between 1799-1859
- Areas burned over between 1859-1898

Note: Multiple ruling on any particular area indicates successive burns. Absence of ruling indicates areas not burned over during the past 180 years to the extent of destroying the forest

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by old burns, as is the case with areas of similar aspect in the other districts of the reserve.

The composition of the forest is as follows:

	Per cent.		Per cent.
Western yellow pine	15	Lodgepole pine	57
White bark pine	2	Great silver fir	3
Alpine fir	4	Engelmann spruce	1
Red fir	18		

The areas of modern burns on which the forest is destroyed amount to 23 per cent, or 103,040 acres. The burned tracts are confined almost entirely to the upper portions of the yellow-pine zone and to the subalpine tracts. About 2.5 per cent, or 10,000 acres, consists of rocky or grassy permanently-deforested slopes.

The stand of commercially-valuable timber in the district is as follows:

	Feet B. M.
Western yellow pine	254,000,000
Red fir	89,600,000
Great silver fir	5,000,000
Total	348,600,000

FOREST FIRES.

It has already been mentioned that forest fires have determined the age of the timber stands in the reserve, and in some degree the species of trees that compose them. Most of these fires burned centuries ago. Recent fires—that is, such as have prevailed during the past thirty-five or forty years—have influenced the complexion of the growing forest in a minor degree only, because sufficient time has not yet passed for much reforesting of the denuded tracts (Pl. CXL).

The forest fires which have ravaged the Clearwater and Salmon river basins fall naturally, as to time, into two periods, namely, those that occurred during the Indian occupancy of the country and those that have originated since the coming of the white man. The extent of the former can best be learned by examining the stands of second-growth forest. The tracts covered by these comprise in the aggregate 1,110,000 acres and are of all ages from 75 to 175 years. It is certain that this much, at least, represents one complete cycle of burns during 200 years of Indian occupancy. Some of the tracts may have been burned over several times within the above period, but of this we can know nothing with certainty. In addition to the 1,110,000 acres there are 220,000 acres of old growths, principally yellow-pine stands, that were repeatedly overrun by fires during this period; there existed, furthermore, large stands of second growths, since burned by white men during the past thirty-five or forty years, which were second growths because they were previously burned by the Indians. The total acreage of these stands we have no means of knowing, but remains of the destroyed forest indicate that about 50 per cent, or 720,000 acres in round numbers, of the modern burns, were in second-growth stands. A large proportion of the present young growth also covers areas burned over before the advent of white men. I would place the amount of such growths at no less than 350,000 acres. Excluding the yellow-pine areas which, whilst overrun by fires, did not lose their forest, there is to be charged to the last two hundred years of Indian occupancy a total of 2,270,000 acres burned forest, assuming that fires due to Indians ceased thirty-five years ago.

The white man came in force into the region thirty-five or forty years ago. Destructive conflagrations have invariably followed in his wake. There are no large portions of either the Clearwater or the Salmon river basins but show some evidence of fires of recent date. Summing up the acreage of the tracts denuded by fires during the time of the white man's occupancy the account would stand about as follows:

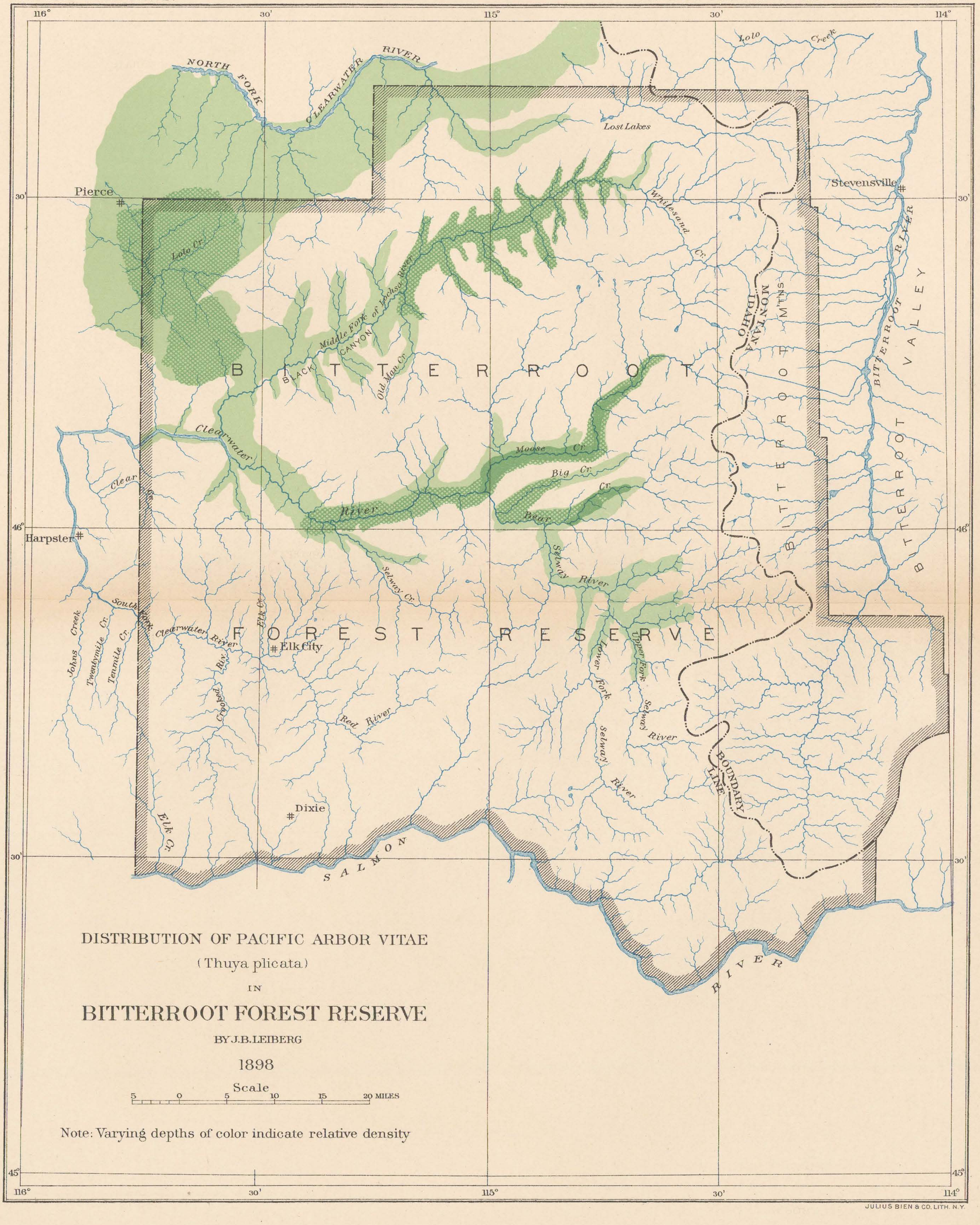
	Acres.
Burned second growths and old growths, proportion not ascertainable	1,250,000
Burned young growths	150,000
Total	1,400,000

If an average is struck, based upon the number of years included in above estimates, it will be found that during the Indian occupancy there were fire losses of 11,350 acres per annum, while during the time that the white man has been in possession 35,000 acres per annum have been destroyed, or a yearly average 300 per cent greater.

This account, large as it is, does not cover it all. The old-growth areas of western yellow pine have been repeatedly burned over, just as they were while the Indians roamed the country. Large tracts of the 35-year to 40-year-old burns, covered with seedling growth, have been destroyed within the past six or eight years. These items are not reckoned in the estimate of the fire losses given above.

The fires that antedate the advent of white men into this region appear to have run over the largest area between one hundred to one hundred and fifty years ago. The highest percentage of the second growth is from 90 to 130 years old.

From time immemorial the Indians had three trails from west to east across the region now embraced within the limits of the Bitterroot Reserve. Two of these trails were used for through travel between the Rocky Mountain regions and the Plains of the Columbia. These trails were what are now known as the Lolo and the Nez Perces trails. The former was a northern route, the latter a southern. The third trail extended eastward to the summit of the Bitterroot Mountains and was used principally as a hunting trail. Its course was along the crest of the Lochsa–Selway divide, and as it ran through the heart of the game region in the Clearwater basins must have been very



DISTRIBUTION OF PACIFIC ARBOR VITAE
(Thuya plicata)
IN
BITTERROOT FOREST RESERVE
BY J. B. LEIBERG
1898

Scale
5 0 5 10 15 20 MILES

Note: Varying depths of color indicate relative density

JULIUS BIEN & CO. LITH. N.Y.

largely traveled. Most of the fires that can be traced to Indian occupancy appear to have originated along the lines of these trails. Almost the entire forest adjoining is second growth, and the areas known as "Bald Mountains," grassy southern slopes long since deforested by fires, are also confined to the tracts traversed by these routes.

It is difficult to state with absolute certainty the reason why the Indians burned the forest. An educated Nez Percé, with whom I conversed regarding the matter, stated that forest fires were never started through design, but might have accidentally spread from signal fires kindled by different bands or individuals while on the hunt, that they might know the whereabouts of one another. The probability is that many fires spread from their camps and others were set purposely to destroy the forest and encourage the grass growth. This latter seems to have been the case in the alpine-fir type of forest along their trails, where now occur so many of the bald or grassy mountain slopes. It is a well-known fact that deer and elk exhibit a special liking for tracts freshly burned, due to the profuse growth of various kinds of weeds

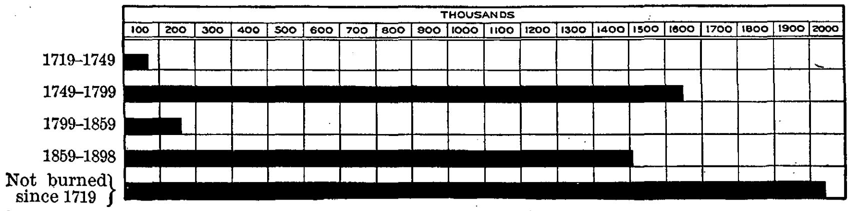


FIG. 2.—Diagram showing areas burned, in acres, in Bitterroot Forest Reserve within different periods.

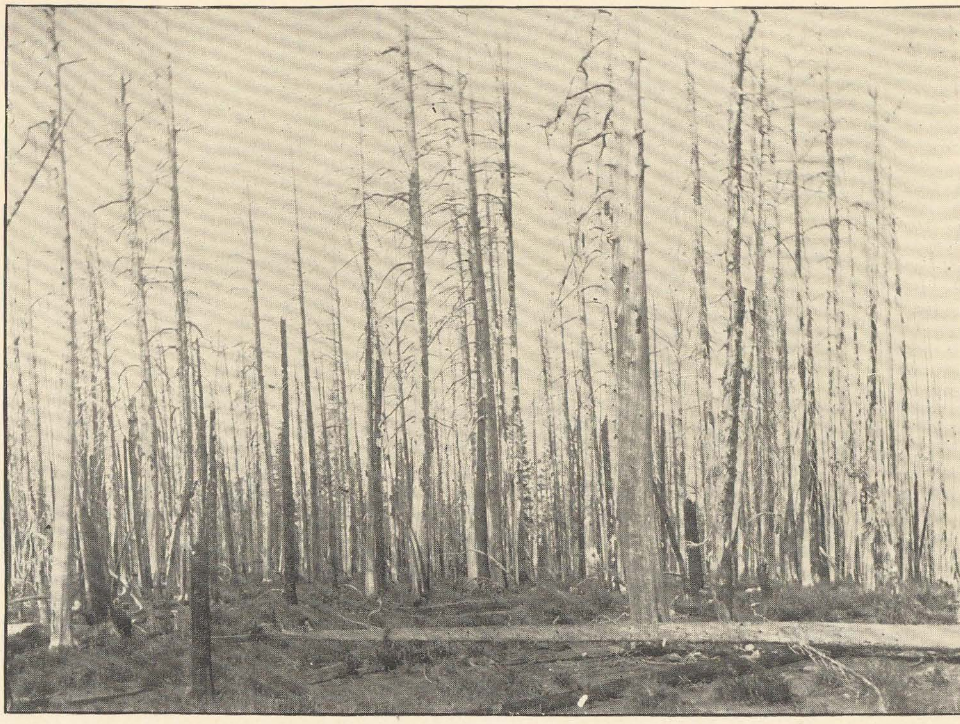
springing up there, which constitute a favorite browse for them. Large tracts of forest doubtless were burned with intent of thus causing the game to congregate in considerable numbers in some particular localities.

The fires kindled by white men have ravaged the forest areas of the reserve in thousands of places. They have not been confined to any particular locality. Early discoveries of placer diggings at Florence, Elk City, and Pierce had the effect of sending many prospectors to the most remote corners of the Clearwater basins, and wherever they went fires and blackened ruins of the forest were left behind to mark their trails and camps. Since then various portions of the region have been regularly and systematically visited every season by hunters and prospectors, and forest fires have closely kept pace with them.

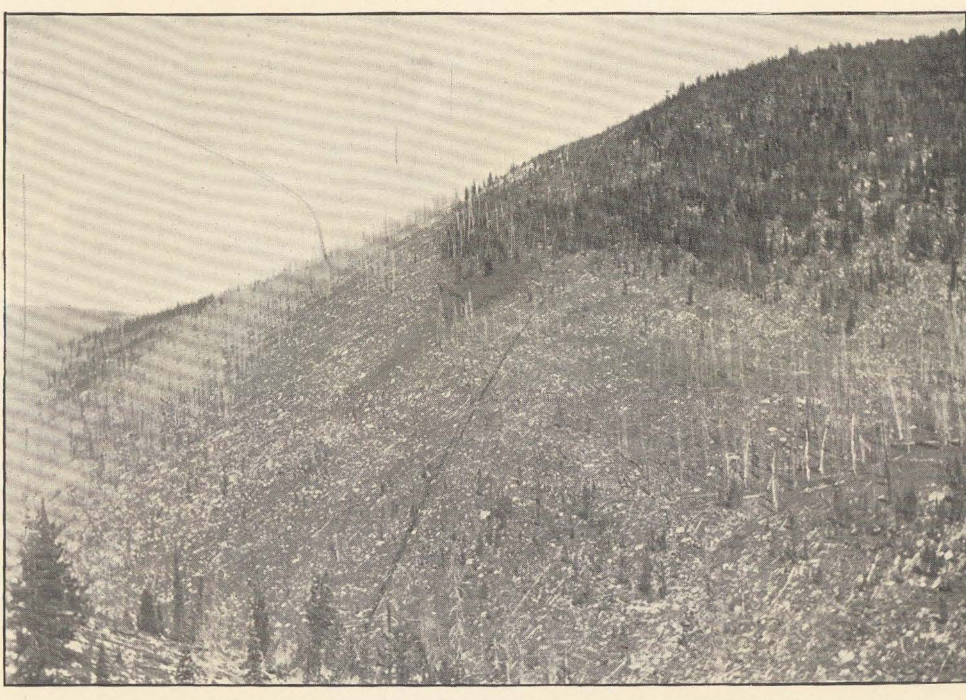
That the responsibility for fires of modern date lies mostly with the prospectors admits of no doubt. To this class belong the greater number of travelers in the Clearwater basins; hunters and trappers are in the minority, and as regards trappers, they pursue their vocation only during the seasons when much rain or snow falls and the timber can not burn. Prospectors, on the contrary, roam over the country in the summer, when the forest litter is dry and ready to burn.

The amount of destruction wrought by fires of modern date is enormous. The largest continuous living block of forest in the reserve comprises about 200,000 acres. The balance is all made up of numerous smaller stands separated from one another by long, wide lanes or large expanses of burned forest. All along the Lolo trail fires have prevailed extensively, burning far into the North Fork of Clearwater Basin and into that of the Lochsa until stopped by the river. Along the divide between the Lochsa and the Selway basins many thousands of acres of forest land have been completely destroyed, the destruction here following closely in the trails of various parties that for many years were seeking the location of "lost mines" of fabulous richness reported to exist somewhere in that region. At the lower levels in the interior of the Selway Basin vast quantities of old growths, consisting of Pacific arbor vitæ, western yellow pine, red and great silver firs have vanished in smoke or been reduced to ashes, while in the upper portion of the basin much of the red-fir and lodgepole-pine growths have shared the same fate. In the South Fork of Clearwater district large areas that carried dense stands of western tamarack, great silver fir, and lodgepole pine have been devastated. The amount of timber destroyed by these recent fires can not be accurately estimated, but is certainly not any less than the quantity now standing, or 5,000 million feet B. M. This does not include the many millions of seedlings and saplings burned with the older growth. It is very probable that the actual amount of timber consumed greatly exceeds the figures given above. Many of the areas of old growths carried immensely heavy stands. In the Selway Basin one finds places where the half-burned trunks of Pacific arbor vitæ, thrown down by strong winds, are piled up to a height of 9 to 10 feet. Some of the northern slopes in this basin bore stands of mixed western yellow pine and red fir. One finds a few acres here and a few acres there of these stands that the fires have spared. They carry as much as 50,000 feet B. M. of merchantable timber per acre of the western yellow-pine species. Thousands of acres of forest of this character have been swept clean by the fires of recent years and are now bare hillsides, without a vestige of living timber.

The after effects of the fires in this region are various, but are always evil, without a single redeeming feature. They are far-reaching and lasting in their consequences, affecting the economic interests not alone of the communities situated adjacent to the burned districts, but even those in most remote localities. The primary interests involved are those of timber and water supply, and through them there is not a single industry which is not more or less affected. The reservoirs of the streams that flow through the Plains of the Columbia lie in the surrounding forest-covered mountains, and whatever changes take place in their forest cover are certain to become manifest in the



A. BURNT WHITE-BARK PINE, LOCHSA-SELWAY DIVIDE.



B. BURNT HILLSIDE, LOCHSA-SELWAY DIVIDE.

Soil washed away; bowlder basement beginning to show.

streams flowing from them. Again, there are good reasons for believing that the local rains which commonly fall in June over a large portion of the agricultural districts on the plains of eastern Washington and eastern Oregon depend for their duration and intensity upon the quantity of snow remaining on the surrounding mountain slopes at the time they occur. The heavier the forest the greater will be the percentage of unmelted snow on the mountains in early summer.

Sterility and aridity of the soil in the mountain districts follow upon the destruction by fire of the forests there. The humus, which is an important soil ingredient, burns readily and is usually completely consumed. Should a bowlder basement exist directly under and in contract with the humus layer, which is the case in many of the canyon bottoms and on slopes as well, complete sterility is apt to ensue, as the remaining soil will wash out from among the bowlders and be carried into the streams. Hundreds of localities in the reserve exhibit this phase of the after effects of forest fires. The run-off is everywhere accelerated on deforested slopes. The snow melts more quickly in the open than where screened from the direct rays of the sun or sheltered from the impingement of strong winds. Especially rapid is the melting of snow in deforested canyons, where the radiation of heat is much greater from bare hillsides than from timbered ones. The placer camps in the reserve afford indubitable and practical evidence concerning the part played by the growing forest in the regulation of the run-off. The working capacities of the various camps depend upon the quantities of water available. It is a well-recognized fact that the ditches or streams whose heads lie in well-timbered slopes carry a more uniform volume of water and retain it longer into the summer than do the water ways that originate in deforested areas. What happens on a small scale in the placer ditches and creeks is indicative of the conditions which eventually will prevail in the large streams unless the forest destruction be stayed.

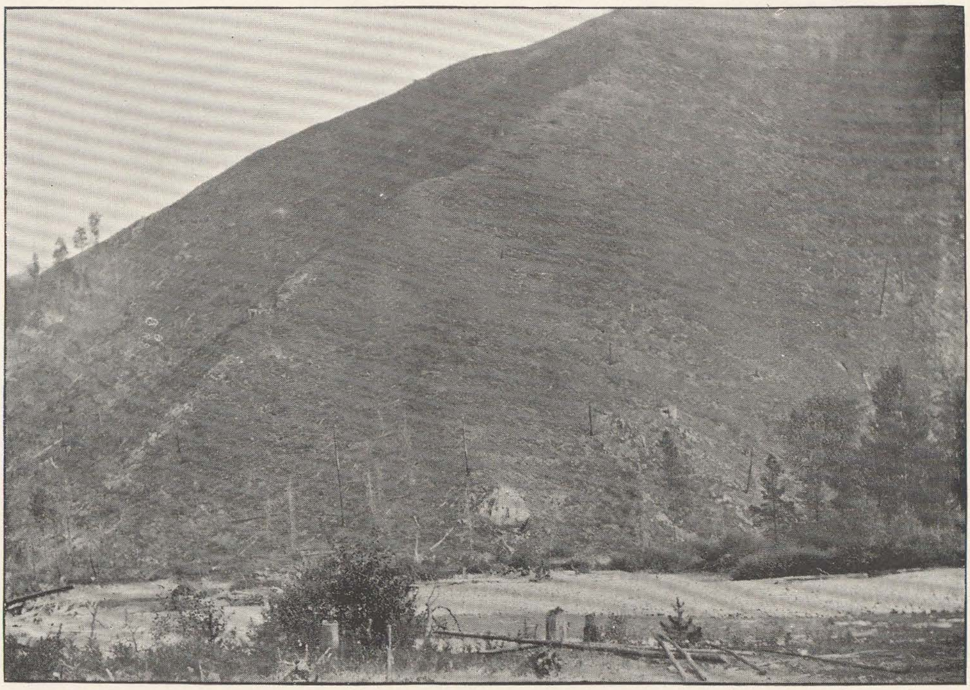
Soil aridity after fires is due to an enormously increased ratio of evaporation from the denuded areas. This result is particularly well marked on slopes with a southern exposure. There are many such in the reserve where the timber was burned two and perhaps three centuries ago, and which show only slight signs of reforestation (Pl. CXLI).

The time required for a renewal of timber growth on burned tracts in the Clearwater basins is dependent upon a variety of conditions. In the zone of alpine fir, on northern slopes, it is fairly rapid, an interval of ten to twenty years sufficing for the firm establishment of a good stand of seedlings. On southern declivities the interval between a burn and a beginning of forest growth is indefinite. The "Bald Mountains," so called, are generally southern slopes burned over centuries ago, which show no clear evidence as yet of an extension of the adjacent forest into their areas. As a rule, when a southern declivity in the zone of the alpine fir is burned to a serious extent, the first result is a grass-covered tract, if the slope possesses no great amount of permanent seepage. In course of time the grass or sedge will give place to dense swards of "bear grass," which, by diminishing evaporation and favoring the retention of soil moisture, prepare the way for a return of the forest cover. Centuries are required to effect these changes. Sometimes northern and eastern slopes in this zone are affected in the same manner, as when they front on some broad valley or basin which offers free traverse for the hot and dry winds that sometimes blow through the Clearwater areas in late summer or early fall. In the Lochsa Basin, between Grave Mountains and Big Sand Lake, are considerable tracts of such slopes deforested by fires fifty to sixty years ago, and now covered with a coarse growth of sedge and grass, with no decided tendency toward reforestation.

In the Upper Selway Basin there is a very general drift toward grassy slopes in the alpine-fir areas after destruction of the timber. The tendency in this direction is, perhaps, on the whole more pronounced here than elsewhere in the reserve, for the reason that the Selway main valley evidently receives a less amount of precipitation and experiences a higher mean summer temperature than the other areas that make up the Clearwater drainage basin.

Reforestation in the mountain white-pine zone is more rapid, active, and certain, because the soil humidity is much greater, due to the reception of the accumulated seepage from the zone above. Both here and in the zone of alpine fir a brush growth is usually the preliminary step to reforestation, provided soil humidity is sufficiently abundant throughout the growing season, but it is not so certainly the case as in the regions north of the Clearwater River. The first species of tree to appear in the return to forest cover is in most instances the lodgepole pine. Fully 80 per cent of the young growth will be found to belong to this species. The well-nigh universal occurrence of this tree as the primary forest growth on the burned areas in the reserve is one of the most serious after effects of the fires. While admittedly of some value as fuel, which is here of little account, it is practically worthless as a timber tree. Where it once effects a lodgment it endures for periods of 90 to 140 years, excluding in the meantime all but a feeble growth of the more generally useful species. At the present time more than a million acres in the Idaho portion of the reserve carry stands of lodgepole pine, varying from 50 to 95 per cent pure. A continuance of the prevailing forest fires will, in time, result in covering most of the remainder of the reserve with a growth of this species.

Reforestation in the western yellow-pine zone is fairly active, and the first growth is not so exclusively composed of lodgepole pine. The larger percentage of the young growth is of red fir.



A. BURNT HILLSIDE IN RESERVE IN BITTERROOT VALLEY.

Burnt twenty-five or thirty years ago; no reforestation or even brush growth as yet.

B. BURNT HILLSIDE ON LOCHSA-SELWAY DIVIDE.

Soil washed away, leaving bowlder basement exposed.

FOREST FIRES DURING THE PRESENT YEAR.

Fires devastated considerable areas of the reserve during the latter portion of July and August of the present year, notwithstanding the rules and regulations promulgated by the Interior Department for their prevention. The heaviest and most widespread fires in Idaho were in the Selway Basin, in the Upper South Fork of Clearwater Basin around Elk City, and in Montana in the valleys of the South Fork of the Bitterroot. There were also many minor fires in scores of widely-scattered localities. That these fires owed their origin to carelessness or design can hardly be doubted. The fires in the Selway Basin were by far the most serious and destructive, as they burned in heavy cedar bottoms and worked their way up the adjoining hillsides into dense growths of red and great silver fir. Fires in the northwest corner of the reserve came in from the direction of Pierce and did damage to the second growths of red fir, mountain white pine, and tamarack on the Lolo and Musselshell. Between Elk City and Newsome a large quantity of old growth of great silver fir was destroyed. The fires that occurred in the Elk Creek bottoms destroyed old and young lodgepole pine, great silver fir, Engelmann spruce, and alpine fir on old burned-over areas in process of reforestation, while fires in the valley of the South Fork of Bitterroot River chiefly damaged growths of lodgepole pine, red fir, and western yellow pine. I can not state the total of the areas actually burned over, as my party passed through the region ravaged by the fires before their final extinguishment, but those seen by me reached an aggregate of over 20,000 acres. They burned without serious check until partially extinguished by rains in the beginning of September.

It was clearly evident that the regulations of the Interior Department were not being very generally observed. After the middle of August the roads and trails in the more accessible and generally traveled portions of the reserve were well posted with the department circular calling attention to the penalty provided for the setting of fires. Little attention was paid to it by the persons most concerned. In two days' travel on the road from Clearwater post-office to Elk City, six camp fires were seen that had been left burning when the campers departed and were slowly eating their way into the adjacent forests.

The most flagrant case that came under my observation occurred in the upper portion of the South Fork of the Bitterroot Valley, where two prospectors made camp one evening at the foot of a tree on which a department fire circular had been posted, and within 500 yards of where a patrol of rangers were stationed. In the morning they broke camp, leaving the fire burning in the midst of a mass of most inflammable material, without the least attempt to extinguish it, although the river with an abundance of water was less than a rod from their camp.

The Bitterroot Reserve is a difficult region to patrol effectively. Especially is this the case with the Idaho portion, where the country generally is extremely rugged and broken. A much larger force of rangers than was stationed there last summer will be needed. Each one of the mining centers requires fully as many rangers as were assigned to the entire Idaho portion, and a considerable number could be scattered through the interior areas to advantage. With the present trails it requires from six to ten days of hard travel to cross the reserve in Idaho, rendering it quite impossible for a party of rangers patrolling the western sections to exercise at the same time a supervision over the regions at the head of the Lochsa and Selway basins. Each summer, as soon as the snow has disappeared sufficiently to allow of travel, prospectors and hunters flock into the region. There can be little doubt that these classes are, in the main, responsible for the fires. A system of registration and license of all persons entering the reserve would accomplish far more toward abating the fire evil than a large force of rangers could possibly do. The conditions of last summer were such that a score of careless or malicious persons could have fired the forest on the reserve in a thousand places, without the least chance or fear of detection and subsequent punishment.

LIST OF SHRUBS GROWING IN THE BITTERROOT RESERVE.

PINACEÆ.

JUNIPERUS NANA Willd.

A trailing shrub growing on rocky slopes throughout the reserve, at elevations above 6,500 feet; occasionally seen as low as 4,500 feet, as on the ridges near Elk City. It is more common on the ridges and immediate spurs of the main range of the Bitterroots than elsewhere.

TAXACEÆ.

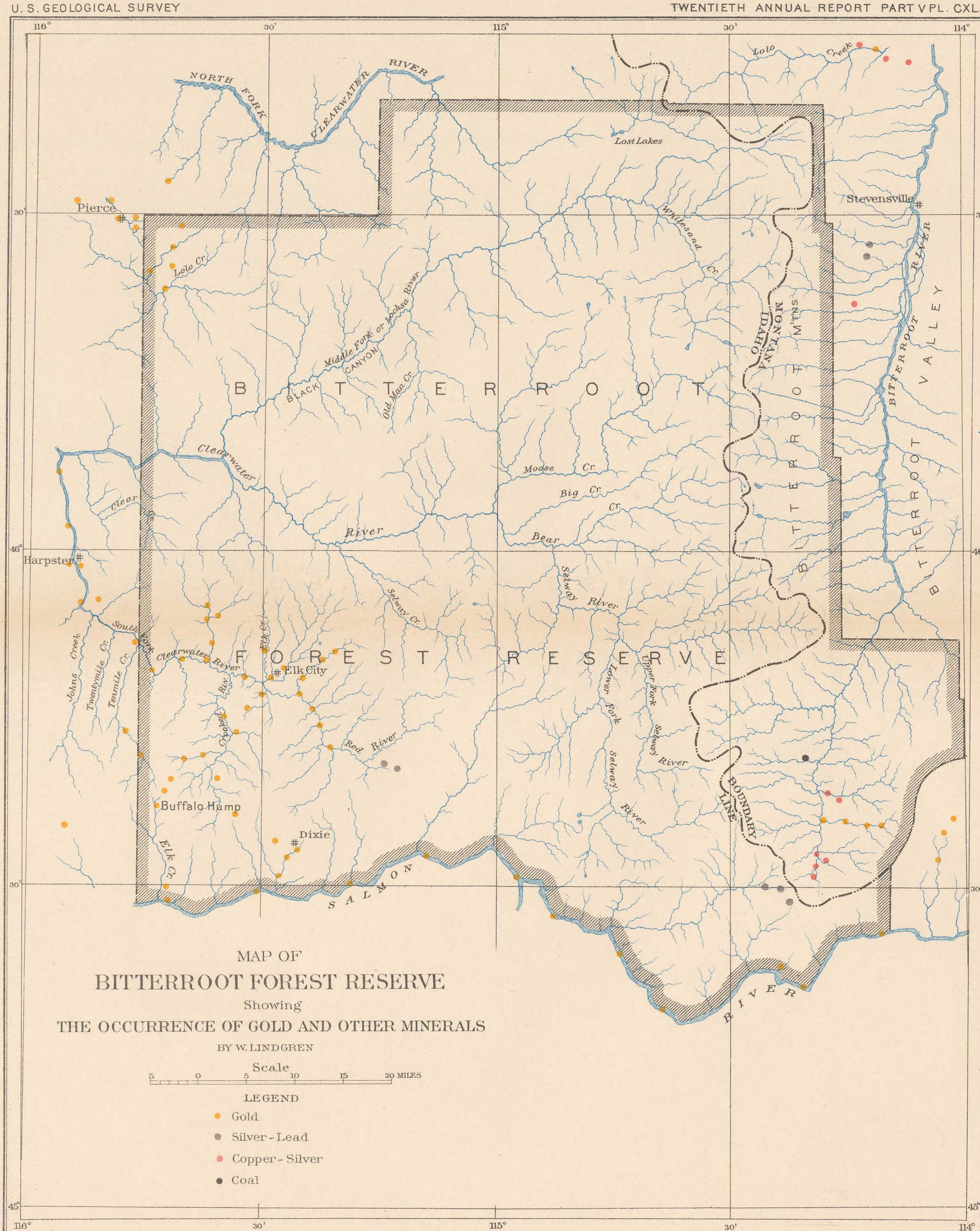
TAXUS BREVIFOLIA forma RADICANS.

A creeping and trailing shrub, extensively rooting and spreading, with long, supple, ascending branches. The shrub is found throughout the reserve on both the east and west side of the main range of the Bitterroots, at all elevations below 8,500 feet. It is especially common on ridges between Grave Mountains and Lochsa Valley, where it sometimes forms thickets of dense growth. Its chief habitat is on humid slopes and in the shade of the heavy cedar groves in the Selway Basin, where it frequently constitutes the only undergrowth.

SALICACEÆ.

SALIX FLUVIATILIS Nutt.

Shrub 4 to 7 feet in height along streams at altitudes below 4,000 4,000 feet.



MAP OF
BITTERROOT FOREST RESERVE
Showing
THE OCCURRENCE OF GOLD AND OTHER MINERALS
BY W. LINDGREN

Scale
5 0 5 10 15 20 MILES

LEGEND
- Gold
- Silver-Lead
- Copper-Silver
- Coal

JULIUS BIEN & CO. LITH. N.Y.

SALIX GLAUCA var VILLOSA Anders.

Shrub 3 to 5 feet high, growing around the margins of lakelets and springy meadows at subalpine heights. It often forms exceedingly-dense thickets on the muddy bottoms of lakelets that are in the process of drying up, coming in on such tracts as the first brush growth. It is of common occurrence throughout the reserve at altitudes above 6,000 feet.

SALIX IRRORATA Anders.

A shrub 5 to 10 feet high, forming dense thickets on gravel bars in the beds of the larger streams on the Idaho side of the reserve. Its range is chiefly between elevations of 3,000 to 4,000 feet.

SALIX LASIANDRA Benth.

A shrub or small tree growing in the lowest valleys of the reserve in Idado. Scarcely comes within our limits.

SALIX NUTTALLII Sargent.

A small tree or more generally a large shrub, appearing in our region chiefly in the form *S. brachystachys* Berth. The species is of universal occurrence throughout the reserve in Idaho below elevations of 5,800 feet, being in many cases the first shrub to cover the ground after deforestation by fires. It is a remarkable fact that most of the individuals of the species grown under such circumstances rarely exist long enough to reach the catkin-producing age, but die while young and give way to other shrubs, chiefly species of *Ceanothus*.

SALIX SITCHENSIS Sanson.

A small tree, or more commonly a shrub, along streams in the Idaho portion of the reserve, at elevations below 3,500 feet. Other species of willows were observed, but not in a determinable state.

BETULACEÆ.

ALNUS ALNOBETULA (Ehrh) Koch.

A shrub with ascending branches, 4 to 8 feet high, growing on ridges above 5,000 feet altitude, but occasionally descending to elevations of 3,000 feet, on northern slopes. One of the most common shrubs in the subalpine forest and in the upper areas of the white-pine zone, where it constitutes about 10 per cent of the undergrowth. It frequently grows in such dense masses around the heads of streams and in springy places that the use of an ax is required in making way through it. Its favorite place of growth is around springs and on very wet slopes, but it often grows on the combs of the ridges and where the slope is quite without seepage. Well-grown specimens attain basal diameters up to 5 inches.

ALNUS RHOMBIFOLIA Nutt.

A small tree or shrub 6 to 15 feet high, along streams and wet meadows at low elevations in the Idaho portion of the reserve.

ALNUS TENUIFOLIA Nutt.

Shrub or small tree 10 to 20 feet high, at low elevations throughout the reserve both in Idaho and Montana; the common alder fringing the streams below 4,500 feet elevation.

BETULA GLANDULOSA Michx.

A shrub of very wide distribution in the reserve at elevations between 4,800 and 8,000 feet. On the Idaho side it is most abundant in the wet, swampy meadows between the peaks of Grave Mountains and the main range of the Bitterroots, where it covers several thousand acres with a nearly solid growth. It is also common in the valley of Little Salmon, and in many other localities. In Montana the species is abundant in the higher valleys of the forks of Bitterroot River. The shrub grows from 3 to 8 feet high and serves as a favorite browse with the moose in the Upper Lochsa Basin.

ULMACEÆ.

CELTIS OCCIDENTALIS (?) Linn.

Not known to me with certainty as occurring within the reserve limits, but as it grows in the valley of Clearwater River above Kamiah, only a few miles west of the reserve boundary, it probably extends far enough east to come within our limits. The species is a low shrub 2 to 4 feet high, with stiff, much-branched, straggling stems, growing on dry, semiarid slopes.

LORANTHACEÆ.

RAZOUMOFSKYA ABIETINA (?) (Dougl.) Greene.

Parasitic shrub, 1 to 3 inches long, on *Pseudotsuga mucronata*. Occurs throughout the reserve at elevations below 4,500 feet. The growth of the parasite causes a proliferation of branches at the point of attack, eventually resulting in the large, dense, interlacing, short and straight, or long and pendulous branch masses so noticeable on very many individuals of the species.

RAZOUMOFSKYA AMERICANA (Nutt.) Kuntze.

Parasitic shrub 2 to 5 inches long, growing on the lodgepole pine (*Pinus murrayana*). It is found throughout the reserve, but is not common on the Idaho side, except along the Salmon River divide, where it follows the host tree to elevations of 7,000 feet. In the Montana portion of the reserve it is concurrent with the lodgepole-pine areas. Its place of attachment is generally on the branches of the host tree, but occasionally it is found growing on the main trunk below the crown. It causes swellings and distortions of the branches and trunk at its point of attachment.

RAZOUMOFSKYA CRYPTOPODA (Engelm.) Coville.

A parasitic shrub, 3 to 6 inches long, growing on the western yellow pine (*Pinus ponderosa*). It occurs throughout the reserve, mostly below 5,000 feet altitude, but ascends on southern slopes to 6,000 feet.

SANTALACEÆ.

LEPARGYRÆA CANADENSIS (Linn.) Greene.

A shrub rarely reaching a greater height than 3 feet. Occurs throughout the reserve but is not especially abundant. It sometimes forms a small percentage of the brush growth on newly-burned areas, and having once obtained a lodgment is apt to persist as a part of the undergrowth in the subsequent lodgepole-pine forest. Its altitudinal range is mostly below the 5,000-foot contour.

RANUNCULACEÆ.

ATRAGENE AMERICANA Sims.

A woody climber, 10 to 15 feet long, growing throughout the reserve, chiefly below 5,000 feet elevation, but reaching altitudes of 6,000 feet on southern slopes.

CLEMATIS LIGUSTICIFOLIA Nutt.

A woody twiner, 10 to 20 feet long, spreading over low bushes and tall herbs or prostrate on the ground. Its habitat is along river banks at low elevations; occurs throughout the reserve.

BERBERIDACEÆ.

BEBERIS REPENS Lindl.

A low shrub, 1 to 1½ feet high; grows throughout the reserve below elevations of 5,500 feet on open, dry hillsides, and is nearly always associated with the western yellow pine. It is the common species of "Oregon grape" in this region.

BERBERIS NERVOSA Pursh.

A shrub rarely above 1 foot in height and preferring deep, shady forests in the white-pine zone as its place of growth. It probably occurs on the Idaho side of the reserve, but I did not observe it anywhere. It is common enough farther north.

SAXIFRAGACEÆ.

PHILADELPHUS LEWISII Pursh.

This shrub, the so-called wild syringa, occurs throughout the entire reserve below elevations of 6,000 feet. Its place of growth is along stream margins and on humid slopes, where it forms light thickets. It reaches a height of 4 to 8 feet, and constitutes about 1 per cent of the undergrowth in the zone of the yellow pine.

RIBES CEREUM Dougl.

A shrub 2 to 3 feet high, growing in the main Bitterroot Valley only. Of most frequent occurrence on the volcanic areas in eastern Oregon and Washington; possibly reaching the Bitterroot Valley by way of the Salmon River Gorge.

RIBES HUDSONIANUM Richards.

This shrub is one of the black currants of the region. It is abundant everywhere throughout the reserve in swampy places below elevations of 6,500 feet, growing from 2 to 4 feet in height. It has a heavy, fetid odor and disagreeable taste. It is not used as food by either Indians or whites, so far as known to me.

RIBES IRRIGUUM Dougl.

This species of gooseberry is plentiful throughout the reserve in Idaho, growing chiefly along streams, on stony banks, and especially in crevices of rockslides. It has an edible fruit, sweet and palatable when mature. The species is confined to the yellow-pine areas, rarely reaching altitudes above 5,000 feet. It grows to a height of 2 to 5 feet.

RIBES LACUSTRE Poir.

A shrub 2 to 4 feet high, growing throughout the reserve at all elevations. It sometimes forms troublesome thickets in swampy places at low altitudes. The fruit of the species is worthless.

RIBES NIVEUM Lindl.

A shrub 3 to 6 feet high, along the extreme western edge of the reserve. Fruit edible, but sour and unpalatable.

RIBES VISCOSISSIMUM Pursh.

A shrub especially abundant and characteristic of the yellow-pine areas, where it occasionally forms 1 per cent of the undergrowth. It reaches a height of 2 to 4 feet, and has an inedible fruit.

ROSACEÆ.

Amelanchier alnifolia Nutt.

A small tree or shrub 6 to 20 feet high, very generally dispersed throughout the reserve areas. It grows along streams and on humid slopes mostly below the 5,500-foot contour, generally accompanying the yellow-pine zone, where it forms a small percentage of the undergrowth. The species is the service berry of the region.

Cercocarpus ledifolius Nutt.

This species, the mountain mahogany, is commonly a mere shrub 4 to 8 feet high, here rarely attaining the dimensions of a tree. It is of frequent occurrence in the valleys of both the Salmon and Bitterroot rivers, extending thence into the Clearwater areas in the Selway Basin. The upper limit of its altitudinal range in the reserve is approximately 6,000 feet.

The mountain mahogany as we find it here is a low, bushy-branched shrub, invariably choosing for its place of growth rocky, semiarid slopes in the yellow-pine zone. It always grows in detached clumps, never here forming the solid chaparral stands that characterize the growth of the species in the semiarid regions of eastern Oregon. The occurrence of the species in the Salmon and Bitterroot valleys is not surprising, in view of the fact that these areas stand in direct connection with the arid regions of the Rocky Mountains, where the shrub abounds. It is different, however, as regards the Selway Basin. Here the species occurs in a region adjoining areas upon which the annual precipitation is markedly heavy. Its presence on these tracts indicates a progressive extension into the Clearwater areas of the arid and semiard conditions of the Rocky Mountains.

Cratægus douglasii Lindl.

A small tree or shrub, 6 to 10 feet high, along river banks at elevations below 3,000 feet.

Cratægus macracantha Loud.; C. columbiana Howell.

A shrub or small tree, 8 to 10 feet high, along banks of the Middle Fork of Clearwater below elevations of 2,500 feet. It is readily distinguished at first glance from the other species of thorn in this region by its red fruit and long, straight thorns. It reaches the Clearwater areas by way of the Snake River Valley, but whether it comes into the Snake by way of the Columbia Valley or whether it follows south the western edge of the timbered sections fronting on the Plains of the Columbia, I can not say. It comes into the northern portions of the plains of the Columbia by way of Clark Fork. I am not aware that the species has an uninterrupted range eastward across the mountains anywhere in the Bitterroot Reserve; it may have such a range in the Salmon Valley, but not along any of the Clearwater forks.

HOLODISCUS DISCOLOR (Pursh) Maxim.

A shrub 5 to 14 feet high, sometimes bushy branched and depressed, but commonly with long, straight, upright, slender stems and branches. It is of common occurrence throughout the Idaho portion of the reserve in the yellow-pine areas below 4,000 feet elevation.

KUNZIA TRIDENTATA (Pursh) Spreng.

A shrub 2 to 4 feet high, growing in the Bitterroot Valley only and hardly within the reserve areas, on dry, rocky, open hillsides in the extreme edge of the yellow-pine forest. Plentiful outside the forested tracts in that valley.

OPULASTER CAPITATUS (Pursh) Greene.

A shrub 2 to 12 feet high, erect or reclining, along river banks. Throughout the reserve, generally below 5,800 feet altitude.

OPULASTER MALVACEUS Greene.

A shrub, 3 to 5 feet high, in the yellow-pine and red-fir areas throughout the reserve, forming about 40 per cent of the undergrowth of the yellow-pine zone. It is the chief brush growth in the preliminary reforesting stage after burns in the yellow-pine zone.

POTENTILLA FRUTICOSA Linn.

A low shrub, 2 to 3 feet high, occurring in the upper sections of the valleys of the Bitterroot River forks and generally throughout the Idaho portions of the reserve at elevations between 5,000 and 7,000 feet. The species belongs to the zones of mountain white pine and alpine fir, where it forms an inconsiderable proportion of the underbrush.

PRUNUS DEMISSA Walpers.

A small tree, or more commonly a shrub, growing throughout the reserve on subhumid slopes and in valleys with 3,000 to 7,500 feet elevation.

PRUNUS EMARGINATA Walpers.

A shrub, or more often a small tree, 5 to 8 feet in height. Occurs throughout the reserve below 3,800 feet elevation.

PRUNUS MOLLIS (Sudw.) Coville and Leiberg.

A shrub, or generally a tree, up to 30 feet in height, of conical growth and symmetrical proportions, sometimes as much as 6 inches in diameter at the base. Occurs throughout the Idaho portion of the reserve in warm valleys below 3,800 feet elevation.

ROSA GYMNOCARPA Nutt.

A shrub, 2 to 4 feet high, growing throughout the reserve areas at elevations between 4,000 and 6,000 feet.

ROSA NUTKANA Presl.

A shrub, 2 to 5 feet high, growing throughout the reserve on areas below 4,000 feet.

ROSA PISOCARPA Gray.

A shrub, 3 to 5 feet high, growing throughout the reserve at elevations below 4,000 feet. The most common wild rose.

RUBUS LEUCODERMIS Dougl.

A shrub, 4 to 6 feet high, growing on humid slopes and along streams. It occurs throughout the reserve, but is not common anywhere. Its range is mostly below the 5,000-foot contour. Fruit edible, juicy, and well flavored.

RUBUS PARVIFLORUS Nutt.

A common shrub in the yellow-pine zone, where it forms nearly 10 per cent of the undergrowth. Its range is chiefly below 6,000 feet. It grows 3 to 4 feet in height. The fruit is soft and insipid.

RUBUS STRIGOSUS Michx.

The most common raspberry on these areas, found throughout the reserve in thickets along river banks and in wet places generally. It grows from 4 to 6 feet in height and scarcely ascends above the 3,000-foot contour.

RUBUS VITIFOLIUS Cham. and Schlecht.

A woody trailer, 10 to 20 feet in length, with evergreen leaves. Occurs in the valleys of the principal Clearwater forks below elevations of 3,000 feet.

SORBUS OCCIDENTALIS (Wats.) Greene.

A shrub, 3 to 6 feet high, subalpine in habitat and confined to elevations between 6,500 and 8,000 feet on the direct western slopes of the main range of the Bitterroots.

SORBUS SAMBUCIFOLIA (Cham. and Schlecht.) Roem.

A shrub, 6 to 15 feet high, erect or reclining. Occurs throughout the reserve areas below 7,000 feet altitude.

SPIRAEA ARBUSCULA Greene.

A shrub 3 to 5 feet in height, found throughout the subalpine areas of the reserve.

SPIRAEA LUCIDA Dougl.

A shrub 1 to 2 feet high, of very common occurrence in the yellow-pine areas, where it constitutes about 20 per cent of the low undergrowth. It sometimes extends into the lower limits of the white-pine areas, but its principal altitudinal range lies below the 6,000-foot contour.

SPIRAEA PYRAMIDATA Greene.

A shrub 2 to 3 feet high, found in the Idaho portion of the reserve. Its range is below the 3,000-foot level.

ANACARDIACEÆ.

RHUS GLABRA Linn.

Shrub 5 to 6 feet high. Occurs in the Idaho portion of the reserve, possibly in the Montana areas as well. Ranges below the 2,500-foot contour.

RHUS TOXICODENDRON Linn.

A suffrutescent species, 2, rarely 3 feet in height, found in the Clearwater Valley below 3,000-foot altitude.

CELASTRACEÆ.

FORSELLESIA NEVADENSIS (Gray) Greene.

A low undershrub common in the Salmon River Valley and extending thence into the areas of the Selway Basin. In its habitat it is confined to the yellow-pine zone below elevations of 4,000 feet. It is one of the species of shrubs that accompany the westward extension of the semiarid areas into the Clearwater basins.

PACHYSTIMA MYRSINITES (Pursh) Raf.

A shrub 2 to 3 feet in height, of very common occurrence in the lower areas of the white-pine zone in Idaho, where it forms from 10 to 30 per cent of the undergrowth. Its principal altitudinal range is between the 3,000-foot and 5,000-foot contours.

RHAMNACEÆ.

Ceanothus sanguineus Pursh.

A shrub 5 to 8 feet high, common in the yellow-pine zone below the 5,000-foot level, where it constitutes from 20 to 30 per cent of the undergrowth, It frequently comes in as the first brush growth on burned-over areas in the upper yellow-pine and the lower white-pine zones, forming an exceedingly dense chaparral in such situations.

Ceanothus velutinus Dougl.

A widely-spreading shrub occurring in various situations as regards moisture and altitude. It is found throughout the reserve between altitudes varying from 2,000 to 7,000 feet. It grows from 3 to 10 feet in height.

Rhamnus alnifolia L'Her.

A shrub 3 to 4 feet in height, found in wet meadows in the upper white-pine and lower alpine-fir zones throughout the reserve.

Rhamnus purshiana DC.

A small tree, or more commonly a tall shrub, 6 to 25 feet in height and as much as 8 inches in diameter. Common throughout the reserve, chiefly along stream margins below 5,500 feet elevation. The larger dimensions are reached in the Clearwater Valley.

CORNACEÆ.

Cornus nuttallii Audubon.

This shrub is of rare occurrence in the Bitterroot Reserve, being confined in its range to the bottom lands and stream banks of the central and lower portions of the Middle Fork and the Selway valleys. Its altitudinal range extends to the 2,800-foot contour line, but it is chiefly found in proximity to the banks of the two streams mentioned, at elevations below the 1,800-foot level.

That the species should occur in the basins of the Clearwater drainage is remarkable. Its home in this latitude is in the Cascades and, so far as known, it does not grow at any intermediate station.

In the Bitterroot Reserve the species grows to a height of 5 to 8 feet, and is commonly associated with thickets of *Cornus stolonifera.*

Cornus pubescens Nutt.; Cornus stolonifera Michx.

Two shrubs, 4 to 6 feet high, occurring throughout the reserve in the yellow-pine areas along streams, between altitudes of 1,800 and 5,000 feet.

ERICACEÆ.

ARCTOSTAPHYLOS UVA-URSI (Linn.) Spreng.

A woody trailer, 3 to 4 feet in length, abundant everywhere in the reserve in the yellow-pine and lower white-pine zones.

AZALEA ALBIFLORA (Hook.) Kuntze.

A shrub of the alpine-fir areas along the main range of the Bitterroots in Idaho only; 4 to 5 feet high.

BRYANTHUS EMPETRIFORMIS (Smith) Gray.

A low undershrub, 1 to 2 feet in height, in the alpine-fir zone, seldom below elevations of 6,500 feet, thence up to the highest summits. It is fairly abundant in these areas and forms a sort of heather on a few of the higher slopes along the north sides of the principal divides.

GAULTHERIA MYRSINITES Hook.

Low, 3 to 4 inches in height, but of shrubby growth. The species occurs in wet subalpine meadows along the main range of the Bitterroots and westward.

GAULTHERIA OVATIFOLIA Gray.

Suffrutescent trailer, 1 to 2 feet in length, in damp woods in the Idaho portion of the reserve at elevations of 5,000 to 6,500 feet.

KALMIA GLAUCA var. MICROPHYLLA Hook.

A common shrub, 1 to 2 feet high, occurring in all of the wet, swampy, subalpine meadows throughout the reserve areas.

LEDUM GLANDULOSUM Nutt.

A shrub, 2 to 3 feet high, growing in subalpine forests, meadows, and glades throughout the reserve. It forms about 5 per cent of the undergrowth in the zone of the alpine fir, and about 40 per cent in the swampy tracts of the same.

MENZIESIA FERRUGINEA Smith.

A shrub occurring in extreme abundance throughout the reserve, at altitudes between 5,000 and 7,000 feet. In the unburned areas of the white-pine zone it constitutes fully 80 per cent of the undergrowth. It grows to a height of 5 to 7 feet, and on humid northern slopes forms the densest thickets of any shrub in this region.

MENZIESIA GLABELLA Gray.

With the preceding, but much less common and ascending to greater elevations. Along the main range of the Bitterroots it is of frequent occurrence as a portion of the undergrowth in the subalpine areas up to 9,000 feet altitude. This and the preceding species are of similar appearance, the chief difference being in the shape of the seeds.

PHYLLODOCE GLANDULIFLORA (Hook.) Coville.

A low, subalpine shrub, a foot or two in height, growing in crevices of rocks along the main range of the Bitterroots at 7,000 to 9,000 feet elevation.

VACCINIUM CÆSPITOSUM Michx.

A suffrutescent species, a foot or so in height, confined to the yellow-pine areas, usually below 4,000 feet altitude.

VACCINIUM MEMBRANACEUM Dougl.

A shrub, varying from 2 to 4 feet in height, common throughout the reserve between elevations of 4,000 and 9,000 feet, but nowhere occurring in what might be termed "extreme abundance." It is the common huckleberry of the region.

VACCINIUM MYRTILLUS Linn.

Low shrub, a foot in height, with the range of the preceding species, but very much less common. Confined to the Idaho portion of the reserve.

VACCINIUM OCCIDENTALE Gray.

A shrub, from 2 to 3 feet in height, extremely common in the Idaho portion of the reserve in wet, swampy, subalpine meadows, where it forms 20 to 40 per cent of the brush growth.

VACCINIUM SCOPARIUM Leiberg.

A low suffrutescent species, a foot in height, growing throughout all the areas of the alpine-fir and the upper portion of the white-pine zone. In the lodgepole-pine forests it constitutes 90 per cent of the undergrowth.

SCROPHULARIACEÆ.

PENTSTEMON ELLIPTICUS Coult. and Fisch.; PENTSTEMON FRUTICOSUS (Pursh) Greene.

Two suffrutescent species, a foot or so high, occurring in clefts of rocks throughout the reserve at elevations between 6,000 and 9,000 feet.

VIBURNACEÆ.

Lonicera ciliosa (Pursh) Poir.

A woody climber, 20 to 60 feet in length, occurring in the yellow-pine zone in the Idaho portion of the reserve below elevations of 4,000 feet.

Lonicera cærulea Linn.

A shrub 2 to 3 feet in height; plentiful in wet subalpine meadows throughout the reserve.

Lonicera involucrata Banks.

A shrub 4 to 6 feet high, usually erect, but sometimes sarmentose; common along banks of streams in the white-pine areas up to elevations of 5,500 feet.

Lonicera utahensis Wats.

Shrub 4 to 6 feet high; throughout the white-pine areas to elevations of 6,000 feet.

Sambucus glauca Nutt.

A tall shrub, sometimes semiarborescent, 8 to 15 feet high; mostly growing in the yellow-pine zone, but frequently ascending into the lower sections of the white-pine areas to elevations of 6,000 feet.

Sambucus melanocarpa Gray.

A shrub 4 to 5 feet high, growing in the white-pine and alpine-fir zones to elevations of 7,500 feet.

Symphoricarpos occidentalis Hook.; Symphoricarpos racemosus Michx.

Two species of shrubs 3 to 4 feet high, occurring in the yellow-pine areas mostly below 5,500 feet elevation.

Viburnum pauciflorum Pylaie.

A species of rare occurrence in this region, 5 to 8 feet high, growing along streams and swampy meadows in the white-pine areas in the Idaho portion of the reserve.

CARDUACEÆ.

Artemisia discolor var. incompta (Nutt.) Gray.

Barely suffrutescent, 2 feet high, growing on subalpine slopes in the Bitterroot Valley.

ARTEMISIA DRACUNCULOIDES Pursh.

A suffrutescent species, 4 to 6 feet in height, occurring in the yellow-pine zone in the Salmon and Bitterroot valleys.

ARTEMISIA FRIGIDA Willd.

A foot or two in height, growing in the Bitterroot Valley and scarcely coming within the reserve limits.

ARTEMISIA LUDOVICIANA Nutt.

Barely suffrutescent, 2 to 3 feet in height, occurring throughout the yellow-pine zone below the 4,000-foot contour.

ARTEMISIA TRIDENTATA Nutt.

This, the common sagebrush, is not of frequent occurrence in the reserve. It is found in the Salmon River Valley to elevations of 6,500 feet, thence crossing over into the South Fork of the Bitterroot Basin. It is plentiful in the main Bitterroot Valley, where it joins the sagebrush areas of the Rocky Mountain region.

CHRYSOTHAMNUS GRAVEOLENS (Nutt.) Greene; CHRYSOTHAMNUS VISCIDIFLORUS (Hook.) Nutt.

Two species of shrubs occurring in the lowest areas of the yellow-pine zone in the Salmon and Bitterroot valleys.

COMPOSITION OF FOREST IN THE IDAHO PORTION OF THE BITTERROOT FOREST RESERVE.

The table following is designed to exhibit the ratio that each of the several species of coniferous trees in the reserve bears to the entire forest growth there, and for the purpose of securing uniformity the standard of 3 inches basal diameter has been adopted for all the species. Trees measuring less are excluded. The ratio of each species as exhibited in the table bears no definite relation to its stand of merchantable timber except in this way, that the smaller the percentage of any given species in Table I and the larger the stand of the same as shown in Table II the less young growth there is of the species in the reserve.

Composition of forest in Idaho portion of Bitterroot Reserve.

District.	Western yellow pine.	Mountain white pine.	Lodgepole pine.	White-bark pine.	Great silver fir.	Alpine fir.	Western larch.	Lyall larch.	Engelmann spruce.	Red fir.	Pacific arbor vitæ.	Alpine hemlock.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
I. North Fork of Clearwater Basin.	0.005	12	25	0.005	9	3	6	None.	19	14	4.5	7.5
II. Lochsa Basin......	8	1	35	.05	.5	10	3	0.0005	20	10	6.5	.0005
III. Selway Basin......	21	None.	17	.05	3.05	7	None.	.0005	11	34	5	None.
IV. South Fork of Clearwater Basin.	2	None.	82	.005	8	.5	.005	None.	2	5	None.	None.
V. Salmon River slopes	15	None.	57	2	3	4	.0001	None.	.5	18	None.	None.

General average of each species for entire reserve.

	Per cent.		Per cent.
Western yellow pine............	9.205	Western larch................	1.8
Mountain white pine	2.6	Lyall larch....................	.0001
Lodgepole pine..................	43.2	Engelmann spruce..............	10.41
White-bark pine	.422	Red fir.........................	16.2
Great silver fir	5.61	Pacific arbor vitæ.............	3.2
Alpine fir.......................	4.9	Alpine hemlock	1.5

AMOUNT OF STANDING TIMBER OF COMMERCIAL VALUE IN THE IDAHO PORTION OF THE BITTERROOT RESERVE.

The table below gives all timber of the species stated having dimensions above 12 inches, basal diameter. This is a much lower standard than is commonly employed in Idaho in the scaling of timber on the root for ordinary commercial purposes, which usually excludes all tie and pole timber and the great silver fir, Engelmann spruce, alpine hemlock, and lodgepole pine, of whatever type. These four species foot up a total of 1,097,200,000 feet B. M., leaving a remainder of 3,802,600,000 feet B. M., which belongs to the species commonly regarded and scaled as lumber trees. To adjust the estimates of the table to the standard in common use, by which 18 to 20 inches are the least basal diameters admissible, there should be subtracted from the figures given for the lumber trees percentages or amounts as follows:

Amount to be subtracted from estimates of timber in Bitterroot Reserve in Idaho.

Species.	Per cent.	Feet B. M.
Western yellow pine..................................	5	5,950,000
Mountain white pine..................................	60	168,000,000
Western larch	30	75,000,000
Red fir	70	934,220,000
Pacific arbor vitæ....................................	40	299,200,000
Total..	....	1,482,370,000

Deducting this amount from the sum of the totals carried by the lumber species leaves 2,320,230,000 feet B. M. as the saw timber of commercial standard sizes in the reserve in Idaho.

If instead of using the standard employed here, namely, 12 inches basal diameter, we take a lower one of, say, 8 inches, basal diameter, and include all trees of the species listed in the table having reasonably clear trunks 10 feet or more in length, the totals should be increased 25 per cent, or 1,224,950,000 feet B. M., a gross total of 6,124,750,000 feet B. M.

Another estimate might be made, based upon all the species of trees in the reserve. In an estimate of this kind the lodgepole-pine growth would become the principal factor in swelling the amount. Owing to its extremely uneven stands it is practically impossible to estimate this species with any near degree of accuracy without a very minute examination of every 50-acre block. Striking a general average, however, of all the larger stands of the species, and including all trees between 8 inches basal and 4 inches top diameter, I estimate that the total arborescent growth on the reserve areas in Idaho, scaled in board measure, amounts to not less than 30,000 million feet in round numbers, all unsound timber excluded.

Timber in the Bitterroot Reserve in Idaho.

Variety.	District.				
	I. North Fork of Clearwater Basin.	II. Lochsa Basin.	III. Selway Basin.	IV. South Fork of Clearwater Basin.	V. Salmon River slopes.
	Feet B. M.	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*
Western yellow pine	6,000,000	150,000,000	700,000,000	80,000,000	254,000,000
Mountain white pine	250,000,000	30,000,000	(*a*)	(*a*)	(*a*)
Great silver fir	85,000,000	20,000,000	90,000,000	222,200,000	5,000,000
Western larch	75,000,000	90,000,000	(*a*)	85,000,000	(*b*)
Engelmann spruce	180,000,000	220,000,000	85,000,000	20,000,000	(*b*)
Red fir	110,000,000	200,000,000	900,000,000	35,000,000	89,600,000
Pacific arbor vitæ	48,000,000	150,000,000	550,000,000	(*a*)	(*a*)
Alpine hemlock	122,000,000	10,000,000	(*a*)	(*a*)	(*a*)
Lodgepole pine, archaic type	(*a*)	38,000,000	(*a*)	(*a*)	(*a*)
Total	876,000,000	908,000,000	2,325,000,000	442,200,000	348,600,000

a None. *b* Insignificant.

RECAPITULATION OF AMOUNT OF STANDING TIMBER OF COMMERCIAL VALUE IN THE IDAHO PORTION OF THE BITTERROOT RESERVE, BY DISTRICTS.

District	Feet B. M.
I. North Fork of Clearwater Basin	876,000,000
II. Lochsa Basin	908,000,000
III. Selway Basin	2,325,000,000
IV. South Fork of Clearwater Basin	442,200,000
V. Salmon River slopes	348,600,000
Total	4,899,800,000

To facilitate comparisons the following table is appended, in which the amounts of standing timber of each species are brought down in tabular form through all the districts:

Standing timber on Bitterroot Reserve in Idaho.

Variety.	District.					Total.
	I. North Fork of Clearwater Basin.	II. Lochsa Basin.	III. Selway Basin.	IV. South Fork of Clearwater Basin.	V. Salmon River slopes.	
	Feet B. M.	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*
Western yellow pine	6,000,000	150,000,000	700,000,000	80,000,000	254,000,000	1,190,000,000
Mountain white pine	250,000,000	30,000,000	(*a*)	(*a*)	(*a*)	280,000,000
Great silver fir	85,000,000	20,000,000	90,000,000	222,200,000	5,000,000	422,200,000
Western larch	75,000,000	90,000,000	(*a*)	85,000,000	(*b*)	250,000,000
Engelmann spruce	180,000,000	220,000,000	85,000,000	20,000,000	(*b*)	505,000,000
Red fir	110,000,000	200,000,000	900,000,000	35,000,000	89,600,000	1,334,600,000
Pacific arbor vitæ	48,000,000	150,000,000	550,000,000	(*a*)	(*a*)	748,000,000
Alpine hemlock	122,000,000	10,000,000	(*a*)	(*a*)	(*a*)	132,000,000
Lodgepole pine, archaic type	(*a*)	38,000,000	(*a*)	(*a*)	(*a*)	38,000,000

a None. *b* Insignificant.

AREAL EXTENT OF THE DIFFERENT FOREST TYPES, OF BADLY BURNED TRACTS, AND OF AREAS TREELESS THROUGH NATURAL CAUSES.

Type of forest.	District.				
	I. North Fork of Clearwater Basin.	II. Lochsa Basin.	III. Selway Basin.	IV. South Fork of Clearwater Basin.	V. Salmon River slopes.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Western yellow pine	25,600	211,200	456,192	98,304	358,400
Mountain white pine	192,000	422,400	50,688	425,984	....
Alpine fir	38,400	774,400	337,920	131,072	89,600
Total wooded area	256,000	1,408,000	844,800	655,360	448,000
Badly-burned areas (tracts denuded by fires during the last thirty-five or forty years, entirely bare of forest, or with sapling or seedling growth, or with a remainder of unburned forest amounting to less than 500 feet B. M. per acre)	76,800	701,000	300,000	262,144	103,040
Areas treeless through natural causes	10,000	70,000	91,000	12,000	10,000

RECAPITULATION OF ACREAGES IN THE IDAHO PORTION OF THE BITTERROOT FOREST RESERVE.

	Acres.
Western yellow-pine type of forest	1,149,696
Mountain white-pine type of forest	1,091,072
Alpine fir-type of forest	1,371,392
Total wooded area	3,612,160
Badly-burned areas	1,442,144
Areas treeless through natural causes	193,000
	1,635,144
Forest-covered tracts wholly untouched by fires or not seriously damaged by them during the past seventy-five years	1,977,016
Total	3,612,160

AVERAGE DIMENSIONS AND AGE OF OLD AND SECOND-GROWTH TREES IN BITTERROOT RESERVE IN IDAHO.

The following table shows the average dimensions and the age of old and second-growth timber:

Average dimensions and age of old and second-growth timber.

Species.	Second growth.	Old growth.
GREAT SILVER FIR.		
Height...feet..	30 to 50	50 to 110
Diameter...do....	1 to 1½	2 to 5
Clear trunk...do....	0 to 20	20 to 50
Age...years..	70 to 150	150 to 400
ALPINE FIR.		
Height...feet..	20 to 70	30 to 90
Diameter...do....	1 to 1½	1 to 2
Clear trunk...do....	0 to 30	0 to 50
Age...years..	75 to 150	
LYALL LARCH.		
Height...feet..	20 to 30	25 to 40
Diameter...do....	½ to ¾	1 to 4
Clear trunk...do....	8 to 12	10 to 20
Age...years..	75 to 175	175 to 400
WESTERN LARCH.		
Height...feet..	50 to 100	90 to 150
Diameter...do....	1 to 2	2 to 4
Clear trunk...do....	20 to 60	30 to 90
Age...years..	175	400
ENGELMANN SPRUCE.		
Height...feet..	30 to 80	80 to 100
Diameter...do....	1 to 2	1½ to 3
Clear trunk...do....	0 to 20	20 to 40
Age...years..	75 to 160	160 to 350

Average dimensions and age of old and second-growth timber—Continued.

Species.	Second growth.	Old growth.
WHITE-BARK PINE.		
Height.....feet..	15 to 25	20 to 40
Diameter.....do....	½ to 1	1 to 4
Clear trunk.....do....	0 to 12	8 to 15
Age.....years..	175	400
MOUNTAIN WHITE PINE.		
Height.....feet..	50 to 120	100 to 180
Diameter.....do....	1 to 2	2 to 5
Clear trunk.....do....	15 to 30	20 to 90
Age.....years..	90 to 120	170 to 350
LODGEPOLE PINE.		
Height.....feet..	20 to 100	....
Diameter.....do....	½ to 1½	....
Clear trunk.....do....	20 to 50	....
Age.....years..	150	....
WESTERN YELLOW PINE.		
Height.....feet..	40 to 90	60 to 120
Diameter.....do....	1 to 2	1½ to 5
Clear trunk.....do....	20 to 40	30 to 60
Age.....years..	160	200
RED FIR.		
Height.....feet..	30 to 85	60 to 135
Diameter.....do....	½ to 1½	1½ to 5
Clear trunk.....do....	0 to 35	20 to 90
Age.....years..	175	275
PACIFIC ARBOR VITÆ.		
Height.....feet..	40 to 65	60 to 120
Diameter.....do....	1 to 2	2 to 8
Clear trunk.....do....	10 to 15	15 to 30
Age.....years..	175	700
ALPINE HEMLOCK.		
Height.....feet..	20 to 30	20 to 90
Diameter.....do....	½ to 1	1 to 6
Clear trunk.....do....	0 to 15	0 to 35
Age.....years..	175	600

THE SAN GABRIEL FOREST RESERVE.

By John B. Leiberg.

TOPOGRAPHY.

The San Gabriel Forest Reserve is situated in southern California, west of the San Bernardino Reserve. It connects with the areas of the latter along its eastern boundary at Cajon Pass, and consists of the crest and the greater portion of the slopes of the western section of the Sierra Madre, or San Gabriel Mountains. It contains 550,000 acres and stretches westward from Cajon Pass for a distance of about 55 miles, with a breadth that varies from 8 to 24 miles.

The main axis of the Sierra Madre in its course through the reserve has a general direction from west to east. Its northern declivities end in the Mohave Desert, while its southern slopes sink, in part, into the Los Angeles Plains and, in part, into the San Bernardino Plains.

The general aspect of the Sierra Madre in its western section is that of an extremely broken and rugged region. The crest line of the main axis of the uplift lies well over toward the north, and this has caused the development of a short northern and long southern slope. Both declivities are very abrupt. The northern one breaks off to the plains directly from the crest of the main backbone, with a comparatively low and short system of ridges and canyons. The southern slope, although much the longer, makes the final dip to the plains at an angle not much less than that possessed by the northern declivities. This is owing to the uniform and considerable altitude of the great system of lateral spurs which stretch southward from the main axis. Seen from the plains either on the north or south the range appears to rise abruptly and precipitously, with none, or, at the most, a very short, low, and inconspicuous foothill region.

The crest line of the main backbone of the range is moderately winding. It is generally very narrow, rocky in some localities, deeply covered with deposits of gravel or coarser detritus in others, its uppermost slopes commonly very steep, frequently breaking off to the canyons in great precipices. Near the western boundaries of the reserve, in the portions adjacent to or connecting with Mount Gleason, the crest is considerably broader and forms small flats here and there. The crests and upper slopes of the lateral ridges, which extend southward from the main divide, are similar to those of the latter. They are mostly sharp and rocky, steep and precipitous, covered with bowlders or other forms of talus accumulations.

The altitudes of the main divide range from 6,000 to 10,000 feet, or possibly somewhat above the latter figure in the peak known as Old Baldy. The most elevated portions of the range are those situated in the eastern tracts of the reserve—Old Baldy and the areas around Cucamonga Peak and San Antonio Range. The crests of the southern lateral ridges run from near 4,000 to 6,000 feet above sea level.

The most striking feature in the orography of the Sierra Madre in the reserve is its canyon system, through which the drainage of the southern slope flows to the plains. Most of these canyons are narrow, rocky gorges, littered with vast accumulations of "wash"—talus slid down from the adjacent hillsides. The most noteworthy in this respect are the canyons which constitute the drainage basin of San Gabriel River. In some localities the channels of the largest forks of this stream are not more than 6 to 10 feet in width, inclosed between walls of rock rising nearly perpendicular several hundred feet, with crests of the inclosing ridges 6,000 to 7,000 feet above the stream bed. Toward Cajon Pass the deep sculpturing of the central areas of the reserve is considerably modified, owing to the lesser height of the ridges. The canyons here are broader and the slopes of the inclosing ridges somewhat less steep and rocky. In the western tracts of the reserve, along Tujunga and Soledad canyons, small portions of the chaparral plains which lie at the foot of the range extend into the mountains along the valleys of those streams. The Sierra Madre differs much from the San Bernardino and San Jacinto uplifts with reference to the configuration of the canyons at the heads of the streams. In these reserves most of the larger canyons terminate in flats or plateau-like basins, but in the San Gabriel Reserve the heads of the streams are mostly situated directly in the steep slopes of the mountain spurs, often in a towering, precipitous wall of rock. When flats occur they are small and insignificant and are commonly more or less deeply gullied, or terraced, with short, sharp breaks. Taken as a whole, the topography of the reserve can be defined as consisting of a series of long, deep, bowlder-strewn, gorge-like canyons, separated from one another by a system of high, precipitous, rocky ridges radiating from a central axis, which stretches through the reserve from west to east.

GENERAL FEATURES OF CLIMATE AND DRAINAGE.

The portion of the Sierra Madre which traverses the reserve separates the Mohave Desert from the Los Angeles Plains, and in part from the San Bernardino Plains. As a water reservoir and distributer to these plains it is of extreme importance.

The climatic conditions of the reserve are semiarid below elevations of 5,000 feet on the southern slope and 4,500 feet on the northern; subhumid between 5,000 and 9,000 feet, and humid on all areas above this latter point. As in the case of the San Bernardino and San Jacinto reserves, these terms—semiarid, subhumid, and humid—are here employed in a relative sense to express the moisture conditions prevailing in the three southern California reserves, without reference to the meaning of these terms when used elsewhere. So far as I am aware, there are no records of the total amount of annual precipitation that falls on the interior and elevated regions of the reserve. The timber and brush growth furnish no very close indication, owing to the modifying influences of other agencies than direct rainfall. The amount of precipitation received by the different portions of the reserve is probably somewhat less than the quantity which falls on the adjoining regions of the San Bernardino Reserve, or less than 25 inches for the tracts close to the 5,000-foot contour line, rapidly diminishing at elevations lower than 4,500 feet, and rising to 30 or 35 inches for areas above the 6,000-foot contour line. The actual annual amount of rain and snow which the higher altitudes receive is not known, and the above is merely an estimate based on the character of the timber growth.

The semiarid tracts of the reserve cover the largest area. They occur on the southern, northern, and eastern slopes of the range, and at the western boundaries complete a circle around the reserve area by an extension southward from the Mohave Desert along Soledad Canyon, and a northward extension along various tributaries of Los Angeles River. Large tracts in the interior of the reserve consist of this class of lands, and predominating, as they do, in point of acreage, determine the chief aspect of the region. The semiarid lands are generally coexistent with a continuous growth of brush and chaparral; not invariably so, however, as many of the low-lying southern slopes which carry scattered groups of big-cone fir must be regarded as belonging to this class, the tree growth on them being merely a result of local conditions of water supply. Likewise, the lands on the northern slopes, sparsely covered with California juniper and piñon pines, are semiarid in character. The total of the different tracts included in this classification is 449,000 acres, or slightly more than 81.6 per cent of the entire reserve area.

The subhumid tracts comprise the areas covered with an approximately continuous coniferous growth. As here classed, they are situated below the 9,000-foot contour line, and generally above the 5,000-foot one, their lower limitations being variable and not very well defined in any locality. They carry a thin, open forest, which is more or less interrupted in its continuity by rock patches or small areas burned long ago and since covered with brush. Apparently the thin growth is largely due to inherent sterility of soil, the steep slope rendering an accumulation of humus or mold impossible. These tracts comprise collectively 96,000 acres, or somewhat more than 17.5 per cent of the reserve area.

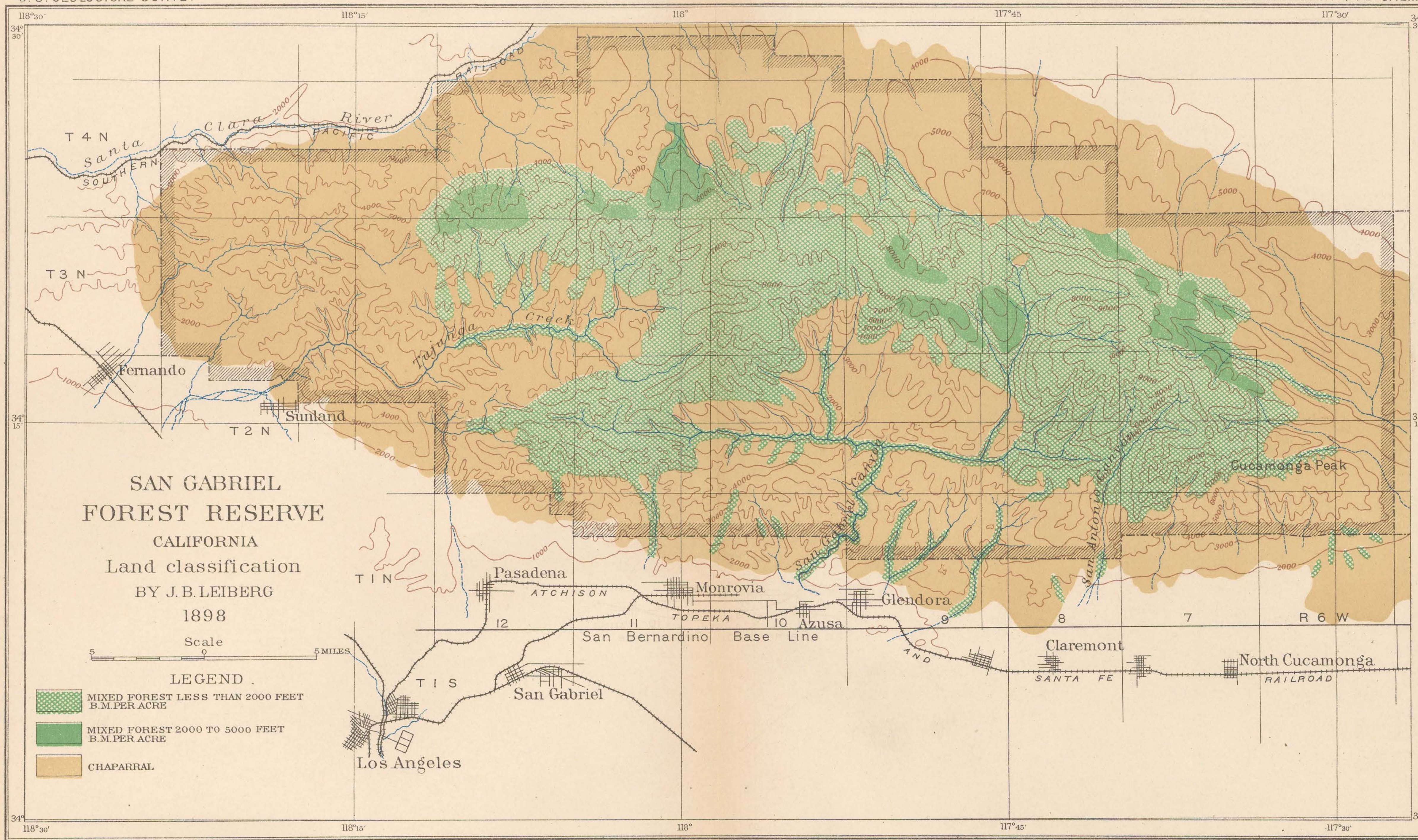
The humid tracts consist of the areas above the 9,000-foot contour line. They only include a few summits in the eastern portion of the reserve. The lands are rocky and sterile, largely devoid of soil covering, and support a growth of mostly low and stunted trees. They contain about 5,000 acres, or less than 1 per cent of the reserve area. The highest summit of the humid tracts is the peak named Old Baldy, which carries small quantities of snow on its northern slopes throughout the year.

Along the Mohave side of the range the semiarid tracts belonging to the reserve gradually merge into those upon which truly arid conditions prevail. The exact dividing line between the two classes is not very sharply drawn. The areas of the desert contiguous to the reserve here appear to be less arid than those in similar situations on the eastern side of the San Bernardino and San Jacinto ranges, and whatever of these lands overlap and extend inside the reserve boundaries are included in the semiarid class.

With reference to the climatic conditions which prevail in the reserve its various areas are as follows:

	Acres.
Semiarid tracts	449,000
Subhumid tracts	96,000
Humid tracts	5,000
Total	550,000

The Sierra Madre supplies the larger portion of the water required for irrigation on the Los Angeles Plains, and, to some extent, on the San Bernardino Plains. In addition, it furnishes considerable quantities for purposes of electric lighting and power. Most of the drainage which flows from the range within the reserve boundaries is discharged from the southern slopes. The quantity flowing from the northern declivities toward the Mohave Desert is insignificant in amount. The water is all appropriated by individuals and corporations, and is very far from sufficient for the lands on the plains that could be brought under cultivation were a larger supply available. Practically all the visible flow from the southern slopes of the reserve area does now its uttermost duty, and the extent of agricultural lands depending on water from this source can not be increased. It is consequently of the highest importance that the water-shedding capacity of the Sierra Madre should suffer no diminution. The quantity of water which is discharged by the range is chiefly conditional upon the amount of fissuring existing in the bed rock. The rock formation is composed of schists that have been invaded and shattered by the intrusion of vari-



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ous kinds of eruptive rocks, originating long and deep fissures everywhere and breaking up the compactness of the bedding planes. Through these fissures large quantities of the water must find its way to great depths, some of it reappearing as springs, some of it sinking below the water level of the canyons and becoming lost, so far as utilization is concerned. Doubtless much of the water sinks also along the bedding planes of the schists, where they are upturned at high angles and more or less broken or disjointed. Owing to this structure of the rock formation water mining has been carried on to a greater extent here and with better results than in the San Bernardino Reserve. The volume of water in Lytle Creek and in the San Gabriel River is noticeably augmented through the results obtained by this kind of mining. The opportunities for extensive work in this direction are great. It is highly probable that in hundreds of localities, especially along the contact plains of the more prominent eruptive dikes, and of the more or less metalliferous quartz veins which abound in many places, a large quantity of water could be intercepted in its downward flow and made to do duty in the irrigation of the agricultural lands on the plains. It is, however, to be noted that the more extensive the water mining becomes the more likely it will be to diminish the volume of the naturally existing springs by draining their feeders at underground points.

The forest growth in the reserve exercises no influence whatever upon the regimen of the streams. There is very little of it in the first place, and its growth is too thin, not even affording a sufficient amount of shade to retard evaporation in any noticeable degree, except in isolated localities which have slight effect on the general aggregate. And, moreover, the humus layer, which in forests of different types and greater density performs the office of an immense water sponge, is wholly lacking here. The chaparral is of value, inasmuch as it contributes to surface stability of the loose soil, or, rather, the sand and gravel covering of the slopes, to some extent preventing gullying and the too rapid slipping of the loose "wash" and talus of the hills into the canyons. This wash, in a measure, performs the function of a humus layer in its capacity of a water absorbent.

The largest drainage basin on the southern slope is that of the San Gabriel. By means of its long and numerous forks it gathers the flow from nearly two-thirds of the reserve area. It supplies large quantities of power for electric lighting and transportation purposes, and the various improvements along its valley to this end are extensive and costly. Its valley is rocky and gorge-like, and where any widenings occur the stream bottoms are littered with great bowlder and gravel deposits. Here and there along the mountain slopes terraces occur, on which rest great deposits of auriferous gravel, which formerly were sluiced and the débris added to the natural accumulation of wash in the stream beds. These deposits are worked yet more or less, but not so extensively as formerly, owing to the appropriation of most of the water by the agricultural interests.

The Sierra Madre is notably deficient in eligible reservoir sites, due partly to the absence of extensive flats at the heads of the canyons and partly to the uniformly rapid fall of many of the streams.

For ages past the canyons heading in the Sierra Madre have carried down and spread out over the Los Angeles and San Bernardino plains vast quantities of gravel and bowlder wash. The lines of wash extend in some cases 10 or 12 miles into the plains from the point where the canyons debouch, and immense quantities are piled up as cones or terraces nearer the mountains. Most of the larger streams are subject to freshets in the spring and waste their surplus water, owing to absence of storage reservoirs. During the periods of high water great quantities of the bowlder litter of the upper sections of the stream channels are shifted to points farther down, to be eventually swept out on the plains.

The streams heading in the northern slopes of the Sierra Madre sink in the Mohave Desert or are very closely utilized for irrigation purposes there. They are all small and carry insignificant volumes of water.

AGRICULTURAL, GRAZING, AND MINING AREAS.

The San Gabriel Reserve contains a minimum of agricultural lands. There are practically none in the interior of the reserve. The canyons are too narrow and rocky, and where a small flat exists, or a widening between the canyon walls, soil is either wholly absent or consists of bowlder, gravel, and sand wash. In occasional places, as where a springy or marshy place exists, or in an angle behind some sheltering spur, or on the top of small terraces bordering the canyons, are found patches of 4 or 5 acres under cultivation, mostly in fruit. Or the farm consists of 1, or at the most 2 acres, and forms the site of a "bee ranch," or surrounds a summer resort. The total acreage of these cultivations is insignificant. On the Mohave side of the range are small cultivated tracts, situated at the openings of canyons into the desert. Most of these cultivated tracts lie outside the reserve areas. Owing to lack of water for irrigation purposes, the acreage of agricultural lands within the reserve on this slope is, and will remain, very small.

The grazing lands of the reserve formerly comprised the slopes at and below the 6,000-foot contour line and many tracts up to 8,500 feet. Long ago the region was thoroughly sheeped over and the grass growth pretty well killed out. It has never generally recovered, being thin and scattering, though it must be admitted that from the first it could not possibly have been of a very luxuriant growth. At the 6,000-foot contour line, and above this altitude, where small flats or springy places occur, there is sometimes a sparse growth of grass, tufted or forming a moderately compact and continuous turf over a few square rods of ground. In much the larger portion of the reserve at the present time grazing areas are practically absent throughout the chaparral-covered tracts. There is a small acreage in many patches of circumscribed extent in the forest zone, the total not exceeding 10,000 acres, and an entire absence of all grass growth on most of the upper forest-covered slopes. No sheep are pastured in the reserve. A few hundred head of stock belonging to residents are scattered throughout the region in various localities. Several hundred head of burros, owned by placer miners, or by proprietors of summer resorts located inside the reserve, chiefly in the San Gabriel canyons, run at large and pick up a precarious living by browsing on the brush and on young seedling trees when obtainable.

The soil is sandy, gravelly, or clayey, depending upon the character of the rocks from which it was derived. The soil of the upper slopes of the ridges, at least near the main axis of the range, is frequently wholly composed of fine, sharp sand. The slope is too steep to permit of any humus or mold accumulations. Whatever is produced of this nature washes down into the canyon bottoms. Where conditions favor its retention and accumulation soil fertility ensues.

Most of the reserve area is mineral bearing. It contains both placer deposits and quartz veins. The latter have been worked but little, if at all; the former have been exploited during a period of many years. The auriferous wash in the canyons of the San Gabriel River has been torn up for miles and sluiced over several times. The heavy deposits of gravel on terraces bordering the streams, a few hundred feet above the present channel, likewise contain gold and have also been sluiced. While placer mining is still carried on at the present time, it manifestly is not on so large a scale as formerly. The use of water for sluicing renders it to some extent unsuitable for irrigation and decidedly unfit for drinking purposes. The distances between the mining points and the places where the water is consumed are not long enough to give the slimes in suspension a chance to settle. As the agricultural interests are more valuable than the mining, and as the use of water by one is inimical to the maintenance of the other, the mining interests are gradually being forced to the wall, at least so far as relates to the placers. The placer work is confined to ground sluicing. Hydraulic mining, which was practiced some years ago, has been discontinued, owing to the great masses of wash ("slickens") that were necessarily thrown into the stream channels, and later, during high water, transported to the plains, covering the fields and choking the various irrigation ditches and pipes.

BRUSH AND FOREST GROWTH.

The conspicuous vegetation in the reserve is of two types: (1) A brush or chaparral growth, more or less mixed with an open, thin, or aggregated timber stand or single trees, or wholly composed of shrubby plants, and continuous except where broken by patches of naked rocks; (2) a forest growth, which, while generally heavy enough to deserve the designation of forest, is mostly of a thin stand, and composed of low, scraggy individuals. The grass and other herbaceous vegetation is so sparse and small that it is hardly noticeable, except along the banks of streams or in moist hollows of the hills, where various bright-flowered species of herbs arrest the eye momentarily.

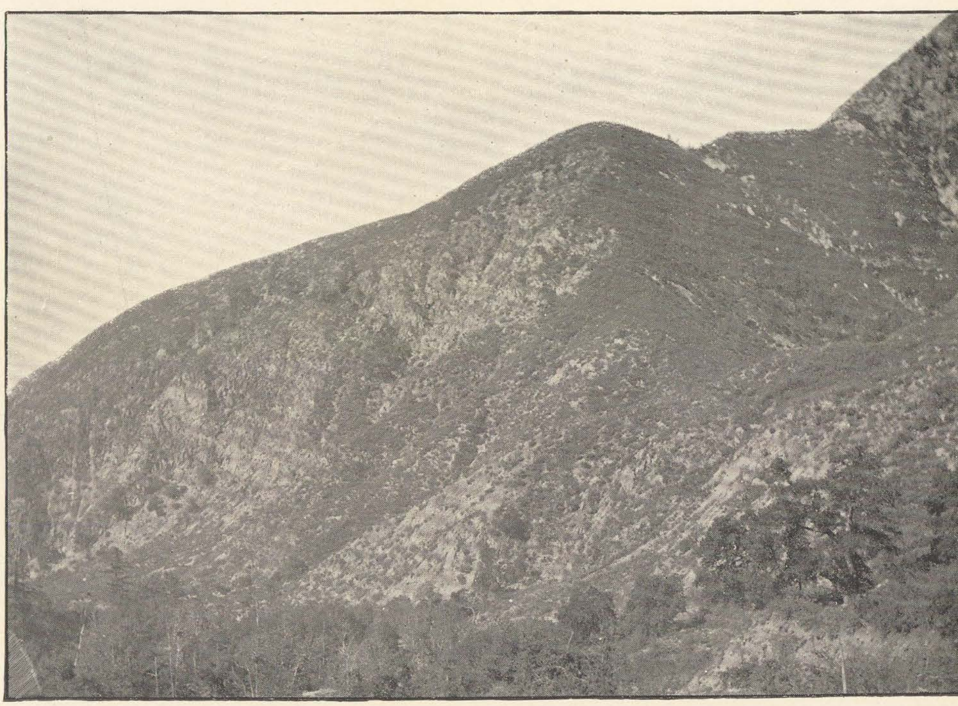
THE BRUSH OR CHAPARRAL.

The chaparral type of vegetation in the reserve bears a general resemblance to the corresponding growth elsewhere described as occurring in the San Bernardino and San Jacinto reserves. It differs, however, in some salient points. In the first place, while it is composed of as many species as in the other two southern California reserves just mentioned, the preponderance of one or two is more strongly marked. Along the streams, where there is an abundance of moisture, in the narrow canyons, and on northern slopes in the interior it frequently forms growths and thickets far denser and higher than on any area in either the San Bernardino or San Jacinto reserves. There is in such localities a constant tendency toward a truly arborescent stature of a few species, as, for example, *Arctostaphylos manzanita* and *Ceanothus divaricatus*. Another point of difference is the inconsiderable height and the open character of the brush growth on the upper part of the semiarid tracts, due to a deficiency of soil and a rapid drainage caused by steepness of slope (Pl. CXLIV).

The common height of the chaparral at middle elevations on the slopes varies from 3 to 4 feet. In the canyons, where there are favorable moisture and soil conditions, it may run up to 12 or 14 feet, or fall to 2 or 3 feet where it grows on dry declivities. At the upper elevations, above the 6,000-foot contour line, 2 feet is a common height, and at higher altitudes it exists merely as depressed patches of brush growth, rising a foot or less above the ground.

The altitudinal range of the brush growth is from the plains level to the highest summits. Above the 6,000-foot contour line it occurs as underbrush in the forest, or as a continuous growth on occasional tracts where the timber has been destroyed by fire and reforestation has not taken place. Its greatest development, however, is on the semiarid tracts, to which it properly belongs, and where it flourishes as a solid and continuous growth. The heaviest chaparral occurs on

A. CHAPARRAL GROWTH ON SUMMIT BETWEEN EAST FORK OF SAN GABRIEL RIVER AND MOHAVE DESERT.



B. CHAPARRAL SLOPES ON NORTH FORK OF SAN GABRIEL RIVER, SAN GABRIEL RESERVE.

the southern and western slopes of the range. The eastern, at Cajon Pass, has a thin growth, and much of the northern or Mohave slope none at all, except the juniper and yucca scrub. The chaparral on the southern slopes extends into the plains, but is there low and open, and composed almost wholly of one genus, the *Adenostoma*, or the so-called "grease wood." Before cultivation and irrigation the plains to the south of the reserve were, probably, uniformly covered with a low chaparral of this species.

The brush-covered tracts within the reserve comprise in the aggregate 445,000 acres, or nearly 81 per cent of the entire reserve. In this estimate are included all the thin stands of mixed timber and scattered groups of big-cone fir below the 5,000-foot contour line, which, while in one sense forming arborescent growths, are usually so intermixed and surrounded by chaparral that they really belong to this latter class rather than to the forest.

The chaparral is composed of 40 or 45 species of shrubs, some of which become trees in favorable situations. Most of them are low, not exceeding 5 feet in height. The greater number are of limited or scattered occurrence, 2 or 3 species forming the larger proportion.

As in the San Bernardino and San Jacinto reserves, there is a zonal arrangement of the various species of shrubs, the distinction depending on altitude. The line of demarkation is clearest between the 6,000-foot and 7,000-foot contours. The chaparral on the northern slopes differs in composition from that on the eastern, southern, and western, owing to the desert conditions of the nearby Mohave areas.

In the following grouping of the chaparral shrubs the same arrangement is employed that is used in listing the species which form the brush growth in the San Bernardino and San Jacinto reserves, as best expressing the composition of the chaparral on the semiarid and subhumid tracts. Only the most conspicuous species are enumerated:

Composition of chaparral on the southern, eastern, and western slopes of San Gabriel Forest Reserve below the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	65
Arctostaphylos manzanita	3
Arctostaphylos tomentosa	Inconsiderable.
Baccharis viminea	Inconsiderable.
Ceanothus crassifolius	1
Ceanothus cuneatus	Inconsiderable.
Ceanothus divaricatus	16
Ceanothus hirsutus	Inconsiderable.
Ceanothus integerrimus	Inconsiderable.
Ceanothus vestitus	Inconsiderable.
Cercocarpus betulæfolius (as shrubs)	.5
Cercocarpus ledifolius (as shrubs)	1
Chrysoma pinifolia	Inconsiderable.

	Per cent.
Eriodyction californicum	Inconsiderable.
Eriodyction tomentosum	Inconsiderable.
Fraxinus dipetala	Inconsiderable.
Fremontodendron californicum	Inconsiderable.
Garrya veatchii	Inconsiderable.
Prunus ilicifolia	Inconsiderable.
Quercus undulata	10
Rhamnus ilicifolia	Inconsiderable.
Rhamnus rubra	Inconsiderable.
Rhus diversiloba	Inconsiderable.
Rhus trilobata	Inconsiderable.
Ribes cereum	Inconsiderable.
Ribes hesperium	Inconsiderable.
Salix lasiandra	Inconsiderable.
Salix lasiolepis	Inconsiderable.
Stenotus interior	1
Styrax californica	Inconsiderable.

Composition of chaparral on the southern, eastern, and western slopes of San Gabriel Forest Reserve above the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	40
Arctostaphylos manzanita	6
Arctostaphylos patula	10
Arctostaphylos tomentosa	Inconsiderable.
Artemisia tridentata	Inconsiderable.
Castanopsis chrysophylla	Inconsiderable.
Ceanothus divaricatus	20
Cercocarpus betulæfolius and Cercocarpus ledifolius (as shrubs)	5
Fremontodendron californicum	Inconsiderable.
Prunus ilicifolia	Inconsiderable.
Quercus undulata	15
Stunted conifers and oaks of otherwise arborescent species	3

The large percentage of "grease wood" (*Adenostoma fasciculatum*) and "buck brush" (*Ceanothus divaricatus*) in the above list is due to the extension of the semiarid chaparral growth into the subhumid areas and the sparse underbrush on the forested tracts.

The chaparral on the northern declivities is very thin and scattered, often wholly absent where forest covers the ground. For elevations above 5,000 feet its principal components are ceanothi and manzanitas; below this altitude scattered juniper scrub, low, bushy piñons, yuccas, and cacti.

The brush growth in the San Gabriel Reserve exists partly as a result of naturally semiarid conditions, partly as a result of fires and deficient reforestation. The groves of big-cone fir and thin, irregular lines of the same species which are found scattered throughout the chaparral, even as low as the 1,500-foot contour line, leave no room for doubt that in times not very far back many of the slopes at middle elevations were timbered. This appears to have been especially the case in the interior of the drainage basins, especially in those of Lytle, San Gabriel, and Tujunga creeks. Whether owing to change in climate or to a change, chemical or otherwise, in the soil, as a result from fires, there is a general and decided tendency to what appears to be permanent enlargements of the chaparral areas at all elevations.

The chaparral in the San Gabriel Reserve is of little or no economic value aside from the very important function of preventing wholly or in part a sliding or washing of loose sands or gravel from the slopes into the stream beds. In some localities a number of species are utilized for fuel. The roots of the *Adenostoma* are sometimes grubbed out for this purpose; but in the stability which its dense and uninterrupted growth gives to the slope surface lies the chief utility of the chaparral, and in this respect it is of far more value than the entire arborescent growth in the reserve.

THE FOREST.

The following list of trees growing in the San Gabriel Forest Reserve is complete so far as it relates to the cone-bearing trees. Probably some of the deciduous-leaved species are lacking in the enumeration, owing to the early date in the season at which the reserve was examined.

List of trees in the San Gabriel Forest Reserve.

CONIFEROUS TREES.

Abies concolor	White fir.
Juniperus californica	California juniper.
Libocedrus decurrens	Incense cedar.
Pinus attenuata	Knob-cone pine.
Pinus coulteri	Big-cone pine.
Pinus flexilis	Limber pine.
Pinus lambertiana	Sugar pine.
Pinus monophylla	Single-leaf piñon.
Pinus murrayana	Lodgepole pine.
Pinus ponderosa	Western yellow pine.
Pseudotsuga macrocarpa	Big-cone fir.

NONCONIFEROUS TREES.

Evergreen species:	
Cercocarpus betulæfolius	Birch-leaf mahogany.
Cercocarpus ledifolius	Mountain mahogany.
Quercus chrysolepis	Canyon live oak.
Quercus wislizeni	Highland live oak.
Yucca arborescens	Tree yucca.
Deciduous-leaved species:	
Alnus rhombifolia	Mountain alder.
Fremontodendron californicum	Fremontia.
Juglans rupestris	Western walnut.
Platanus racemosa	California sycamore.
Populus trichocarpa	Black cottonwood.
Quercus californica	California black oak.
Salix lasiandra	Western black willow.

The arborescent growth on the eastern, southern, and western slopes of the Sierra Madre in the reserve, below the 1,500-foot contour line. It consists chiefly of oak, cottonwood, willow, and sycamore, with occasional stretches of mountain mahogany on the bowlder wash in the canyons, and is confined to banks of streams, or occurs in sheltered places in hollows of the mountain spurs where seepage is abundant. These growths nowhere form dense stands.

The first coniferous growth begins at the 1,500-foot contour line in the interior basins of the reserve, but scarcely below the 3,000-foot level on the slopes which front directly on the San Bernardino and the Los Angeles plains. Is composed exclusively of one species, the big-cone fir. At the 1,500-foot level the tree occurs as solitary individuals, gnarled, stunted, and ragged, rising from dense masses of intertangled chaparral shrubs. With rise in elevation the number of individuals of the species rapidly increases. Between the 3,000-foot and the 5,000-foot contours the species forms extensive growths, sometimes exclusively covering the entire eastern and northern slopes of spurs, or stretching along the sharp combs of ridges, stunted and weather-beaten, in thin, narrow fringes. Occasionally it forms segregated groves in the midst of the otherwise uniform chaparral growth, when it represents remains of much larger and denser stands, which covered the mountain sides at these elevations at a no very distant period. Between elevations of 3,500 feet and 8,000 feet this species forms the bulk of the forest growth and is, in general, the most common tree throughout the reserve. At the 4,000-foot contour line the coniferous growth is increased by the addition of knob-cone pine (*Pinus attenuata*) and big-cone pine (*Pinus coulteri*), both species rather local in their distribution in this reserve. At altitudes of 5,500 feet, incense cedar (*Libocedrus decurrens*) and western yellow pine (*Pinus ponderosa*), begin to form a noticeable proportion of the forest covering, and the areas carrying timber stands capable of supplying mill timber may be said to commence.

At altitudes of 6,000 feet white fir (*Abies concolor*) and scattered trees of sugar pine (*Pinus lambertiana*) begin to grow. This latter species attains merchantable size and contributes a small percentage to the forest stands above the 6,500-foot level. At 8,000 feet altitude most of the oaks disappear, and stands of limber pine (*Pinus flexilis*) and lodgepole pine (*Pinus murrayana*), take the place of the other coniferous species which here begin to thin out.

At 9,000 feet elevation most of the coniferous trees have ceased to grow and the stands are chiefly composed of the following, which continue to the highest summits:

Abies concolor	White fir.
Pinus flexilis	Limber pine.
Pinus murrayana	Lodgepole pine.

The forest on the northern slopes above the 6,000-foot contour line is composed of the same species which make up the stands on the other declivities at similar elevations, with the exception of scattered trees of single-leaf piñon (*Pinus monophylla*), in the eastern sections of the reserve as high as the 7,500-foot level. Below the 6,000-foot contour the various conifers thin out rapidly and are replaced by juniper scrub, scattered trees of the single-leaf piñon, and arborescent yuccas.

The forest growth in the San Gabriel Reserve presents the three general types which occur in the San Bernardino and San Jacinto reserves, namely, the semiarid, subhumid, and humid. But they are here far from being as closely demarcated as is the case in the two last-named reserves. The east and west trend of the Sierra Madre evidently causes a different distribution of moisture from that produced by the north and south trend of the ranges which form the San Bernardino and San Jacinto uplifts, and the altitudinal extensions and limitations of the forest are changed accordingly.

The timber growth on the semiarid tracts—that is, on those situated below where the western yellow pine constitutes 2 per cent or more of the forest growth—is of two kinds. The first, which prevails on the northern slopes, consists mostly of piñon and juniper scrub; the second occurs on the eastern, southern, and western declivities, and is composed of the big-cone fir, small quantities of big-cone pine, knob-cone pine, and the various species of oak, willow, cottonwood, sycamore, and mountain mahogany which occur here, merely owing to the moisture conditions caused by the streams whose banks they line. The coniferous tree growth on these tracts is always open, often scattered. The individual trees of the big-cone fir species are low and stunted, gnarled and twisted, rarely with any clear trunk, frequently displaying large basal diameters, with heavy, wide-spreading limbs starting a few feet from the ground, where they grow in sheltered localities; or with many short, straight, broken, and ragged branches pointing toward the northeast, where they stand on slopes or ridge combs exposed to the pressure of the southwesterly gales.

This class of timber growth is of little value except for fuel. The proportions of the principal species which compose it are as follows:

Composition of forest on semiarid tracts in San Gabriel Reserve.

	Per cent.
Alnus rhombifolia	Inconsiderable.
Cercocarpus betulæfolius. } Cercocarpus ledifolius }	0.5
Fremontodendron californicum	Inconsiderable.
Juniperus californica	1
Pinus attenuata	Inconsiderable.
Pinus coulteri	Inconsiderable.
Pinus monophylla	4
Platanus racemosa	2

	Per cent.
Pseudotsuga macrocarpa	80
Quercus californica, Quercus chrysolepis, Quercus wislizeni	10
Yucca arborescens	Inconsiderable.

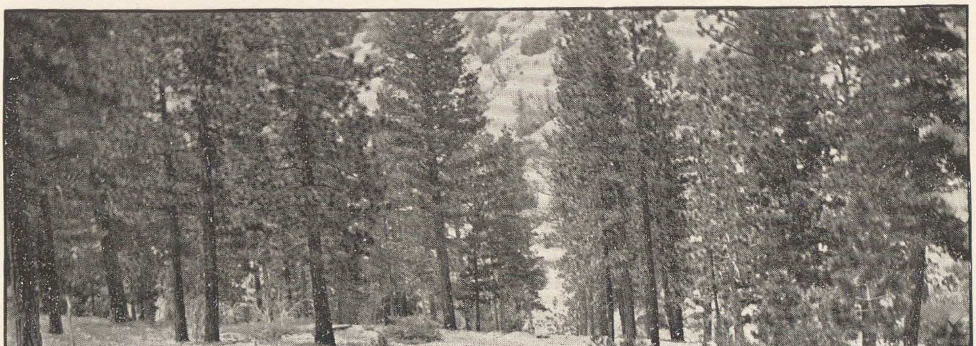
Owing to the extremely scattered distribution of the tracts which carry timber of this class, it is difficult to state the exact acreage of them. In some localities there are but 2 or 3 acres, forming a small grove; in other localities merely a few groups of trees, while in still other places, especially toward the upper limits of the tracts or on northern declivities, the stands cover 200 or 300 acres, or even more, without any breaks of chaparral growth. I estimate that of the 449,000 acres comprising the semiarid tracts about 75,000 acres bear timber of the character described above.

The second type of forest covers the subhumid tracts in the reserve, or the belt of mountainous summits and slopes situated approximately between the 5,500-foot and 9,000-foot contour lines. It contains the merchantable timber of the region. The growth is open and park-like, consisting chiefly of western yellow pine, sugar pine, and big-cone fir, interspersed with a few oaks. A great deal of rocky ground and loose talus slopes break the continuity of the stands in the high and steep region around Old Baldy and Cucamonga peaks. At the lowest elevations there is a moderate quantity of underbrush composed of scrub oak, manzanita, mountain mahogany, and ceanothus; at the higher elevations there is but little, or often none. In localities where fires have run through the forest and killed the underbrush there is more or less litter, according to the density of the dead undergrowth. The areas which carry forests of this type comprise in the aggregate 96,000 acres, and exist along the crests of the main range and its higher laterals, and on the adjacent slopes within the altitudinal limits above specified, forming a tolerably continuous forest belt on the crest of the main axis of the range from the western portions of the reserve, beginning at Mount Gleason, to the eastern areas along Lytle Creek. The subjoined table exhibits the relative proportions of the various species of trees which form the growth.

Composition of the forest in San Gabriel Reserve between the 5,500-foot and the 9,000-foot contours.

	Per cent.
Abies concolor	25
Libocedrus decurrens	3
Pinus attenuata	Inconsiderable.
Pinus coulteri	Inconsiderable.
Pinus flexilis	1
Pinus lambertiana	6
Pinus monophylla	Inconsiderable.
Pinus ponderosa	20
Pseudotsuga macrocarpa	40
Oaks	2

A. SUMMITS BETWEEN SAN ANTONIO AND ICE-HOUSE CANYON.



B. MERCHANTABLE TIMBER, NEAR HEAD OF LYTLE CREEK, SAN GABRIEL RESERVE.

The forests on the humid areas in the San Gabriel reserve are chiefly composed of the following species, and in the proportions noted:

	Per cent.
Abies concolor	35
Pinus flexilis	15
Pinus murrayana	45

This growth contains no merchantable timber. It lies above the 9,000-foot contour line, and consists of a few of the summits and slopes in the eastern portion of the reserve, with a total area of about 5,000 acres. It forms an open forest, with scanty and low underbrush, and is much broken by bare, rocky expanses (Pl. CXLV, *A*).

The forest growth in the reserve which attains sufficient size and development of clear trunk to deserve the designation of mill timber really consists of but one class, closely corresponding in appearance and value to the growth designated as second-class in the forests of the San Bernardino and San Gabriel reserves. However, in order to specify more closely the areas and to show the quantity of timber which is capable of being utilized for ordinary mill purposes, a division is made, so as to form two classes of what would otherwise be but one.

The areas of the first of these classes comprise 25,000 acres. The trees occur in small bodies, varying in size from 50 to 400 or 500 acres. They are situated on the slopes of the main axis of the range, at the heads of canyons in sheltered localities, on small flats or terraces around Mount Gleason, on the upper tributaries of the San Gabriel forks at the head of Lytle Creek, and in the valleys of some of the larger streams which head in the northern slope. The timber is, in general, poor in quality. A large proportion, 50 to 60 per cent, bears long and broad fire scars on the basal portions of the trunks. The crown development is, in general, excessive in relation to the proportion of clear trunk. Fully 50 per cent is so situated, as regards accessibility, that it can not be reached without the construction of expensive roads. The stand is thin and open, not exceeding 5,000 feet B. M. per acre, and rarely reaching this figure (Pls. CXLV, *B* and CXLVI, *A*). The total quantity of merchantable timber carried by the tracts embraced in this class is 50 million feet B. M., divided between the various species of lumber trees as follows:

	Feet B. M.
Pinus ponderosa	35,000,000
Pinus lambertiana, Libocedrus decurrens, and Abies concolor	15,000,000
Total	50,000,000

The second-class timber is in every respect of very poor quality. Much of it is very badly fire scarred. Still more, growing on ridges where it is freely exposed to heavy wind pressure from all directions and where scanty soil is the rule, presents nothing but a low, stunted, depressed growth, with long, living branches, commencing at or close to the ground. Comparatively little is fit for mill timber. Much the larger proportion grows on steep slopes and is practically inaccessible (Pl. CXLVI, *B*). The distribution of these tracts is along the main axis and slopes of the range, everywhere mingling with those which carry the first-class timber. The total of the different areas coming under this classification is 71,000 acres, and the stand, by including the best of the big-cone and white fir, amounts to 30 million feet B. M., distributed among the various species in the following amounts:

	Feet B. M.
Abies concolor	5,000,000
Libocedrus decurrens and Pinus lambertiana	5,000,000
Pinus ponderosa	10,000,000
Pseudotsuga macrocarpa	10,000,000
Total	30,000,000

Summarizing the stand of timber of the two classes for the entire reserve, the account of merchantable timber stands as follows:

	Feet B. M.
First class	50,000,000
Second class	30,000,000
Total	80,000,000

This is divided between the various species in these proportions:

	Feet B. M.
Abies concolor	9,500,000
Libocedrus decurrens	5,000,000
Pinus lambertiana	10,500,000
Pinus ponderosa	45,000,000
Pseudotsuga macrocarpa	10,000,000
Total	80,000,000

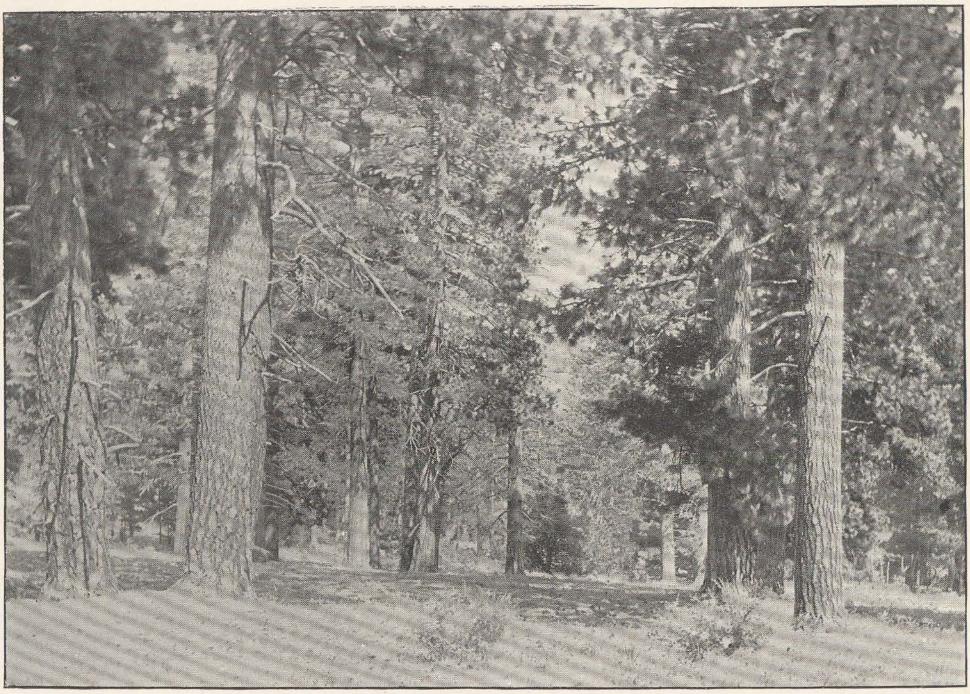
A large quantity of the timber in the reserve has no other than a fuel value, as already noted. I estimate that the forest unfit for purposes of lumber contains in the aggregate 400,000 cords of wood.

LOGGING OPERATIONS IN THE RESERVE.

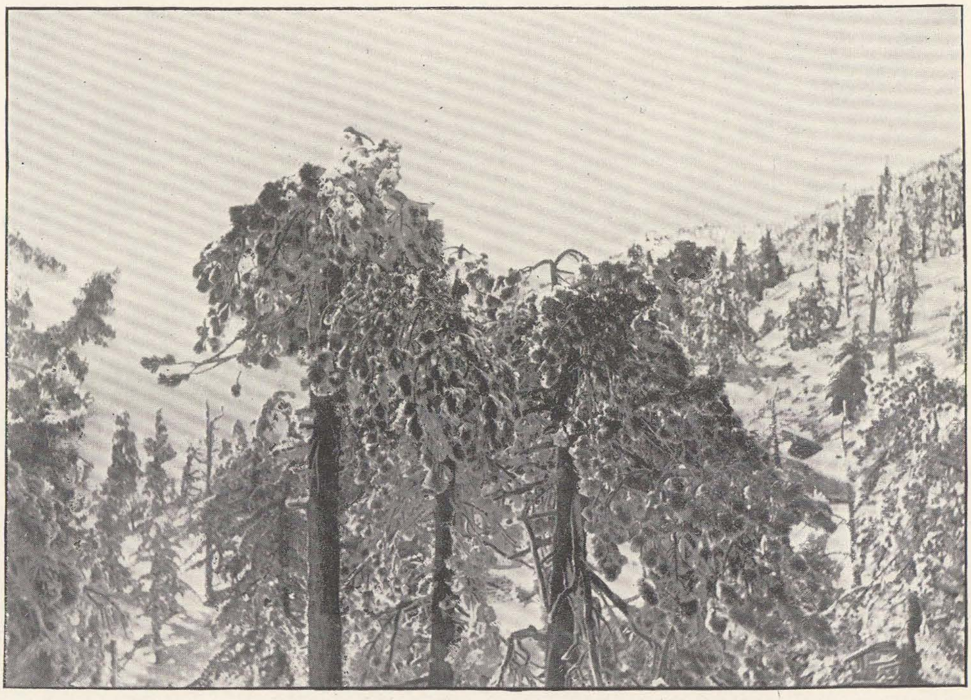
Small quantities of pine and incense cedar have been cut from most of the flats or other accessible places in the reserve in past years. The total quantity is insignificant. No place is logged clean, and in late years, since the reserve was established, lumbering operations within the reserve areas have practically ceased. The difficulties attendant upon the transportation of logs or lumber from the interior and high portions of the reserve, where most of the mill timber is found, are so great as to be nearly prohibitive except where the lumber can be used right on the ground.

The following species of trees are logged and the percentages opposite each shows the ratio which each bears to the total cut:

	Per cent.
Pinus ponderosa	99.99
Pinus lambertiana and Libocedrus decurrens	.01



A. MERCHANTABLE TIMBER, HEAD OF LYTLE CREEK, SAN GABRIEL RESERVE.



B. SUMMITS BETWEEN CUCAMONGA PEAK AND HEAD OF SAN ANTONIO CANYON.

The reasons for the small cut of sugar pine and incense cedar is to be found in their growth at high elevations, where access is difficult or impossible.

Dimensions of the principal forest trees in the San Gabriel Reserve.

Species.	Diameter.	Height.	Clear trunk.
	Feet.	*Feet.*	*Feet.*
Abies concolor	$1\frac{1}{2}$ to 2	40 to 70	None to 20
Libocedrus decurrens	$1\frac{1}{2}$ to $2\frac{1}{2}$	50 to 90	Commonly none.
Pinus flexilis	1 to 3	8 to 25	None to 10
Pinus lambertiana	1 to 3	20 to 50	10 to 20
Pinus monophylla	$\frac{2}{3}$ to 1	15 to 20	None.
Pinus murrayana	1 to 2	20 to 60	None to 10 to 40
Pinus ponderosa	1 to 3	30 to 90	10 to 20
Pseudotsuga macrocarpa	1 to 5	30 to 60	None to 12

FOREST FIRES.

The San Gabriel Reserve has suffered far more severely from forest and brush fires than have the San Bernardino and San Jacinto reserves. All the timbered areas show evidences of recent fires. The commercially valuable timber, never very large in quantity, has suffered severely, the destruction where the trees have been wholly consumed or merely killed amounting to fully 15 per cent. In addition a large proportion of the yet living timber is deeply marked by long and wide fire scars on the lower 8 or 10 feet of the trunk, very materially lessening the value of the timber so affected or rendering it totally unfit for logging purposes where the fire scars are deep. The greatest damage in the commercial timber has been done to the western yellow pine, notwithstanding its superior fire-resisting qualities. This is due to the fact that of the lumber trees the western yellow pine here descends lower into the brush-covered tracts than is the case with the sugar pine, incense cedar, or white fir. Among the species unfit in a general way for sawmill uses the big-cone fir has sustained the greatest damage, likewise owing to its extensive growth in the chaparral. Large tracts that not so long ago were covered with stands of this tree are now either bare or growing up to brush as a result of fires.

The brush areas show traces of past fires almost everywhere. Recent fires have burned over 10,000 or 12,000 acres, situated at the heads of the different branches of Lytle and San Gabriel canyons, and in the region of Tujunga Creek and Mount Gleason.

The after effects of fires in the brush and timber are somewhat different from the results of fires in the San Bernardino and the San Jacinto reserves. The fires in the timber invariably result in an enlargement of the chaparral area. Reforestation in the reserve is everywhere deficient, while the extensions of the brush into the timbered tracts along the lines which the fires have cleared are sure and comparatively rapid. These extensions bring an added danger to the still living adjacent forest, because the fires spread more widely and rapidly by means of the brush growth, there not being a sufficient quantity of litter of other kinds on the forest floor to support extensive conflagrations.

The chaparral when destroyed by fire is rarely root killed and soon springs up again. The danger is here that the rains and snows may cause the surface of the hill slopes, composed of loose sand and gravel, to slide into the canyons before a new growth has sprung up; for while the roots are not usually killed by a fire, there can be little doubt that their hold on the soil is temporarily materially weakened and that the surface is more or less loosened by the heat from the flames. When the chaparral is burned whatever trees stand isolated or in small groves in its midst are destroyed. As the big-cone fir is the most common species on such tracts, its destruction is also more complete. There are many indications that the brush growth above the 1,500-foot contour, at least outside the direct southern slopes to the Los Angeles and San Bernardino plains, owes its extensions upward to the destruction of large and continuous stands of big-cone fir which formerly flourished here.

The brush fires here, as elsewhere in southern California, are difficult to extinguish or check during the dry season. The tangled character of the chaparral at low and middle elevations favors the rapid spread of conflagrations.

It is and will continue to be a difficult matter to prevent fires in the San Gabriel Reserve so long as any brush remains to be burned. The private and corporate interests centered there are so numerous and various that it constantly requires the coming and going of many persons in and out of the reserve, and the greater the travel passing back and forth the greater will be the likelihood of fires being set, accidentally or carelessly, the former of which, in case of forest or brush fires, is very generally synonymous with the latter.

RESERVE BOUNDARIES.

The present boundaries of the reserve are mostly satisfactory and could be improved only by extending them westward so as to join the eastern boundaries of the recently established Pine Mountain and Zaca Lake Reserve.

THE SAN BERNARDINO FOREST RESERVE.

By John B. Leiberg.

TOPOGRAPHY.

The San Bernardino Forest Reserve, situated in southern California, comprises the region which forms the summit and slopes of the San Bernardino Range of mountains. It occupies an intermediate position between the San Gabriel and the San Jacinto forest reserves. It connects with the former at Cajon Pass, and is separated from the latter by the plains which constitute San Gorgonio Pass.

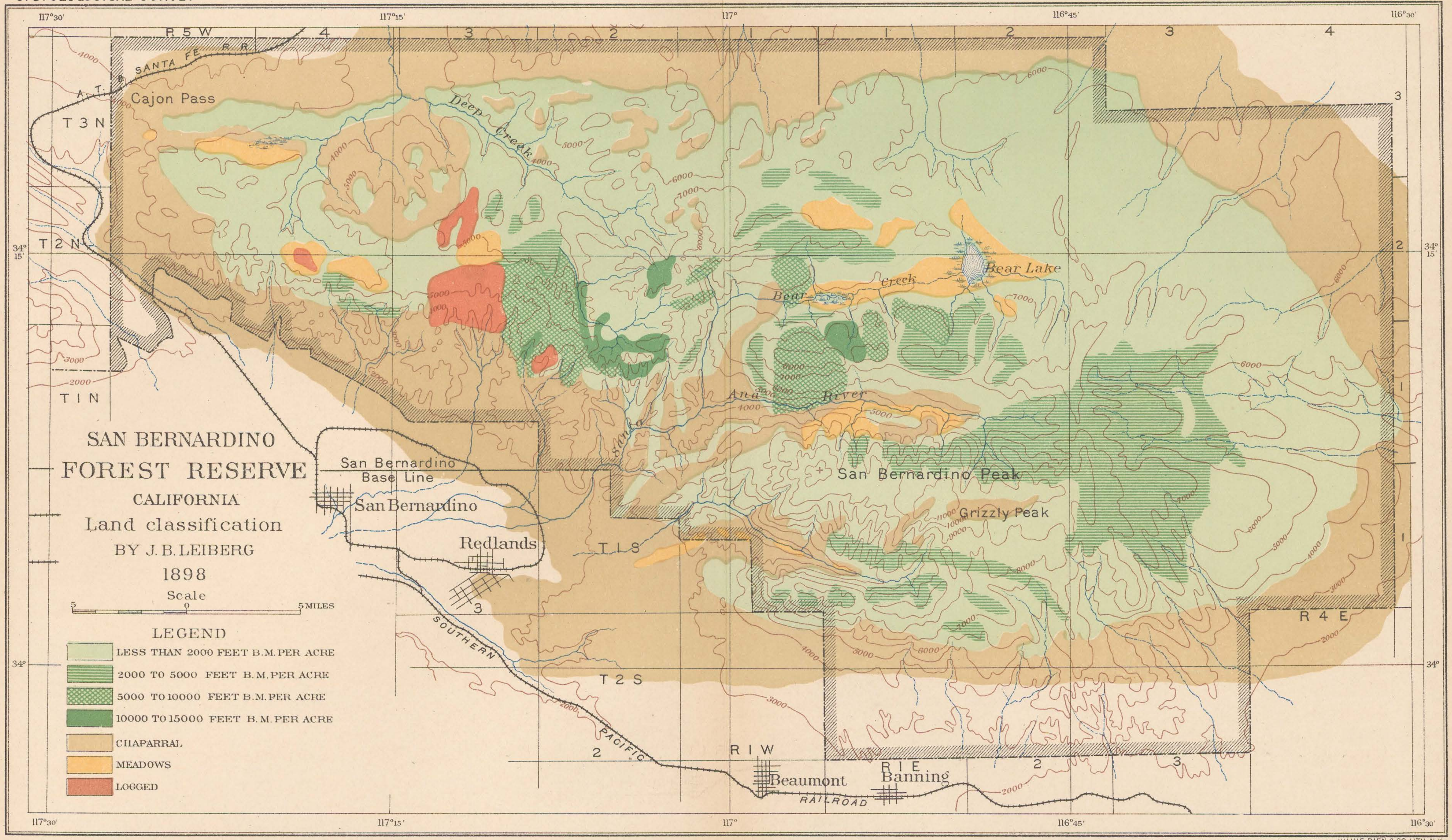
The San Bernardino Range is an uplift stretching in a general direction from northwest to southeast, with a length of about 45 miles, and a width which varies from 12 miles at its northwest termination, to 40 miles along its southern boundary. Its northern and eastern declivities slope to the Mohave Desert; its southern and western into the San Bernardino Plains and their extensions at San Gorgonio Pass. The area of the reserve, approximately placed at 737,000 acres, is nearly equally divided between the slopes ending in the Mohave Desert and those which terminate at the eastern edge of the San Bernardino Plains.

In its orographical aspect the uplift presents one general type, modified here and there in local particulars. Broadly defined, it consists of a central axis with a rather sinuous crest line, which is usually narrow, mostly very rocky, varying in elevation from 5,000 to 9,500 feet above sea level, crowned with occasional peaks which rise but a few hundred feet above the general crest level, with secondary ranges or spurs, few and short in the northwestern and southeastern portions, long and of high altitude in the southwestern areas, the slopes of the uplift usually steep, with a more or less extensive foothill region of low elevation surrounding the entire system.

The crest line of the uplift begins a short distance east of Cajon Pass. It commences with a southeasterly trend, which it maintains for a distance of 20 miles, and has a mean elevation of 5,100 feet. On the western face it presents a very steep slope, which, in some instances, as at the breaks of Waterman Canyon and around Strawberry Peak, fall away from 1,000 to 1,500 feet in almost sheer drops between the few spurs sent out from the central axis in these localities. Beyond the first series of abrupt breaks lies a comparatively low, much-sculptured foothill region, which forms a more gradual slope to the plains. On the eastern side the declivity is at first more gentle, being broken in part by a number of small flats and basins parallel with the main axis of the range, and in part by portions of the Deep Creek drainage basin, of which the long diameter is transverse to the general direction of the crest. The slope becomes steep within a mile or so of the Mohave Desert, where the final break involves a rather abrupt descent of 700 to 800 feet, or in some cases 1,000 feet. The sculpturing throughout the area is low as a rule, but the rocky and stony character of the surface gives a rough aspect to its contours. The crest of the range throughout the first section of 20 miles is of rounded outline, harldy over one-fourth mile wide in any place, uniform in elevation, with but one or two prominent rises above the general level, the most conspicuous one being Strawberry Peak, with an altitude of 5,750 feet.

At the head of Plunge Creek, a short distance beyond Highland Mill, the crest begins to swerve more toward the east. It soon strikes the heads of streams tributary to the Santa Ana drainage basin and turns rather abruptly east, forming the divide between the Deep Creek and the Santa Ana basins. It maintains this easterly course for a distance of 30 miles, with a mean elevation of about 7,200 feet. It is extremely rocky and mostly very narrow, seldom but a few rods in width. It is studded at frequent intervals with rocky eminences which in some instances rise 1,000 feet above the general altitude of the crest line. It abounds in saddles and corresponding rises. Along the southern face of the ridge its slope falls away with extreme rapidity to the levels of the Santa Ana Valley until the upper portion of Bear Creek is reached. This stream, a tributary of the Santa Ana, heads in a plateau-like basin which parallels the crest of the range on the south for a distance of nearly 12 miles and breaks its abrupt slope. However, at the head of Bear Creek a secondary range leaves the main axis with an elevation as great, or even exceeding it, and forms the divide between the plateau portion of the creek and the main valley of the Santa Ana River. The steep southern slope of the crest line, broken by the interposition of the above-mentioned plateau, is thereby merely shifted to the southern face of the Bear Creek divide. The northern side of the central axis in this section gives rise to the upper tributaries of Deep Creek, which flow through a deeply-sculptured region intersected by a number of secondary ranges that parallel, more or less closely, the primary one.

At the head of Bear Valley one branch of the central crest of the uplift turns nearly due south, a direction which it maintains to San Gorgonio Pass, where it ends, while the other, and perhaps to be considered as the extension of the main axis, appears to join the various



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desert ranges more to the east. In the section from Bear Valley to San Gorgonio Pass the crest attains its greatest elevation, namely, 9,600 feet, at the head of some of the more northern tributaries of the Santa Ana. On the western slope it sends out two long secondary ranges, which form the divide between Santa Ana River and Mill Creek and between Mill Creek and San Gorgonio Pass. The Santa Ana River–Mill Creek divide rises to elevations of 11,700 feet in Grayback Peak and to about 10,000 feet in San Bernardino Peak, a few miles to the west (Pl. CXLVII). The Mill Creek–San Gorgonio divide varies in altitudes from 7,000 to 8,000 feet. The slopes of these divides descend at high angles to the bottoms of the canyons which they inclose. Especially is this the case with the southern declivities of the Mill Creek–San Gorgonio divide. On the eastern slope the crest line of the central axis, less rocky and of greater width than in the two preceding sections, is flanked by a system of parallel ranges inclosing narrow and rocky canyons or broad, sandy flats, the whole forming a foothill region between the main ridge and the Mohave Desert.

The general aspect of the San Bernardino uplift is that of a rough and rugged region, whether seen from the plains' levels, where the more gentle slopes are lost to view amidst the mass of bold and abrupt declivities from the summits, or from any point of vantage in the interior, where one sees only the sharp crests of the ridges and the depths of the intervening canyons. From near the breaks at Cajon Pass to the head of the Santa Ana good roads follow the central ridge of the uplift, sometimes on the summit, at other times on the slopes when the crest line becomes too narrow or rocky. Following these roads the aspect of the upper areas is rather pleasing. The plateau of the upper Bear Creek Basin and the small flats which occur here and there have the effect of relieving the ruggedness of the landscape in some degree. The broad mesa regions which form such conspicuous features in the San Jacinto Reserve are wholly lacking here (Pl. CLVII).

GENERAL FEATURES OF CLIMATE AND DRAINAGE.

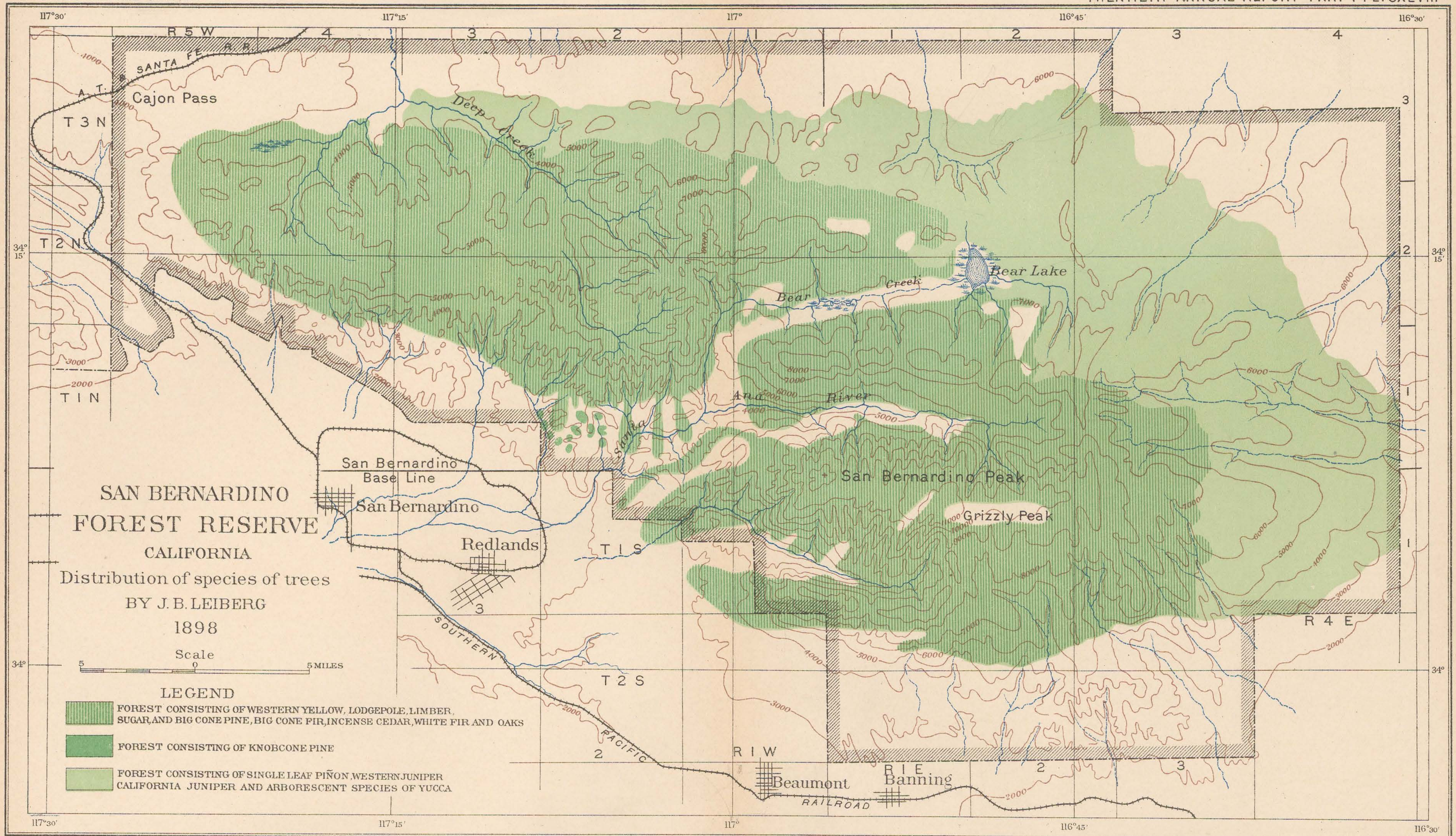
The San Bernardino uplift stands interposed as a great wall between a region where true desert conditions prevail and one which receives a sufficient degree of moisture to be classed as semiarid. The range along the entire length of its northern and eastern slopes fronts on the Mohave Desert; the western and southern slopes end in the San Bernardino Plains. It can not be doubted that were the San Bernardino uplift removed the desert conditions prevailing over the Mohave regions would likewise obtain on the San Bernardino Plains.

The areas within the reserve boundaries are subject to various climatic conditions ranging from desert, semiarid, and subhumid, to such as can be classed as humid, at least in a relative sense. The desert tracts of the reserve are situated on the Mohave side of the uplift and, as here reckoned, comprise all areas on the northern and eastern slopes below the 3,000-foot contour line, in the aggregate approximately 30,000 acres, or a trifle more than 4 per cent of the reserve area.

The semiarid lands occur on all slopes. As here limited they include all chaparral or brush-covered tracts which do not support a tree growth, as well as some that do. In the latter category fall all the piñon areas on the northern and eastern slopes, and the sparse and scattered growths of big-cone fir and knob-cone pine on the western and southern. The altitudinal limits of the semiarid tracts are very irregular. On the western and southern slopes their upper boundaries lie, in a general way, along the 4,800-foot contour line, while their lower are at the plains' levels. In the northern portion of the reserve, 5 to 6 miles south of Cajon Pass, and throughout a considerable portion of the Deep Creek Basin the semiarid belt is quite narrow; beginning at the 3,000-foot contour it scarcely extends above the 4,200-foot level. South of the Deep Creek Basin, where the crest of the main axis of the uplift turns southward, the Mohave slope faces more directly east and the semiarid tracts run up to elevations of 8,000 feet. They form an uninterrupted belt around the uplift, the western joining the eastern in the north at Cajon Pass; in the south at San Gorgonio Pass. There is no place where the semiarid belt crosses the uplift from east to west through the forested areas. The nearest approach to a junction occurs at the head of Bear Creek, where an extension from the Mohave side crosses the crest of the range and nearly joins the semiarid tracts which follow the valleys of Santa Ana River and Bear Creek.

The amount of precipitation which falls annually on the arid and semiarid tracts of the uplift has not been gaged, so far as I am aware, nor does the brush growth furnish any certain indication. It is evident there are various degrees of aridity throughout these tracts, depending on different causes, of which the principal are exposure and altitude. It is certain that the western slopes receive a greater precipitation than the eastern, and the higher elevations more than the lower. The areas classed as semiarid comprise 437,000 acres, or somewhat over 59 per cent of the entire reserve.

The subhumid areas comprise the tracts between the 4,800-foot and the 9,500-foot contours, with the exception of the piñon-covered slopes, the high semiarid region at the head of Bear Creek, and a portion of the southern slopes at San Gorgonio Pass. The annual precipitation which they receive is estimated at 25 to 35 inches, the amount varying with altitude. Their boundaries are practically concurrent with the forest-forming timber growth between the above-mentioned contour lines, their lower limits coinciding with the exterior lines of the



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growths of western yellow pine, while their upper extensions cease with the incomings of pure stands of lodgepole pine and limber pine. The total of the areas included within these lines amounts to 250,000 acres, or somewhat more than 33 per cent of the entire reserve.

The humid region includes those tracts which are situated above the 9,500-foot contour line. They are classed as humid merely in a relative sense, as the total precipitation received by them throughout the year probably does not exceed 40 inches. They are situated mostly on the Santa Ana River–Mill Creek divide, where they include the high summits of San Bernardino and Grayback peaks, while the lesser portion covers the crest of the Mill Creek–San Gorgonio divide. The Mill Creek–Santa Ana River divide carries snow throughout the year on the northern slopes, where the elevation exceeds 10,500 feet. No portion of the humid tracts has a universal timber line, the southern slopes carrying stands of living forest to the crests of the highest ridges. The humid tracts comprise an aggregate area of 20,000 acres, or nearly 3 per cent of the reserve.

The climatic areas of the reserve are as follows:

Climatic areas in San Bernardino Reserve.

	Acres.
Humid tracts	20,000
Subhumid tracts	250,000
Semiarid tracts	437,000
Desert or arid tracts	30,000
Total	737,000

The larger quantity of water shed by the eastern slope drains into Deep Creek Basin, which constitutes the head of Mohave River. Most of the streams which unite to form Deep Creek flow through narrow and rocky gorges, except near their heads, where they usually rise in flats of small extent. None of the gorges are very deep. In the section of the uplift south from the Deep Creek drainage basin the water finds its way to the Mohave through steep, rocky ravines. But little of it reaches the desert level. The greater quantity sinks and is lost to view at short distances from its first rise. The drainage from the southern slope flows into the plains at San Gorgonio Pass, soon sinking in the sand and gravel after reaching the plains. This slope is short and extremely steep, and sheds but little water.

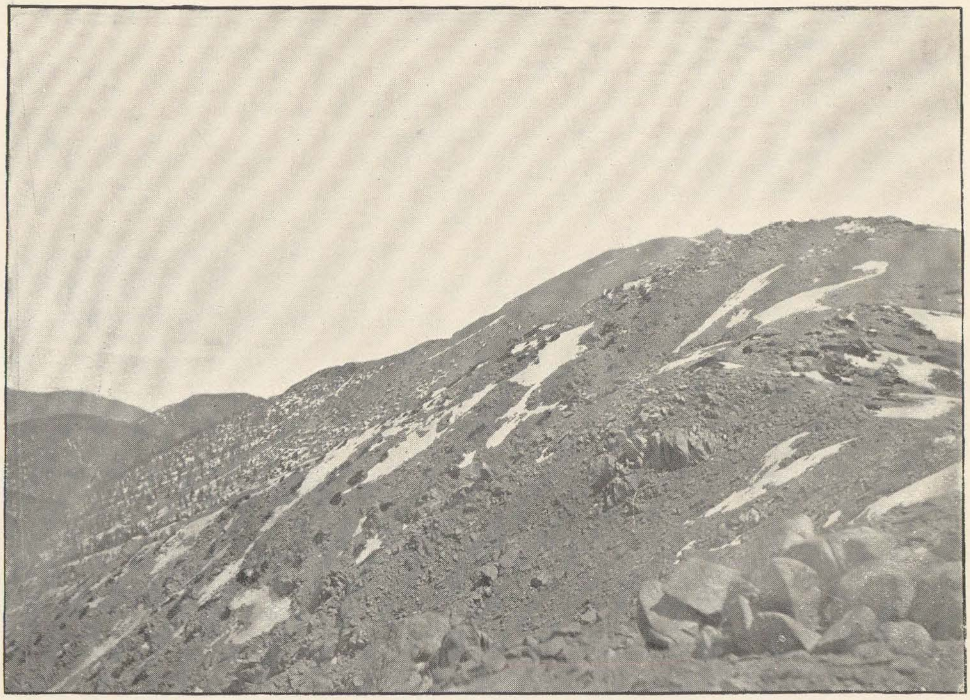
The western slope is of the highest importance as regards its water-shedding capacity. A greater quantity is discharged from it than from any of the other areas of the reserve. It flows into the San Bernardino Plains, and all of it, or at least the largest percentage, would sink in the gravel and wash of these plains if not previously intercepted. This drainage is of extreme importance to the agriculture of these plains, as they would otherwise be too arid for the growth of anything but the native chaparral. The private and corporate water rights that control the distribution of water to the various irrigation districts constitute properties of very great value.

The two largest drainage basins on the western slope are the Mill Creek and the Santa Ana valleys. They receive most of the water discharged from the subhumid slopes of the reserve and the entire quantity flowing from the high snowy summits around San Bernardino and Grayback peaks. The upper portions of their valleys are steep and rocky. In the middle and lower sections are small meadows or level expanses. Mill Creek receives but few tributaries; Santa Ana River a large number, most of which are short and insignificant. The biggest of the Santa Ana tributaries is Bear Creek, which has for its head a system of meadows comprising about 7,000 acres, which collectively form the largest plateau area in the reserve.

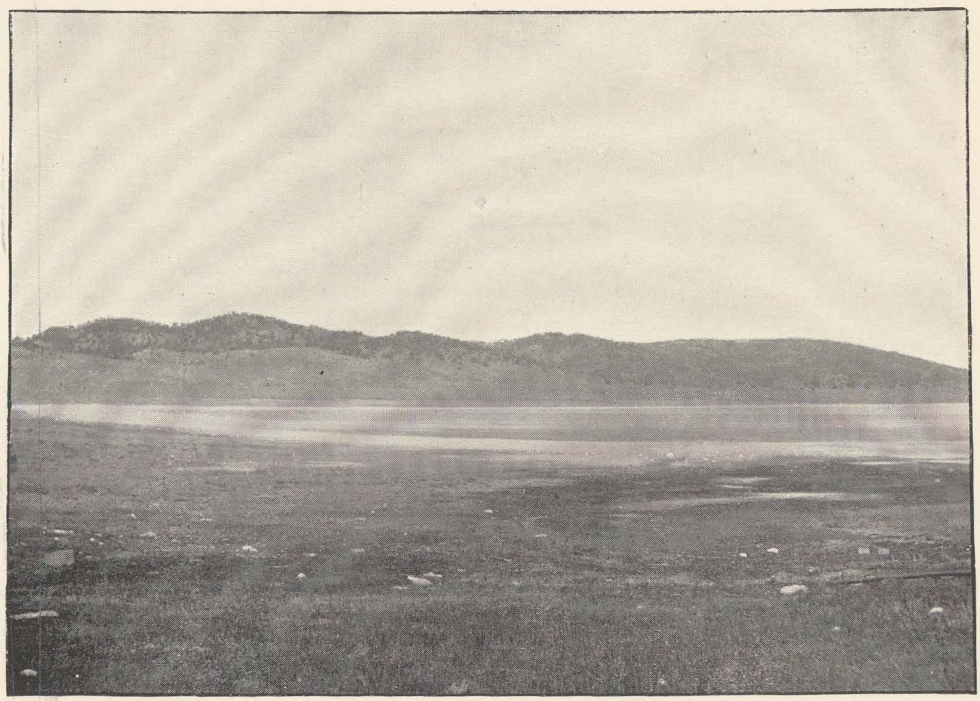
The drainage from Santa Ana north to Cajon Pass is discharged to the plains through narrow, rocky, gorge-like canyons, which head directly in the upper slopes of the main axis of the uplift without any intervening flats at their heads. Their descents are at first extremely rapid, some of them taking nearly vertical plunges of 1,000 to 2,000 feet.

The stream channels and the valley bottoms of the larger streams from bluff to bluff are littered with great masses of large and small bowlders and heavy beds of gravel. These accumulations gradually work down the valleys under the influence of the spring freshets and are finally swept out on the plains, where they constitute the so-called wash. The canyons on the eastern slopes, which carry but little water, are not especially active in this work, but those on the western and southern slopes, with their larger volume and flow, have in the past thrown out immense quantities of this talus débris. Since the water has been appropriated for irrigation purposes at various places along the streams, the movement of the wash from the upper portions of the valleys to the plains is not nearly as great as formerly. Some of the streams, notably Mill Creek, are cutting into the ridges at their heads at a very rapid rate, and great quantities of rock and gravel are constantly sliding into the stream channels, but along most of them the slopes have acquired a permanent status and but little slipping of the loose surface was noticed.

Practically all the visible water which flows from the San Bernardino Range is appropriated. Some of it is used for irrigation purposes, some supplies drinking water to the various towns located on the plains, and some furnishes power for electric lighting. Storage dams are constructed or are in process of erection at various points, but owing to the rapid descent of the streams and the small size of the flats at their heads eligible reservoir sites are not plentiful. The largest storage reservoirs in the reserve are those which cover the Bear Creek Plateau and the Deep Creek Basin. The latter, owned by the Arrowhead Company, not completed at the time of my examination,



A. SUMMIT OF GRAYBACK PEAK, NORTHERN SLOPES SAN BERNARDINO RESERVE.



B. UPPER BEAR LAKE, SAN BERNARDINO RESERVE.

is intended to impound the waters of the entire Deep Creek drainage basin, comprising approximately an area of 100,000 acres. The Bear Creek reservoir is supplied by the drainage from an area of about 35,000 acres. It is formed by the erection of a dam 35 feet high across Bear Creek at the foot of the meadows which border its head, and is situated where the creek makes a first break to the canyon portion of its course through a rocky gorge about 250 feet in width. The dam forms an artificial lake 1 to 2 miles long and one-half to three-fourths miles wide, according to the season of year and the scarcity or abundance of rain or snow. The reservoir is situated at an altitude of 7,000 feet. Its principal supply is drawn from small and short creeks heading in the surrounding ridges and from a permanent, extremely alkaline lake at the very head of the flat, which is fed by numerous permanent springs and whose waters do not have a direct outlet into the reservoir, at least not during seasons of low water, but find their way into it by slow percolation through the narrow intervening meadow area. The water in the reservoir is extremely filthy, owing to the utilization of the adjoining meadow lands as pasture grounds. When the water in the reservoir is low the filthy condition is much aggravated, as the stock then graze on ground which will constitute reservoir bottom later when a rise occurs (Pl. CXLIX).

Water mining or tunneling into the mountain sides to intercept the downward flow of drainage which would otherwise be lost offers extended opportunities in the San Bernardino Reserve. The water-shedding capacity depends here, as in the San Jacinto Reserve, upon the amount and direction of fissuring of the underlying bed rock. The rock formations of the uplift are partly granitic, partly crystalline schists, or but slightly altered sedimentary rocks. The sedimentary rocks largely, if not wholly composed of limestones, occur on the Mohave side of the range and send a broad lobe over on the San Bernardino slopes at the head of Bear Creek. The sedimentaries or schistose rocks and the granitic formations south of Bear Creek are widely shattered and contain many fissures, as shown by the numerous springs which issue in this portion of the reserve. Water tunnels exist on the Mohave side, the Rose mines obtaining their water chiefly from this source. There are some of these tunnels in process of construction on the slopes of the Mill Creek–Santa Ana River divide and in the upper or middle portions of Mill Creek Valley. There is little doubt but that a large percentage of the precipitation which falls on the San Bernardino uplift is lost in deep-seated fissures of the range. It is a well-established fact that an artesian basin underlies portions of the San Bernardino Plains, and the origin of its waters lies probably in the downward flow through fissures existing in the uplift. Much of this, which is now lost, could be recovered through water tunnels driven into the mountain slopes at proper places.

AGRICULTURAL, GRAZING, AND MINING AREAS.

The lands suitable for agricultural operations within the reserve lie below the 6,000-foot contour line, and consist of small flats at the heads of streams, level tracts in the valleys, and bench lands on the summits of low spurs or small mesas between the canyons. These various areas are situated in the Santa Ana and Mill Creek valleys, on the slopes facing San Gorgonio Pass, at the head of City Creek, at Strawberry Flats, Seeley Flats, and at several other localities on the southern and western slopes, and comprise 25,000 acres, of which not more than 1,200 acres are under cultivation. It is all in small lots and is mostly devoted to the production of garden truck and fruit. The bar to the utilization of the agricultural lands is a lack of water. With the entire quantity flowing from the reserve already appropriated for purposes of irrigation on the plains, it is not probable that the areas now under cultivation within the reserve limits will ever be extended to any noticeable extent. There are no agricultural lands on the Mohave side of the uplift.

The reserve contains a large grazing area. It comprises all the subhumid tracts above the 4,800-foot contour line and those along the slopes and in the bottoms of Santa Ana River and Mill Creek as low as the 3,000-foot contour line. The grazing lands consist of the timbered areas exclusive of the pure piñon growths, margins of streams, the more open and sparse chaparral growth, the tracts cleared of forests as the result of logging operations, and level stretches of meadow land free or nearly so from timber growth. The total of grazing lands is 350,000 acres, or nearly 50 per cent of the reserve area. Formerly this class of land included considerable stretches of the semiarid tracts, but extensive sheep-pasturing in past years has nearly destroyed all growth of grass on the unfenced lands below the subhumid belt. The present value of the grazing lands varies considerably. The areas which possess a thin soil have never recovered from the damage done by the sheep. They now produce only a stunted growth of native grasses, or they are wholly bare of all vegetation or covered with large patches of coarse native or introduced weed species. The lands where a deeper layer of mold existed have more or less recovered, especially such as are under fence. As a rule, the pasture areas in the forest and on the chaparral slopes were never covered with a very close or continuous turf. The grass growth existed chiefly as detached bunches or as scattered aggregations of a small number of stems. In the loose, sandy soil which prevails in the reserve the grasses were but poorly rooted and were easily destroyed by the close pasturage and trampling of the sheep. The open meadow lands form the choicest of the grazing areas. They are all owned by private individuals or by corporations, and are to a large extent under fence. In some cases they furnish a small amount of coarse hay. The growth on them consists mostly of species of sedges and rush, the whole forming a dense, close sward. The total area of the meadow lands is estimated at 15,000 acres. They are situated in the basin of Deep Creek, chiefly in Holcomb and Little Bear creek valleys; along the upper portion of Bear Creek, which contains nearly 50 per cent of them, and in the upper portion of Santa Ana Valley. Some of the meadow lands have been transformed into storage reservoirs for irrigation water, as already noted.

The soil in the reserve is mostly a sandy or gravelly detritus. The top layer of mold is thin everywhere except in the hollows where flats exist. Here it is often several feet in depth, owing to the accumulations which have been swept in from adjacent ridges. In the upper portion of Bear Valley the soil is extremely alkaline, derived from the limestone areas in the neighborhood. The lake, which partly fills the valley, is surrounded by and has for its bottom a bed of alkaline ooze of unknown depth. The soil on the Mohave side, following the limestone belt, is also alkaline in a high degree wherever any flats that receive seepage occur.

There are no sheep pastured within the reserve limits, but several hundred head of stock run at large in various places. Owing to the drought which prevailed throughout southern California during 1898, several thousand head of cattle were driven into the reserve for pasturage, principally in the Deep and Bear creek basins.

The mineral resources of the region are not generally in a very active stage of development at the present time. The region south and southwest from Deep Creek contains the mineral-bearing areas. The ores are auriferous and cupriferous. Some of the former are free; others are base. A great many claims have been located in the past, worked a while, and then abandoned, as the discarded arrastres in various places along Bear Valley go to prove. The mining developments at the present time are mostly confined to a few properties in Holcomb Valley in the upper Deep Creek Basin and at the Rose mines on the Mohave side. No placer mines were observed in active operation anywhere in the reserve.

BRUSH AND FOREST GROWTH.

Excluding grass and rush growths on the open meadow lands or scattered throughout the forests, the vegetation on the reserve consists of (1) a brush growth wholly free from timber, or distributed in the timbered tracts as undergrowth; (2) of a timber growth, open and scattered or closer and forest forming.

THE BRUSH OR CHAPARRAL.

The brush type of vegetation in the reserve, in southern California commonly designated chaparral, is a growth composed of many species of shrubs, some, and the greater number, low in stature; a few semiherbaceous; others nearly tall and stout enough to be classed as arborescent. In its lower forms, when it covers the slopes and plains with a nearly uniform growth, it might be considered as constituting the heathers of California. When composed of semiarborescent species it usually presents a scraggy appearance, frequently forming almost impenetrable masses, a dense jungle of interlocking hard and stiff branches from the scrub oaks which largely compose it, mixed with the more pliable mountain-mahogany shrubs, the whole mass fortified against attack by a plentiful sprinkling of the hard, knotty, and divergent limbs of various species of manzanita, with a bounteous supply of spinescent ceanothi. In the chaparral herbaceous vegetation is very scanty. The dense shade of the heavy mass of brush effectually prevents the growth of smaller plants. The chaparral presents its most uniform growth at low and middle elevations or along streams. Although it is composed of deep-rooted species, which can endure very great degrees of aridity, it always forms the heaviest stands where there is a fair amount of moisture. On the very dry tracts it is low, stunted, and scattered or nearly absent.

In the San Bernardino Reserve the chaparral growth varies in height from 3 to 10 feet. It covers all the arid and semiarid lands excepting the regions of the piñon pines. It is not wholly confined to the semiarid tracts, however, extending into the forest areas in the subhumid belt, and far up the slopes where humid conditions prevail. It does not cease completely short of the 10,000-foot contour line. Compared to the growth which lies below the 4,800-foot contour the quantity above this limit is small.

The chaparral tracts within the reserve cover 370,000 acres, or a trifle more than 50 per cent of the entire area. The growth which they carry is usually dense on all the slopes from Cajon Pass to Mill Creek; farther south it is thinner, often much scattered and of lower stature, especially on the declivities which descend into San Gorgonio Pass. On the Mohave side the chaparral is more open still, being chiefly composed of yuccas, scrub junipers, and cacti. The upper line of the solid brush growth is considerably higher on the eastern slope than on the western, due to the influence of the hot and dry desert air. At the head of Bear Valley the line curves upward to the 8,000-foot contour line, carrying arborescent yuccas along with it to elevations of 7,500 feet. The lower limit of the chaparral growth on the eastern slope is at the desert edge. On the western slope it extends into the plains, with the same species composing it that form the growth on the lower slopes of the San Bernardino uplift. The extensions of the brush growth on the plains are low and open, and cover most of the tracts which are not under cultivation.

The chaparral above the 4,800-foot contour line exists mostly as underbrush in the forest. Where this is composed of sugar pine, western yellow pine, white fir, or oak, it occurs as detached clumps. In exceptional localities south of Holcomb Valley, at the head of Bear Valley and on the Santa Ana River–Bear Creek divide, where the piñon pines of the semiarid tracts ascend to elevations of 9,500 feet, the chaparral, composed of mountain mahogany and juniper scrub, and two or three species of ceanothus, is very dense among the piñon pines.

In the open subhumid areas, denuded of its timber by fire or ax, the brush is mostly low and scattered. On slopes at high elevations, where fire has run and destroyed the growth of lodgepole pine and limber pine, there is often found a uniform, low, but dense growth of the shrubby chinquapin.

The chaparral in the reserve is composed of 30 to 40 species of shrubs, most of them frutescent, not more than 4 feet in height, while a few are semiarborescent and attain a stature of 8 to 15 feet. Most of the species are of limited occurrence, 10 or 12 constituting the bulk of the growth. Certain species very common in the San Jacinto Reserve are lacking here, while a few others not common there are plentiful here. As compared with the chaparral in the San Jacinto Reserve, that in the San Bernardino is lower in height and more open.

There is a sort of zonal grouping of species in the chaparral not very clearly differentiated below the 7,000-foot contour line so far as relates to altitudinal limitations. The growths on the eastern and western slopes are, however, very different both in species and in the relative percentages of such as are common to both.

In the following lists of chaparral shrubs a division has been made at the 5,000-foot contour line, as best representing natural conditions, namely, the regions treeless, or nearly so, and the forested areas. Only the most conspicuous species are enumerated:

Composition of chaparral on the southern and western slopes of San Bernardino Reserve below the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	80
Arctostaphylos manzanita	Inconsiderable.
Arctostaphylos tomentosa	Inconsiderable.
Baccharis viminea	Inconsiderable.
Ceanothus crassifolius	1
Ceanothus cuneatus	Inconsiderable.
Ceanothus divaricatus	5
Ceanothus integerrimus	Inconsiderable.
Ceanothus sorediatus	Inconsiderable.
Cercocarpus betulæfolius	Inconsiderable.
Chrysoma pinifolia	Inconsiderable.
Cornus nuttallii	Inconsiderable.
Dendromecon rigidum	Inconsiderable.
Diplacus glutinosus	Inconsiderable.
Eriodyction californicum	Inconsiderable.

	Per cent.
Eriodyction tomentosum	Inconsiderable.
Fraxinus dipetala	Inconsiderable.
Garrya veatchii	Inconsiderable.
Pentstemon antirrhinoides	Inconsiderable.
Prunus ilicifolia	Inconsiderable.
Quercus undulata	10
Rhamnus rubra	Inconsiderable.
Rhus diversiloba	Inconsiderable.
Salix lasiandra	Inconsiderable.
Salix lasiolepis	Inconsiderable.
Stenotus interior	1
Styrax californica	Inconsiderable.
Umbellularia californica	Inconsiderable.

Composition of chaparral on the western and southern slopes of San Bernardino Reserve above the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	15
Arctostaphylos manzanita	10
Arctostaphylos patula	3
Artemisia tridentata	.01
Castanopsis chrysophylla	2
Ceanothus cuneatus	1.2
Ceanothus divaricatus	18
Ceanothus vestitus	.8
Cercocarpus betulæfolius	10
Cercocarpus ledifolius, as shrub	20
Cornus nuttallii	Inconsiderable.
Fremontodendron californicum	Inconsiderable.
Juniperus californica, as shrub	2
Quercus undulata	15

The considerable percentages of *Cercocarpus betulæfolius* and *Cercocarpus ledifolius* in the composition of the chaparral are due to the long upward and westward sweep of the brush growth on the eastern slope of the uplift.

Composition of chaparral on the eastern slope of San Bernardino Reserve below the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	5
Arctostaphylos glauca	Inconsiderable.
Arctostaphylos tomentosa	Inconsiderable.
Ceanothus cuneatus	2
Ceanothus divaricatus	5
Ceanothus pinetorum	Inconsiderable.
Ceanothus vestitus	Inconsiderable.
Cercocarpus betulæfolius	8
Cercocarpus ledifolius	10
Juniperus californica, as shrub	15
Quercus undulata	3
Agaves, cacti, and yuccas	50

The large percentage of agaves, cacti, and yuccas is caused by the proximity of the desert. If a division be made on the eastern slope at the 3,500-foot contour line the composition of the chaparral would stand as follows, between this altitude and the desert:

	Per cent.
Juniperus californica, as shrub	25
Agaves, cacti and yuccas, more or less arborescent	73
Other species, chiefly scrub mountain mahogany	2

The shrub growth on the eastern slope above the 5,000-foot contour is nearly identical with that given for the western slope at similar elevations, excluding, however, *Arctostaphylos patula* and *Castanopsis chrysophylla*, which do not occur.

The chaparral in San Bernardino Reserve exercises the same functions noted for it in the examination of San Jacinto Reserve. It prevents the sandy and gravelly soil (which is very soft and slides readily as soon as thoroughly water-soaked) from slipping off the steep hillsides into the canyons, and thus contributes to the stability of the slopes. It also retards the evaporation of soil moisture and permits more to percolate through the soil to the underlying fissured bed rock than otherwise would.

The chaparral areas in the reserve are such by reason of conditions of climate and drainage. In a few instances they are due to past fires and deficient reforestation, but the larger portion of them show no evidence of ever having been forested in past times. The shrubs which compose the growth are chiefly species belonging to arid and semi-arid climates. The trees which occur here and there in the chaparral below the 4,800-foot contour line, other than the piñon and junipers, owe their existence to local conditions of water supply, streams, springs, or seepage.

The chaparral on the San Bernardino uplift possesses no great economic value aside from that connected with its contribution to the stability of slope and retardation of evaporation from the soil. Several species, such as scrub oak, juniper, and mountain mahogany are utilized as fuel, likewise the roots of *Adenostoma fasciculatum*. The other species of *Adenostoma*, *A. sparsifolium*, plentiful and of large growth in the San Jacinto Reserve, is lacking here.

THE FOREST.

The list of trees which follows includes the complete coniferous growth in the reserve and most of the deciduous-leaved and evergreen species other than conifers. A few not having their foliage expanded at the time the examination was made could not be determined. They were chiefly willows.

List of trees growing in the San Bernardino Forest Reserve.

CONIFEROUS TREES.

Abies concolor	White fir.
Juniperus californica	California juniper.
Juniperus occidentalis	Western juniper.
Libocedrus decurrens	Incense cedar.
Pinus attenuata	Knob-cone pine.
Pinus coulteri	Big-cone pine.
Pinus flexilis	Limber pine.
Pinus lambertiana	Sugar pine.
Pinus monophylla	Single-leaf piñon.
Pinus murrayana	Lodgepole pine.
Pinus ponderosa	Western yellow pine.
Pseudotsuga macrocarpa	Big-cone fir.

NONCONIFEROUS TREES.

Evergreen species:	
Cercocarpus ledifolius	Mountain mahogany.
Quercus chrysolepis	Canyon live oak.
Quercus wislizeni	Highland live oak.
Yucca arborescens	Tree yucca.
Deciduous-leaved species:	
Alnus rhombifolia	Mountain alder.
Fraxinus velutina	Leather-leaf ash.
Fremontodendron californicum	Fremontia.
Juglans rupestris	Western walnut.
Platanus racemosa	California sycamore.
Populus trichocarpa	Black cottonwood.
Quercus californica	California black oak.
Salix lasiandra	Western black willow.

The arborescent growth on the western and southern slopes of the San Bernardino uplift begins at the plains level, or at the 1,600-foot contour line. At first the growth is thin and scattering, consisting mostly of thin lines of alder, cottonwood, and oak, and is confined to the canyons and immediate banks of streams, occasionally extending into the plains, when the stands are made up of willow and cottonwood. A few miles back from the outlet of big canyons like Mill Creek, Santa Ana, and Waterman, the growths of alder, sycamore, willow, and oak often become very dense, particularly when small flats or widenings in the canyon bottoms, holding seepage, occur. At altitudes below the 3,000-foot contour line the chief components of the arborescent flora are as follows:

Forest trees in San Bernardino Reserve below 3,000-foot contour.

Alnus rhombifolia	Mountain alder.
Platanus racemosa	California sycamore.
Populus trichocarpa	Black cottonwood.
Quercus chrysolepis	Canyon live oak.
Salix lasiandra	Western black willow.

The coniferous trees begin to grow at altitudes of 3,000 feet. The first to appear are big-cone pine (*Pinus coulteri*) and big-cone fir (*Pseudo-*

tsuga macrocarpa). They occur as single trees or small aggregates on the summit of the spurs, in sheltered ravines, or in recesses in the hills. With increase of altitude the growth gains in density rapidly, the big-cone fir filling the upper portions of the canyons with heavy, close stands or more open, long lines of trees. At the head of Plunge Creek and in the region between this stream and City Creek a tract of about 4,000 acres, is covered with knob-cone pine (*Pinus attenuata*), which in some instances forms thick growths on the northern slopes, when their general aspect is very similar to close stands of lodgepole pine, but is mostly growing as scattered trees over the slopes. This species ceases to grow at the 5,000-foot level.

At 4,800 feet elevation the arborescent growth begins to form forest, with the following species constituting the chief components:

Composition of forest in San Bernardino Reserve at the 4,800-foot contour.

Abies concolor	White fir.
Libocedrus decurrens	Incense cedar.
Pinus coulteri	Big-cone pine.
Pinus ponderosa	Western yellow pine.
Pseudotsuga macrocarpa	Big-cone fir.
Quercus californica	California black oak.
Quercus chrysolepis	Canyon live oak.

At altitudes of 5,400 feet the forest growth is extended by the addition of sugar pine (*Pinus lambertiana*), which increases rapidly in number of individuals with elevation, and at 6,000 feet, in the basins and on the slopes of South Fork of Deep Creek, forms the bulk of the merchantable-timber stands. Between altitudes of 6,000 and 7,000 feet big-cone pine (*Pinus coulteri*) and big-cone fir (*Pseudotsuga macrocarpa*) thin out and disappear. At the 7,000-foot contour line the western slope receives two species of conifers from the eastern side, namely, western juniper and single-leaf piñon, the composition of the entire forest growth at this altitude being as follows:

Composition of forest in San Bernardino Reserve at 7,000-foot contour.

Abies concolor	White fir.
Cercocarpus ledifolius	Mountain mahogany.
Juniperus californica	California juniper.
Juniperus occidentalis	Western juniper.
Libocedrus decurrens	Incense cedar.
Pinus lambertiana	Sugar pine.
Pinus monophylla	Single-leaf piñon.
Pinus murrayana	Lodgepole pine.
Quercus chrysolepis	Canyon live oak.

The lodgepole pine at the 7,000-foot contour line exists merely in isolated localities, the region in proximity to Bear Creek Meadows being the only place that came under my observation.

At elevations of 9,500 feet the following species reach their ultimate upward limits, at least as compact growths, a few stragglers going possibly 200 or 300 feet higher.

Composition of forest in San Bernardino Reserve at 4,500-foot contour.

Abies concolor	White fir.
Cercocarpus ledifolius	Mountain mahogany.
Juniperus occidentalis	Western juniper.
Libocedrus decurrens	Incense cedar.
Pinus lambertiana	Sugar pine.
Pinus monophylla	Single-leaf piñon.
Pinus ponderosa	Western yellow pine.

The canyon live oak (*Quercus chrysolepis*) ceases with all other species of oak at the 8,000-foot contour line.

From 9,500 to 11,700 feet, which is the highest elevation in the San Bernardino Range, the forest consists almost wholly of limber pine (*Pinus flexilis*) and lodgepole pine (*Pinus murrayana*).

The forest growth on the eastern slope of the uplift begins at the 3,500-foot contour line. Northeast of Deep Creek it consists chiefly of big-cone fir (*Pseudotsuga macrocarpa*). Southeast of that stream it is composed of the following species:

Composition of forest southeast of Deep Creek.

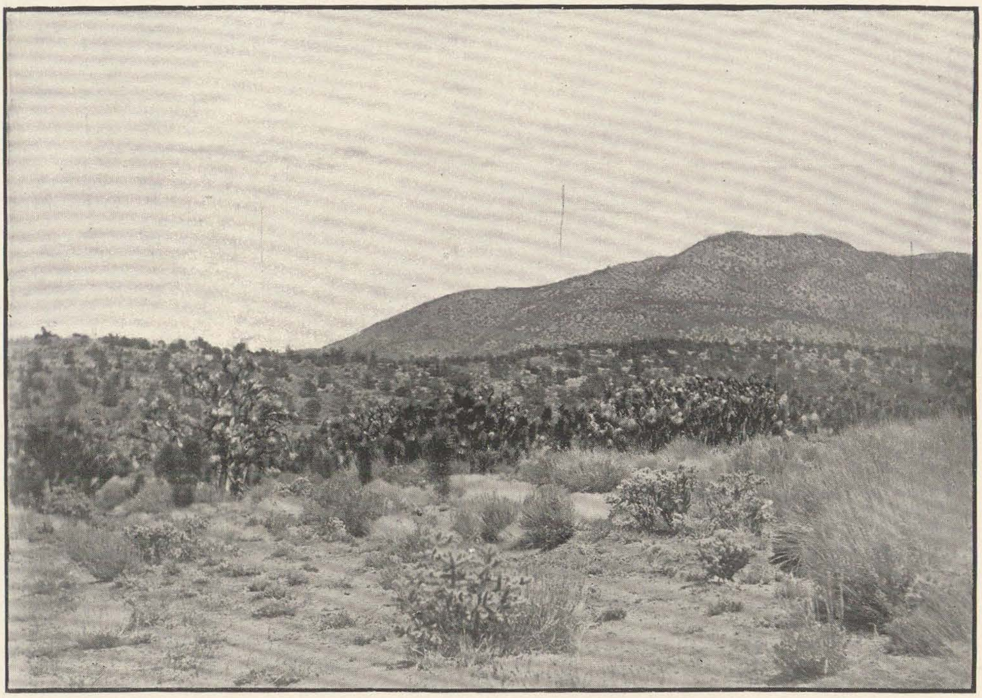
Cercocarpus ledifolius	Mountain mahogany.
Juniperus californica	California juniper.
Pinus monophylla	Single-leaf piñon.
Yucca arborescens	Tree yucca.

At elevations of 6,500 feet the forest becomes more compact and of denser growth upon the addition of white fir (*Abies concolor*) and western yellow pine (*Pinus ponderosa*).

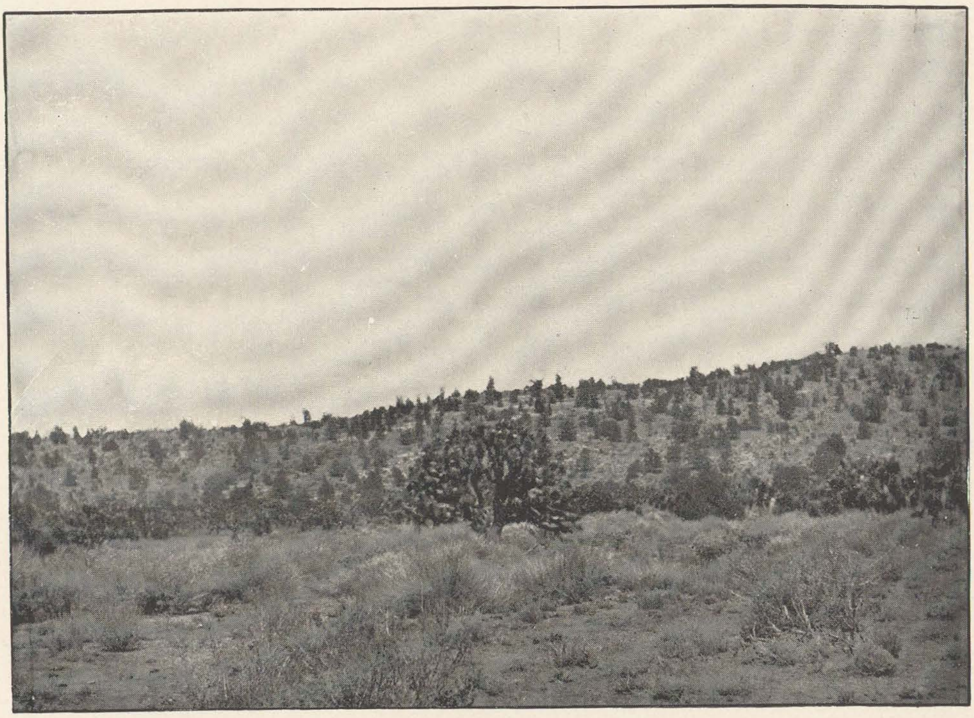
The stands carrying these two species exist on the slopes of the main axis only. The lateral ranges between the crest of the uplift and the Mohave Desert east of the Bear Valley and Santa Ana heads carry a forest composed exclusively of the four kinds occurring southeast of Deep Creek. From the 6,500-foot to the 9,500-foot contour line there is no essential variation in the general type of the forest from that noted above, except that the tree yucca ceases between the 7,500-foot and the 8,000-foot contour lines.

The forest on the slopes of San Bernardino uplift presents three types, corresponding to semiarid, subhumid, and humid climatic conditions. The two first are not always well defined as to their altitudinal limitations, the long upward curve of the semiarid belt of the eastern slope, for example, in some places apparently superimposing its own peculiar forest on the subhumid tracts. This condition is more seeming than real, however, as the existence of a piñon forest here is in the nature of an intrusion of this element from the east, with a consequent pushing westward of the subhumid forest. The humid areas are well differentiated from the other two.

The forest of the semiarid regions of the San Bernardino uplift is essentially composed of piñon stands. The thin lines and groups of trees of other species which occur on the western and southern slopes



A. YUCCA AND PIÑON FOREST (MOHAVE SIDE), SAN BERNARDINO RESERVE.



B YUCCA AND PIÑON GROWTH, SAN BERNARDINO RESERVE.

in the chaparral areas are due to local conditions of moisture supply, streams, springs, or seepage, which afford the required subhumid conditions. This forest forms an open or dense growth. At low elevations, 3,500 to 4,500 feet, it is sparse or scattered, 4 to 40 per acre. Above 4,500 feet and below 6,500 feet the stands are moderately heavy in a relative sense, varying from 100 to 400 trees per acre. Above the last-named elevation occurs the densest growth, when 500 to 1,000 trees to the acre are found on some of the areas between Holcomb Valley and Bear Lake (Pls. CXLIX, CL, and CLI, *A*).

The piñon forest in this reserve is not so exclusively composed of one species of tree as is that on the eastern side of the San Jacinto uplift. Various other species enter it and form considerable percentages. The lowest areas have little or no underbrush; the middle sections carry a chaparral which is mostly open and scattered, but sometimes close, and composed of cactus, yucca, scrub juniper, and mountain mahogany. In the upper areas the cactus and yucca disappear, but the scrub juniper and mountain mahogany persist, and, with various species of *Ceanothus*, make a moderately close chaparral. There is a minimum of litter in the piñon forests, consisting of dead yuccas, cacti, and tops of piñons. There is no humus and no turf.

The commercial value of the piñon is in the fuel which it furnishes. Owing to its extremely slow growth it makes prime firewood. The yucca and juniper also have a fuel value, although in a less degree.

The percentages of the different species which collectively form the piñon stands are as follows:

Trees of piñon type in San Bernardino Reserve.

BELOW THE 6,500-FOOT CONTOUR.

	Per cent.
Cercocarpus ledifolius, as tree	Inconsiderable.
Juniperus californica, as tree	4
Juniperus occidentalis	1
Pinus monophylla	93
Yuccas	2

ABOVE THE 6,500-FOOT CONTOUR.

	Per cent.
Abies concolor	10
Cercocarpus ledifolius	15
Juniperus occidentalis	25
Pinus monophylla	38
Pinus ponderosa	10
Yuccas and scattering oaks	2

The areas covered by forest of the piñon type comprise in the aggregate 65,000 acres.

The second type of forest in the reserve is that which covers the subhumid tracts. Its chief development is between the 5,000-foot and 9,500-foot levels. This type contains nearly all the mill timber in the reserve. Its chief components are the sugar pine, western yellow pine, and white fir. The stands of this class of forest are open where the growth averages 200 years old and upward, or where patches of rocky ground, with little or no soil, intervene to break the continuity. Where the forest is younger, or contains a notable percentage of the California black oak or canyon live oak, the growth is usually close, often exceedingly so. It contains scarcely any litter except where logging operations have been carried on. Scattered clumps of underbrush of manzanita, ceanothus, and various other shrubs are distributed sparingly where the stand is close or of advanced age, more generously in the edges where the timber thins out and becomes scattering, and abundantly where the forest has been destroyed and reforestation has not yet taken place.

The areas in the reserve carrying forests of the western yellow-pine type comprise 249,000 acres and are situated as follows:

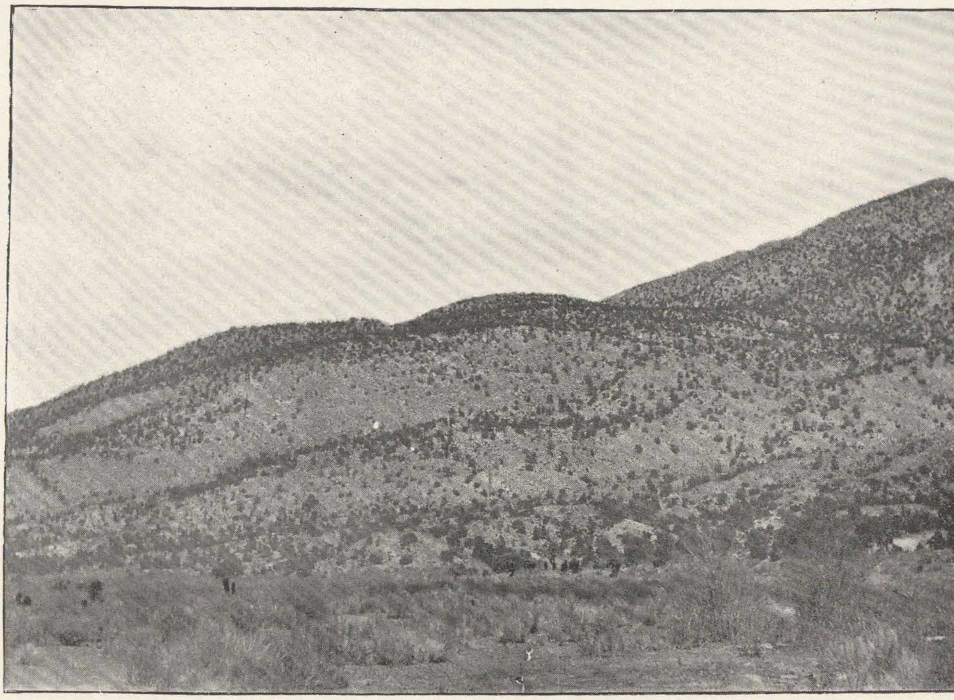
Trees of western yellow-pine type in San Bernardino Reserve.

	Acres.
EASTERN SLOPE OF THE RANGE.	
Deep Creek Basin	91,000
Slopes along main crest of uplift south of Deep Creek	4,000
	95,000
WESTERN SLOPE OF THE RANGE.	
Slopes along main crest from Cajon Pass to Santa Ana Valley	3,000
Santa Ana Basin	142,000
Mill Creek Basin	4,000
	149,000
SOUTHERN SLOPE OF THE RANGE.	
Declivities facing San Gorgonio Pass	5,000

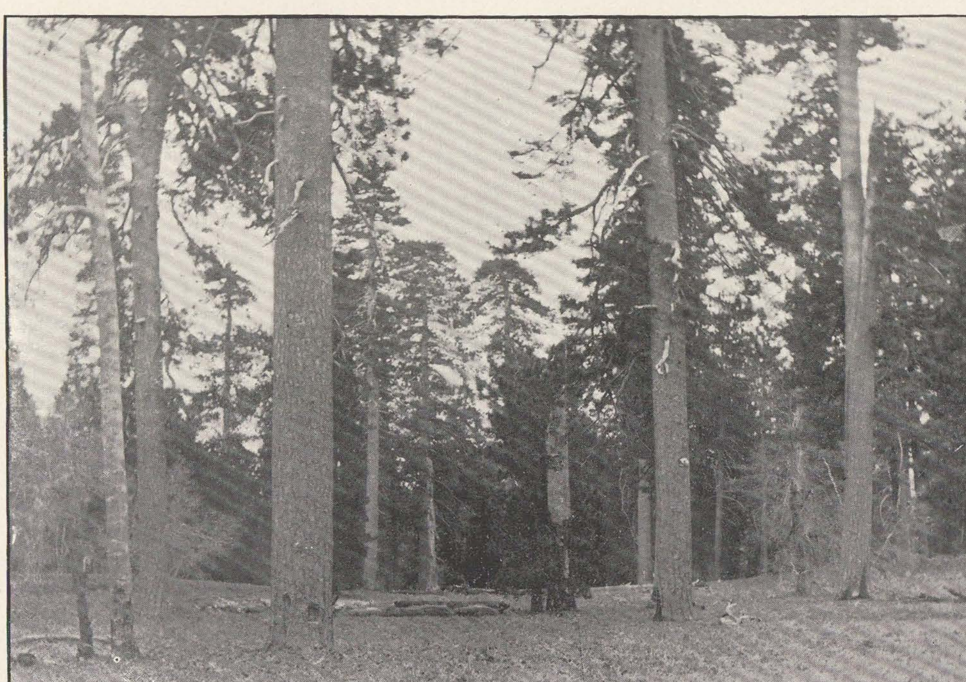
The percentages of the species which form the general type of the subhumid forest vary considerably with altitude. The following tables exhibit the proportions existing between the 3,000-foot and the 8,500-foot contour lines, excluding stragglers of the single-leaf piñon and the California juniper:

Composition of forest of the western yellow-pine type in San Bernardino Reserve between the 3,000-foot and 6,000-foot contours.

	Per cent.
Abies concolor	6
Libocedrus decurrens	3
Pinus attenuata. Inconsiderable; less than	1
Pinus coulteri	2
Pinus lambertiana	8
Pinus ponderosa	64
Pseudotsuga macrocarpa	14
Quercus californica	1
Quercus chrysolepis	1
Quercus wislizeni	Inconsiderable.
Alnus rhombifolia, Platanus racemosa, Populus trichocarpa, and willows	1



A. PIÑON FOREST NEAR EDGE OF MOHAVE DESERT, SAN BERNARDINO RESERVE.



B. COMMERCIALLY VALUABLE TIMBER OF FIRST CLASS, SAN BERNARDINO RESERVE.

Composition of forest of the western yellow-pine type in San Bernardino Reserve between 6,000-foot and 8,500-foot contours.

	Per cent.
Abies concolor	30
Libocedrus decurrens	4
Pinus coulteri	Inconsiderable.
Pinus lambertiana	8
Pinus murrayana	1
Pinus ponderosa	52
Pseudotsuga macrocarpa	.5
Quercus californica	Inconsiderable.
Quercus chrysolepis	3
Alnus rhombifolia, Platanus racemosa, and willows	1

The subhumid forest extends to the 9,500-foot contour line, and in limiting the above tables to the 8,500-foot level the intention has been to indicate the composition of the forest tracts which bear stands of commercially valuable timber, or, more specifically, mill timber. Above the 8,500-foot contour line the stands of the western yellow-pine type are thin and open. The trees are dispersed, standing alone, with considerable intervals of bare ground between each, or in small aggregates, surrounded by a low chaparral of ceanothus and manzanita species. The oaks thin out and disappear at 8,000 feet elevation, as do the alders, sycamores, and willows at short distances above the 6,000-foot contour line. A considerable mixture of lodgepole pine in places along the Santa Ana River–Mill Creek divide lowers the percentage of the other species, chiefly the western yellow pine, while a notable elevation of the altitudinal range of the white fir on the eastern slope of the central axis of the uplift increases the proportions of this species abnormally in relation to the elevation. The composition of the forest from the 8,500-foot level to the highest summits of the uplift is as follows, excluding straggling piñons and junipers:

Composition of forest in San Bernardino Reserve between the 8,500-foot and 11,500-foot contours.

	Per cent.		Per cent.
Abies concolor	45	Pinus lambertiana	8
Libocedrus decurrens	2	Pinus murrayana	35
Pinus flexilis	4	Pinus ponderosa	5

This table includes a large proportion of species properly belonging to the upper areas of what is designated in this report as humid tracts, species which mostly thin out and disappear at the 9,500-foot contour line. If a division is made at this line the complexion of the forest which is situated above it and constitutes a very natural type will stand as follows, representing in its relative position, if not wholly in species, the alpine-fir type of the forests north of California.

Composition of forest in San Bernardino Reserve between the 9,500-foot and the 11,500-foot contours.

	Per cent.		Per cent.
Abies concolor	8	Pinus murrayana	40
Pinus flexilis	50	Pinus ponderosa	1
Pinus lambertiana	1		

The forest between the 9,500-foot and the 11,500-foot contour lines generally contains no mill timber. When any occurs it is of the white fir species. The limber pine and the lodgepole pine furnish none. As a rule the forest of this type is open and the trees widely dispersed. Whatever stands of close growth there are consist of lodgepole pine, occasionally with some mixture of white fir. The forest is much interrupted in its continuity by breaks of bare rocks or by tracts of burned-over ground covered with a close, low growth of shrubby chinquapin principally, with some spinescent ceanothus in places.

The forest growth of economic importance except as firewood can here, as in the San Jacinto Reserve, be divided into two general classes. The first of these comprises stands where trees fit for mill timber predominate; the second class consists of areas upon which, from various causes, the forest growth is of poor quality, usually lacking in trunk development, with a preponderance of crown growth, or consisting of species which are not at all or rarely sawn. These tracts are not absolutely confined to what is here denominated the subhumid regions or forest of the yellow-pine type. Short extensions project into the humid areas, carrying percentages of white fir, the trees of which possess the requisite diameter and length of clear trunk to fit them for mill timber. Likewise certain lands southeast of Deep Creek Basin, which carry a growth of piñon pine as the chief component of their forest cover, contain scattered tracts, slopes of ravines, and flats, which are in part clothed with growths of western yellow pines and white fir (Pls. CLI, CLII, CLIII).

The areas carrying forest suitable for mill timber comprise 249,000 acres, of which 90,000 acres belong to the first class and 159,000 acres belong to the second class. They are distributed between the various sections of the reserve as follows:

Timber areas of first class in San Bernardino Reserve.

	Acres.
Deep Creek Basin, including drainage into Mohave Desert and Cajon Pass, northeast of Deep Creek	28,000
Slopes to Mohave Desert southeast of Deep Creek	2,000
Slopes to San Gorgonio Pass	1,900
Mill Creek Basin	1,600
Santa Ana Basin	55,000
Western slopes to San Bernardino Plains, between Santa Ana and Cajon Pass	1,500
Total	90,000

A. TIMBER AREAS OF FIRST CLASS, NEAR BEAR VALLEY, SAN BERNARDINO RESERVE.

B. TIMBER AREAS OF FIRST CLASS, BETWEEN HIGHLAND AND ORCHARD CREEK.

The timber on these tracts is of fair quality, with few defects, except in the white fir and incense cedar, which species have, in many localities, been damaged severely by fires. The damage to the western yellow pine consists here, as elsewhere, chiefly in fire scars on the basal portions of the trunks. Occasionally trees of this species are found wholly consumed to the root or only partially so, which is also the case now and then with sugar pines. Most of these tracts are situated between the 4,800-foot and 8,500-foot contour lines. The stand of timber varies from 1,500 feet B. M. per acre to 15,000 feet B. M. per acre, which is the maximum density as ordinarily scaled here. Tracts containing 1,500 feet B. M. per acre have, as a matter of course, a light timber growth, but not therefore of inferior quality. Some of these thinly-forested sections owe their condition to logging operations, others have a few trees of good size among masses of oak, juniper, or mountain mahogany, while in other cases fires or natural sterility of the soil have caused the thin growth.

The forest areas of the second class comprise tracts which carry less than 1,500 feet B. M. per acre. The timber is mostly of inferior quality. Much of it consists of stands growing in rocky places, where soil sterility has produced a stunted growth, or on very steep slopes, where semiarid conditions follow an excessive rapidity of drainage. In some localities the stands are in exposed places, where frequent westerly gales have caused gnarled and crooked trunk development of the trees, with the characteristic umbrella tops. A great deal of the area consists of bare, rocky tracts, with but a tree or two. The areas which carry this class of timber are situated in part above the 8,500-foot contour line and in part between the 4,500-foot and the 8,500-foot contour lines (Pl. CLIII). Their distribution is as follows:

Timber areas of second class in San Bernardino Reserve.

	Acres.
Deep Creek Basin, including drainage into Mohave Desert and Cajon Pass northeast of Deep Creek	63,000
Slopes to Mohave Desert southeast of Deep Creek	2,000
Slopes to San Gorgonio Pass	3,100
Mill Creek Basin	2,400
Santa Ana Basin	87,000
Western slopes to San Bernardino Plains between Santa Ana and Cajon Pass	1,500
Total	159,000

Four species of conifers supply all the lumber drawn from the forests of the reserve. They are as follows, with the percentage of each to the entire cut:

Lumber trees of San Bernardino Reserve.

	Per cent.
Abies concolor	.005
Libocedrus decurrens	3
Pinus lambertiana	4
Pinus ponderosa	92

It will be seen from this table that the western yellow pine leads the other species, singly or collectively, in the quantity of lumber which it supplies. The sugar pine, growing chiefly in the upper and rockier portions of Deep Creek Basin, where it is difficult of access, is not so largely cut as would be the case were it more generally distributed; the incense cedar is mostly worked up into shingles or shakes; the white fir is rarely sawn. The big-cone fir, here commonly called "hemlock," is very rarely utilized, even when it occurs with a fair development of clear trunk, as it sometimes does. None of the oaks or sycamores are sawn, and the latter species is always of small growth in this reserve.

In the estimates of the merchantable or mill timber in the reserve, the species enumerated in the following list are included:

Merchantable-timber species in San Bernardino Reserve.

Abies concolor	White fir;
Libocedrus decurrens	Incense cedar;
Pinus lambertiana	Sugar pine;
Pinus ponderosa	Western yellow pine;
Pseudotsuga macrocarpa	Big-cone fir.

The estimates are based upon a butt diameter of 14 inches, a size which is as low as is ordinarily logged here, and trees having clear trunks less than 10 feet in length are excluded from the estimates.

Estimate of quantity of merchantable timber in San Bernardino Reserve.

	Feet B. M.
On forest areas of first class	429, 440, 000
On forest areas of second class	71, 530, 000
Total	500, 970, 000

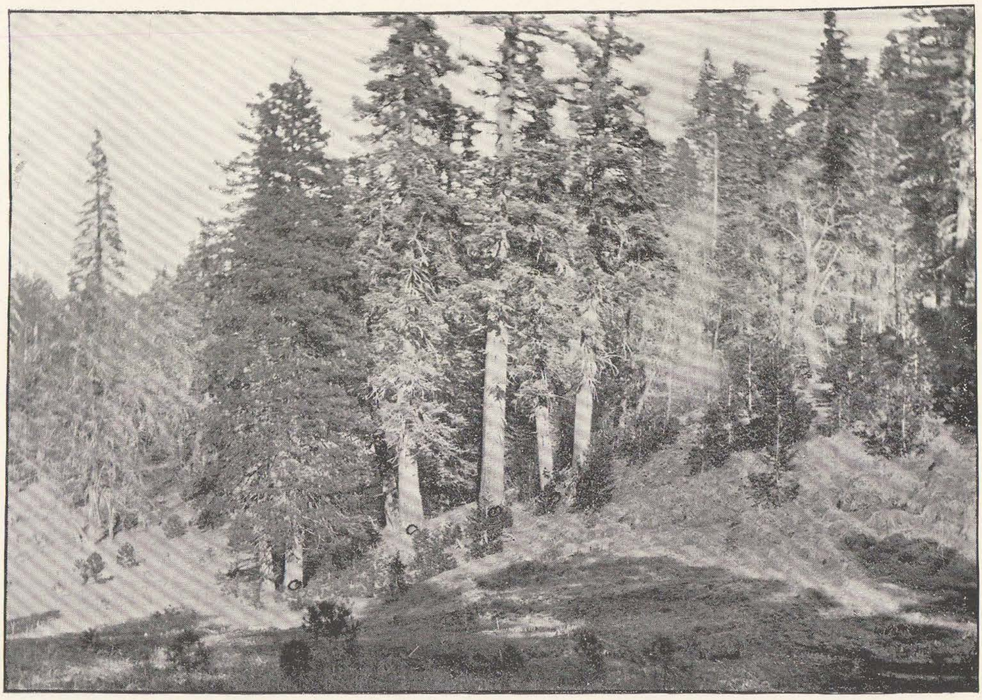
Distributed as follows:

	Feet B. M.
Deep Creek Basin, including areas to the northeast draining into Mohave Desert	164, 000, 000
Slopes to Mohave Desert southeast of Deep Creek	9, 000, 000
Slopes to San Gorgonio Pass	9, 750, 000
Mill Creek Basin	8, 480, 000
Santa Ana Basin	303, 740, 000
Western slopes of the uplift from Santa Ana to Cajon Pass draining into San Bernardino Plains	6, 000, 000
Total	500, 970, 000

The proportion furnished by each of the species of conifers included in these estimates is shown in the subjoined table:

	Feet B. M.
Abies concolor	78, 170, 000
Libocedrus decurrens	22, 100, 000
Pinus lambertiana	50, 100, 000
Pinus ponderosa	340, 400, 000
Pseudotsuga macrocarpa	10, 200, 000
	500, 970, 000

A. TIMBER AREAS OF FIRST CLASS, SAN BERNARDINO RESERVE.



B. WHITE-FIR GROWTH, NEAR ORCHARD CANYON, SAN BERNARDINO RESERVE.

The forests on the areas nere aesignated as humid and semiarid carry no timber fit for other purposes than firewood, except on some of the upward and downward extensions from the subhumid and semiarid tracts, as noted above. A large quantity of the big-cone fir between the 3,000-foot and 6,000-foot contour lines likewise has only a fuel value. The other species which compose the forest growth on the subhumid areas, aside from those which are classed as timber trees, are either wholly unused or are merely converted into firewood. I estimate that the forested tracts in the reserve contain in the aggregate not less than 256 million cubic feet of timber unsuitable for other purposes than firewood, distributed as follows: Piñon stands, 44,800,000 cubic feet, or 350,000 solid cords wood; stands of other species, 211,200,000 cubic feet, or 1,650,000 solid cords wood.

LOGGING OPERATIONS IN THE RESERVE.

The first timber cutting in the reserve dates back many years, at least as far back as the early Mormon settlements on the San Bernardino Plains. There were no other adjacent tracts from which mill timber could be obtained. The earliest cutting, to judge by the stumps, appears to have been on the areas southeast from Cajon Pass, where the mill timber begins, and southward to the portions of Deep Creek included in the drainage basin of the south fork of this stream. In later years, before the region was set apart as a reserve, private or corporate owners obtained control over the forested areas; and now, with the exception of piñon stands, growths at high altitudes or on steep slopes inaccessible, or nearly so, thin lines of trees along the canyons or scattered bunches in the recesses of the spurs, the Government neither owns nor controls the forested areas of San Bernardino Reserve. The largest holdings under one management are those controlled by the Highland Mill Company, which are said to aggregate 100 million feet B. M., and which are situated in the Deep Creek Basin and to some extent on the crest of the uplift adjacent to the Highland Mill at the head of City Creek. There are four sawmills in the reserve, one located near Strawberry, another on Fleming Creek, one a short distance north of this stream, and one at Highland. None were operating at the time the examination was made. The mill on Fleming Creek runs occasionally; the others were closed down. The largest establishment, the Highland Mill, has been idle for a number of years past. The total of the areas which have been logged and culled of mill timber in recent times amounts to about 5,000 acres. The logs are sawn at the mills located in the timber. Only the lumber is hauled down to the plains. The steep slope which extends from the foot of the uplift where it joins the San Bernardino Plains to the crest of the range, where the timber and mills are situated, has entailed large expenditures to secure easy grades for the various highways which afford the means of communication between the two sections. These roads are all toll roads, and are, at least in part, owned by the same corporations which control the bulk of the mill timber in the reserve. By placing a toll high enough to be practically prohibitory on timber, manufactured or in the rough, hauled over these roads, the corporations have made it impossible for anyone to log there except under their auspices or with their permission. Owing to the same reason, firewood is not cut and hauled from the upper areas of the reserve to any great extent. Most of the fuel is cut in the valleys of the larger streams and on the lower portions of the slopes which are reached by free roads. Considerable inroads have been made in some of the piñon areas on the eastern slope in cutting wood and timber for the Rose mines. This cutting is not done in solid blocks. A few cords are cut here and a few cords there, or an acre or two are cut clean in a particular neighborhood and operations are transferred to some other point. The piñon timber can not be cut profitably, except where it is of a certain density. Where the trees are much scattered nothing is cut.

Dimensions of the principal forest trees in San Bernardino Reserve.

Species.	Diameter.	Height.	Clear trunks.
	Feet.	*Feet.*	*Feet.*
Abies concolor	$1\frac{1}{2}$–$2\frac{1}{2}$	30– 90	0–40
Juniperus californica	1 –4	20– 40	None.
Libocedrus decurrens	$1\frac{1}{2}$–3	40– 90	0–30
Pinus attenuata	$\frac{1}{3}$– $\frac{1}{2}$	20– 35	None.
Pinus coulteri	$\frac{5}{6}$–$1\frac{2}{3}$	20– 40	None.
Pinus flexilis	1 –3	20– 40	0–15
Pinus lambertiana	2 –4	60– 90	20–35
Pinus monophylla	$\frac{2}{3}$–$1\frac{1}{2}$	15– 40	None.
Pinus murrayana	1 –3	20– 30	10–20
Pinus ponderosa	2 –5	40–120	20–60
Pseudotsuga macrocarpa	$1\frac{1}{2}$–3	40– 60	0–30
Quercus chrysolepis	1 –$2\frac{1}{2}$	20– 50	0–15

FOREST FIRES AND REPRODUCTION.

There are no areas outside of the piñon belt in the coniferous forest of the San Bernardino Reserve which do not show evidences of having been burned over at various times in the past. In the piñon forest small tracts have been burned here and there, the whole aggregating 500 or 600 acres. Recent fires in the commercially valuable timber have caused the greatest damage in the Santa Ana Basin between Bear

Valley and Santa Ana River, where tracts comprising collectively 500 acres have been burned over within the past two years and 50 per cent of the forest destroyed. In the noncommercial timber, at the 9,000-foot contour line and upward, big fires have raged in many localities on the high summits of the Mill Creek–Santa Ana River divide, about 60 per cent of the lodgepole pine and 4 to 5 per cent of the limber-pine growths having been destroyed over areas aggregating 20 square miles. The damage to the commercially valuable timber has not been great—on the whole, not over 2 per cent. The firs and incense cedars have suffered more severely than the other species, having less fire resistance.

The chaparral has been burned extensively. The entire area of this growth on the western and southern slopes shows indications of repeated burnings. Recent fires within the past two or three years have burned over 3,000 or 4,000 acres. The burning of the chaparral is not such a serious matter as would appear at first glance. The species of shrubs which compose it are all perennials, most of them are deep-rooted, and few are fire-killed. In a few years after a fire in the chaparral most of its effects are obliterated by the fresh growth which has sprung up in the meanwhile.

The fires which run in the forest are low, having only a small amount of litter to feed on. The fire is not very hot, does not spread with great rapidity, and is easily controlled. The brush fires are very difficult to subdue. Their intensity depends upon the season of the year and the force of the winds. During the dry season they spread with great rapidity and are practically uncontrollable unless stopped by some natural obstacle. In the spring they burn more slowly, and can easily be confined and prevented from extending over any very considerable area.

Fires in the piñon forest do not travel far. Underbrush and litter are too scanty to permit of any widespread conflagrations. The yuccas and cacti burn readily, however, and where the growths of them are dense assist in a rapid spread of the fire. The foliage of the yuccas burns quickly, and the long spines which stud various species of cactus burn as readily as though dipped in oil.

The reproduction of the commercially valuable forest is good throughout, whether it has been destroyed by fire or ax. The species which come in to replace the removed growth are generally the same as those which existed previously on the same areas. The only notable exception occurs on the logged areas west of Fleming Creek, where in some localities young incense cedars are appearing in disproportionate numbers on lands formerly covered with a growth composed mostly of western yellow pine.

On the areas carrying noncommercial timber above the 9,500-foot contour line reproduction of the forest is deficient wherever burned.

There is a noticeable tendency to solid chaparral growths on such tracts, as may be seen on the southern slopes of the Santa Ana River–Bear Creek and on the Santa Ana River–Mill Creek divides. The chief growth which comes on such places is a mixture of shrubby chinquapin, and various species of manzanita and spinescent ceanothus.

The reproduction of the piñon stands is generally deficient. One sees but few seedlings of either the juniper or the single-leaf piñon species on the Mohave side of the uplift. On the western slope, at the head of Bear Valley, these species have a comparatively dense growth and a sufficient number of seedlings to maintain it.

BOUNDARIES AND ACCESS.

The boundaries of the San Bernardino Reserve are so natural that no suggestions relative to a change in them can be made.

There is, however, another point to which I desire to call attention. This relates to the means of communication with the forest areas from the plains. On the Mohave side of the uplift a number of roads and trails lead into the reserve. These roads are free and communication over them with the interior of the reserve is easy. On the western slope the only wagon roads leading into the forested tracts are toll roads owned by private corporations. The section of road from Highland Mill to Bear Valley, along the crest of the ridge, is likewise a toll road. These corporations charge persons traveling on Government service toll, or not, according to their pleasure. The Arrowhead Company customarily refunds the toll or gives a pass upon proper application, but not so with the Highland Company, controlling the City Creek road. Considering the fact that the different corporations own the bulk of the commercially valuable timber which grows in the reserve, and that the Government, in patrolling the reserve in general, protects this timber as well, it would be but a matter of equity that officers of the Government should at all times be entitled to the free passage of these roads. There should be a definite understanding in regard to the matter. It is an intolerable condition of affairs that the officers of the Government can not enter this forest reserve by any and all roads without being obliged to pay for the privilege.

THE SAN JACINTO FOREST RESERVE.

By John B. Leiberg.

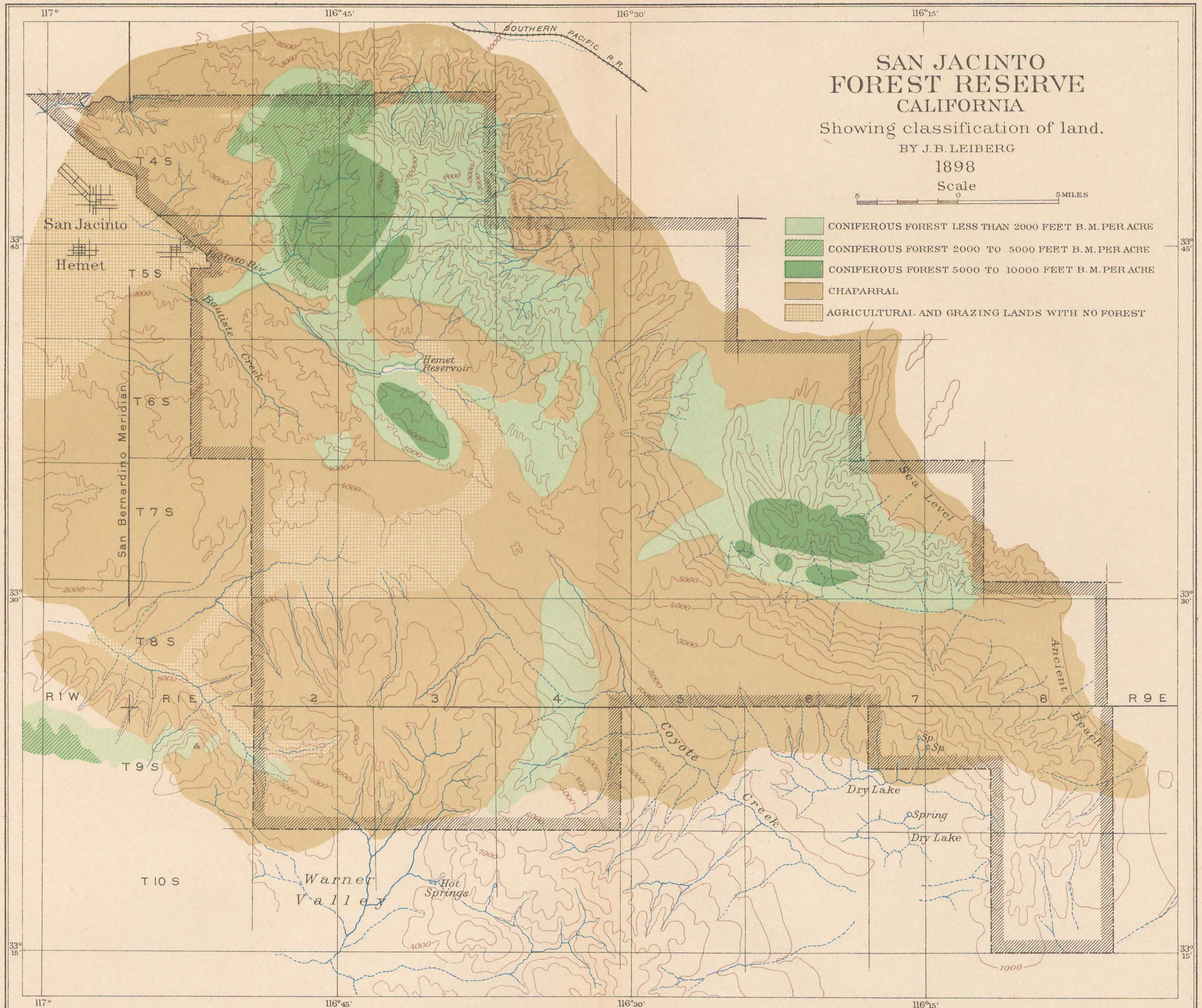
TOPOGRAPHY.

The tract of land in southern California set apart and designated as the San Jacinto Forest Reserve consists wholly of the uplift known as San Jacinto Mountains, and covers approximately an area of 740,000 acres, of which 550,000 acres are on the western side and 190,000 acres on the eastern side of the crest of the uplift. Its northern termination is at San Gorgonio Pass, a gap 4 or 5 miles wide, between the San Bernardino and the San Jacinto ranges, where a westward extension of the Colorado Desert connects with an eastward extension of the San Bernardino Plains. The eastern side fronts directly on the Colorado Desert; the southern and southwestern portions connect through various ranges and mesas with the mountains known as Smiths Range, south of Temecula Canyon, while the northwestern areas abut on the San Jacinto Plains. Within the reserve boundaries the orographical aspect of the San Jacinto uplift comprises three chief types. They are (1) the main San Jacinto Range with its various spurs; (2) Toro or Bull Mountain Range; (3) the Mesa regions.

The San Jacinto Range, as the name is commonly applied, begins at San Gorgonio Pass and extends southward for a distance of 25 miles. It rises abruptly from the plain that forms this pass and attains its culminating point a few miles to the south, in San Jacinto Peak, at an elevation of nearly 11,000 feet. South of the peak the altitude falls away rapidly, varying from 7,000 to 9,000 feet for the more prominent summits. The crest line of the range is narrow and rocky throughout. On the northern and eastern declivities the descent from the summit to the base or the plains level is generally uninterrupted and extremely sharp, with the slopes furrowed by numerous ravines and narrow, bowlder-strewn canyons. On the western side of the range the slope is not so direct, being broken by a number of plateau-like basins which constitute the heads of the various streams that ultimately form the San Jacinto River. These basins lie from 2,000 to 5,000 feet below the crest of the range, and with the exception of one at the head of the South Fork of the San Jacinto, are small in area, containing but a few hundred acres each. They are separated from one another by broad, rocky spurs, which rise from 500 to 1,500 feet above the floors of the basins, and occasionally bear small flats on their summits. The breaks to the San Jacinto Plains are mostly between the 4,500-foot and the 5,000-foot contours. The first descent is rapid and steep, but nowhere so sharp as on the eastern side of the range. The rise from the basins to the crest of the main range is usually abrupt, especially along the northern portion. Some of the terraces, such as those at the head of the middle and north forks of the San Jacinto, are partially recessed into the great spurs which flank San Jacinto Peak, and terminate against nearly perpendicular walls of rock 3,000 feet to nearly 4,000 feet in height. The termination of the main San Jacinto Range occurs at the head of the South Fork of the San Jacinto River, where the crest line sinks to an elevation of 5,000 feet, or less than 500 feet above the general level of the plateau basin of the stream, and not more than 75 feet above the visible water level in this portion of the divide at the time of year the locality was visited, namely, March. The divide at this point seems to be chiefly a mass of sand and gravel, and the rise is barely sufficient to separate the waters of the San Jacinto from the drainage into the Colorado Desert by way of Toro Creek. At this place the San Jacinto Range is divided into three branches. One turns to the north and forms the divide which separates the drainage of the South Fork of San Jacinto from that which flows into Cohuila Creek. It is variously known as Cohuila Range or Wild Hog Ridge, and attains an altitude of 7,000 feet. The second of the branches, at first nearly dissolving in the mesa, and scarcely noticeable as a defined range for 3 or 4 miles, pursues a southwesterly course, gradually rising in height, and constitutes the connecting ridge between the San Jacinto Mountains and Smiths Range, south of Temecula Canyon, and beyond the reserve limits.

The third of the branches is named Toro or Bull Range. It rises abruptly from the mesa at the head of Toro Creek, reaching elevations between 8,000 and 9,000 feet. It has a southeasterly trend for about 27 miles, when it terminates in the Colorado Desert. It is not a detached range, for aside from its connection with the main San Jacinto at the head of Toro Creek, it also joins various ranges farther south, beyond the reserve boundaries, through several intermediate spurs which leave its southwestern slopes near the Santa Rosa Indian Reservation. The Toro Range is steep and rocky, and most of its slopes are littered with immense accumulations of slidden, loose bowlders. It covers largely the six townships in the southeastern portion of the reserve.

The Mesa region is composed of two areas, connected, however, at the heads of Toro and Coyote creeks. Together they comprise 37 per cent of the entire reserve area, and form the most prominent fea-


SAN JACINTO
FOREST RESERVE
CALIFORNIA
Showing classification of land.
BY J. B. LEIBERG
1898
Scale
5
0
5 MILES
CONIFEROUS FOREST LESS THAN 2000 FEET B. M. PER ACRE
CONIFEROUS FOREST 2000 TO 5000 FEET B. M. PER ACRE
CONIFEROUS FOREST 5000 TO 10000 FEET B. M. PER ACRE
CHAPARRAL
AGRICULTURAL AND GRAZING LANDS WITH NO FOREST
117°
116°45'
116°30'
116°15'
33° 45'
33° 30'
33° 15'
SOUTHERN PACIFIC R.R.
San Jacinto
Hemet
San Jacinto Riv.
Bautiste Creek
Hemet Reservoir
San Bernardino Meridian
T 4 S
T 5 S
T 6 S
T 7 S
T 8 S
T 9 S
T 10 S
R I W
R I E
2
3
4
5
6
7
8
R 9 E
Sea Level
Ancient Beach
Coyote Creek
Dry Lake
Spring
Dry Lake
Sp.
Warner Valley
Hot Springs
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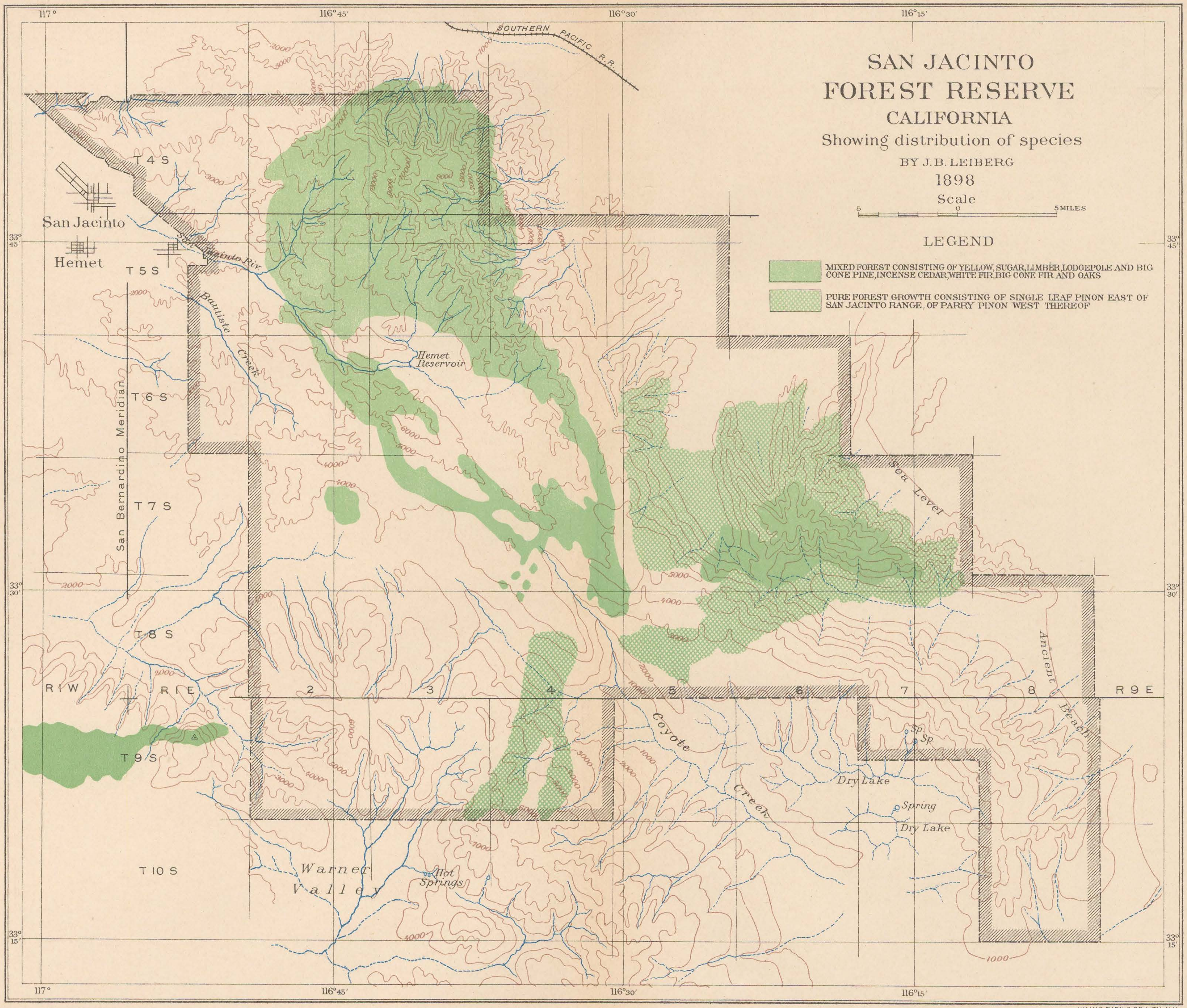
tures in its topography after the mountain tracts which center in San Jacinto Peak. One of the mesas is on the eastern side of the San Jacinto Range, flanking the Toro Range on the northeast. It is known as the Toro or Piñon Flat. The other is situated on the western slope and is named Cohuila Mesa. The mesas together form a plateau region, but their surface is not that of a level plain. Toro Mesa is furrowed in many directions by canyons from the Toro Range, and to some extent by those heading in the southern portion of the San Jacinto Range, but the canyons are not of great depth, rarely exceeding 150 feet from the plateau level to their bottoms. Cohuila Mesa contains large areas of level land in the eastern portion. It is not much cut up by canyons, but is intersected by a number of low ranges of hills, some of which are detached, while others are branches from Cohuila or Wild Hog Ridge, or from the ranges which unite the San Jacinto with Smiths Range south of Temecula Canyon. The average elevation for the level portions of the mesas is between 3,000 and 3,700 feet above sea level. Toro Mesa fronts on the Colorado Desert, into which it slopes through a series of sharp, extremely rocky breaks. The slopes of Cohuila Mesa on the south and west lie outside the reserve boundaries, and break off partly into the Temecula Canyon and in part into the canyons of tributaries of the Santa Margarita. The northern edge of the mesa drops off into the San Jacinto Plains. The slopes of the mesas are mostly steep and bowlder-strewn, and are gashed by numerous canyons which, however, do not cut back very far into the body of the plateau. The two mesa areas contain in the aggregate 273,000 acres, of which amount Toro Mesa covers about 40,000 acres and Cohuila Mesa 233,000.

GENERAL FEATURES OF CLIMATE AND DRAINAGE.

The San Jacinto Mountains are surrounded by a region which varies from semiarid to true desert. The desert area may be regarded as beginning at the summit of the San Gorgonio Pass, just east of Banning Station, on the Southern Pacific Railroad, whence it extends, as a portion of the Colorado Desert, along the entire eastern base of the uplift. The semiarid regions include the balance of San Gorgonio Pass westward, the San Jacinto Plains, and the canyons and broken mesas to the south as far as Smiths Range. Within the areas of the reserve conditions prevail that range from what might be considered humid through various degrees of subhumid to semiarid and desert. The tracts receiving sufficient precipitation to be classed as humid are the summits and slopes of San Jacinto Peak, at altitudes above 9,000 feet. The amount of the annual rainfall and snowfall on these areas is not known. The temperature conditions at above elevations are inimical to the growth of brush and timber, which do not, therefore, furnish any reliable indications, but snow is said to accumulate to a depth of

15 feet on San Jacinto Peak in midwinter, and the northern slopes of the peak at elevations above 9,500 feet usually carry snow throughout the year. The entire area included in the humid tracts, as here limited, embraces about 12,000 acres. The subhumid tracts are situated between the 4,800-foot and 9,000-foot contours, but are very far from including the entire reserve area between these elevations. Their exterior boundaries coincide very closely with the limits of growth of the western yellow pine, the sugar pine, and the white fir. The regions which may fairly be included under the designation subhumid are as follows: The northern slopes of San Jacinto Peak throughout and the eastern declivities to a point about 8 miles south from San Gorgonio Pass, but scarcely extending below the 5,900-foot contour; the western slopes of the main San Jacinto Range from San Gorgonio Pass south a distance of 20 miles; the summit and eastern slopes of Cohuila Range for a distance of about 4 or 5 miles south from the gorge of the South Fork of the San Jacinto, where Hemet dam is situated; and, lastly, the northern and southern slopes of Toro Range for a distance of about 10 miles southeast from the head of Toro Creek, but in this locality limited to areas above the 6,500-foot contour. None of these belts of subhumid country are wide. Most of them are less than 2 miles in width. The basins of the north and middle forks of San Jacinto are the widest, being about 4 miles between the exterior boundaries. The total area of the subhumid tracts is approximately 90,000 acres. The quantity of rain and snow that falls during the year on these areas is, so far as I am aware, not recorded. The character of the brush and timber growth, as compared with the same in regions where the annual precipitation is known, would indicate 20 or 25 inches of water for altitudes 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, with perhaps 25 to 30 per cent less for the latter altitudes on the eastern slope.

The semiarid tracts are practically all the areas below the 4,500-foot contour on the northern, western, and southern slopes and between the 6,500-foot and 2,800-foot contours on the eastern. In some localities the upper limits extend far above the 6,500-foot contour, as at the southern termination of the San Jacinto Range, where semiarid conditions prevail at 7,500 feet altitude. The entire mesa region is semiarid, even where covered with a growth of piñon pines. There are various degrees of semiaridity. The eastern slope, facing the desert, experiences these conditions in a far more intensified form than do the western slopes at identical altitudes. The low portion of the San Jacinto Range where it joins the Toro Mountains affords free traverse to the hot and dry winds of the desert, which must account for the high elevation to which semiarid conditions extend in that locality, but in general the greater degree of aridity which prevails on the



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eastern slope is due to the high crest of the San Jacinto Range, which compels precipitation on the western slope and allows but little to pass over the eastern. The reserve areas upon which semiarid conditions prevail amount to 600,000 acres in the aggregate.

The tracts which are true deserts exist on the eastern slopes of the uplift, chiefly along the borders of Piñon or Toro Mesa, and on the southern end of the Toro Mountains, and contain about 38,000 acres.

With reference to their climatic features we have thus the following acreages as distinct areas with the reserve limits:

Climatic areas in San Jacinto Reserve.

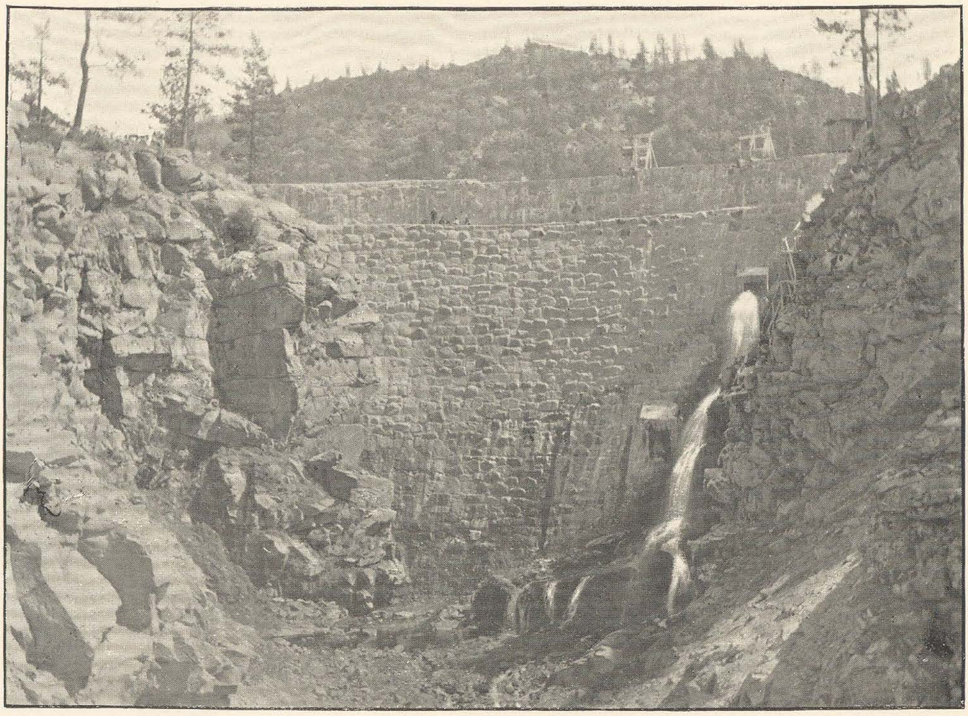
	Acres.
Humid tracts	12,000
Subhumid tracts	90,000
Semiarid tracts	600,000
Desert or arid tracts	38,000
Total	740,000

The drainage from the western slopes of the San Jacinto uplift is mostly carried by San Jacinto River and Cohuila Creek. There are, in addition, several smaller streams, mere gashes into the sides of Cohuila Mesa or along the slopes leading down from San Jacinto Peak, which during the wet season serve as channels for small quantities of seepage from the adjoining slope. The main artery for the run-off is San Jacinto River, and it carries fully 85 per cent of the entire annual drainage from the western slope. The San Jacinto River has three main forks—a northern, a middle, and a southern. They head in the San Jacinto Range, the northern and middle forks drawing their water from the nearly continuously snow-capped summits and flanks of San Jacinto and the adjacent peaks, while the southern one is supplied from ridges and slopes which carry snow only during the height of the winter season. Under the head of Topography reference has been made to the upper plateau basins of the San Jacinto forks, which are practically the reservoirs of all the streams that feed the San Jacinto. The upper basin of the south fork contains about 55,000 acres; that of the middle fork about 15,000 acres, and that of the north fork approximately 25,000 acres. The San Jacinto tributaries discharge their waters from the upper basins to the plains through narrow, rocky gorges and rough, bowlder-littered canyons. The descent is very rapid, 300 to 600 feet per mile for the first 2 or 3 miles. If much water were discharged through these canyons their streams would be torrential in every instance and their accumulations of bowlders would be swept out on the plains.

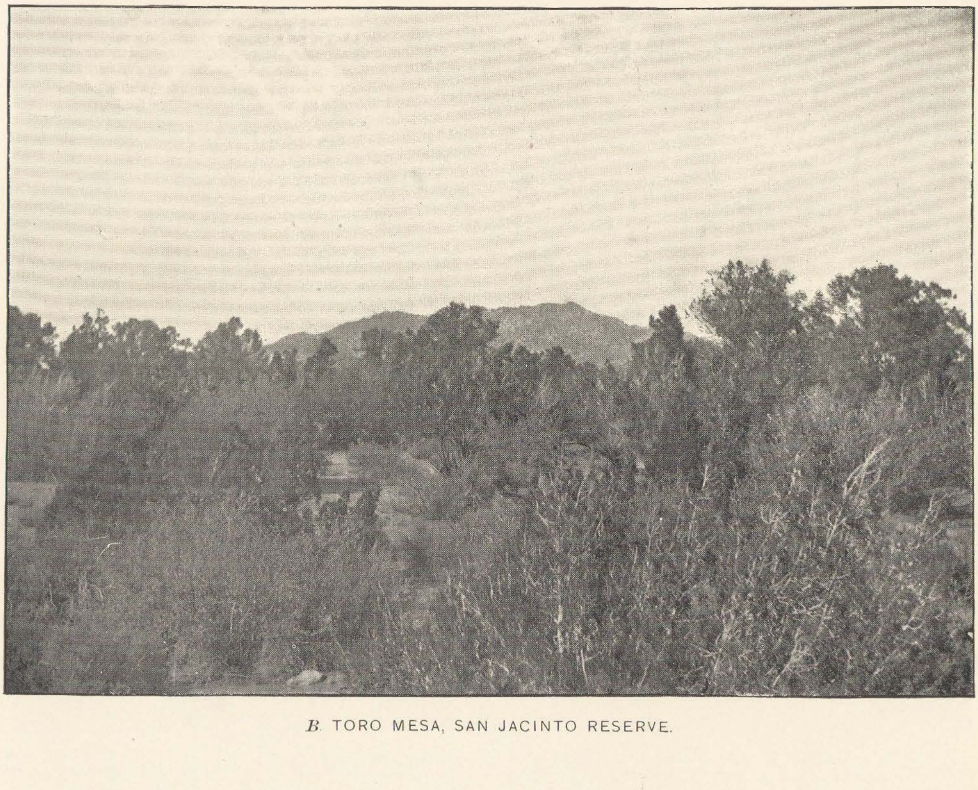
Cohuila Creek, the only other large stream draining the western slope, originates partly on the levels and in the intersecting ridges of Cohuila Mesa and partly in a number of springs, the largest seen in the reserve, near Cohuila Agency. The creek is a small, insignificant, and sluggish stream in its course through the mesa, with a shallow canyon, which deepens where the plateau breaks off to the Temecula Canyon tributaries.

The drainage from the eastern slope is insignificant. It all flows into the desert and is swallowed up in its sands. Most of the streams never even reach the desert line, sinking within a mile or two of their rise. The largest of them is Toro Creek, situated midway between the northern and southern boundaries of the reserve. It has a drainage basin of approximately 65,000 acres. The streams issuing from the wooded eastern slopes of Toro Mountain are all small, and carry water only during the wet season. Along the southern boundary of the reserve Coyote Creek drains a portion of Cohuila Mesa and the wooded southwestern slopes of Toro Mountain through Santa Rosa Creek. The volume of water in these streams is small, and disappears wholly or in part during the summer, except close to their heads.

The drainage from the San Jacinto uplift is important in that it supplies a certain quantity of water to the plains for irrigation purposes. In this respect the San Jacinto River system is the most prominent. The volume of water carried by the other streams, both on the eastern and western slopes, is not sufficient to irrigate the lands adjacent to them, much less those at some distance away. The only tracts in the reserve which shed a sufficient quantity of water to become of importance in conserving the water supply are those situated in the San Jacinto basins. As their aggregate extent is only 97,000 acres, it follows that of the 740,000 acres in the reserve only a trifle over 13 per cent is of any consequence as furnishing natural reservoirs for the storage of water. In point of fact, even this area, small as it is, suffers diminution if rigidly limited. The only tracts supplying a visible run-off throughout the year are the humid and subhumid ones. The semiarid lands shed water only during or immediately after heavy rain or snow, and 20 per cent of the upper basin of the South Fork of the San Jacinto is composed of decidedly subarid tracts. In other words, the total amount of water that can be drawn from the San Jacinto Forest Reserve to irrigate lands situated outside its boundaries on the plains below is limited to the quantities derived from an annual precipitation of 25 to 35 inches over 86,000 acres, and from 15 to 20 inches over 15,000 to 20,000 acres more. So far as I am aware there are no recorded measurements showing how much of this precipitation is shed as a visible run-off. The quantity depends upon several factors, as the amount lost by evaporation, the percentage absorbed by the soil, and that which sinks into crevices of the bed rock, and the depth and direction of these crevices. The amount of fissuring the bed rock has undergone is the chief of these factors, not alone in the San Jacinto Reserve, but also in the adjacent San Bernardino and San Gabriel



A. HEMET DAM, 135 FEET HIGH, ACROSS SOUTH FORK OF SAN JACINTO RIVER.



B. TORO MESA, SAN JACINTO RESERVE.

reserves. As the rocks are almost wholly composed of granites there are no definite cleavage planes, and the surface fissuring at least is largely the result of the intrusion of various eruptive dikes. These dikes have opened numerous fissures. Some have been filled with quartz and are mineral-bearing veins; others are narrow crevices along the contact planes of the dikes. It is safe to assume that most of these lines of fracture are water channels and are actively concerned in carrying away the waters that fall on the surface of the San Jacinto uplift. The fissuring must extend to great depths, as nowhere at the base of the mountains nor along their slopes are there to be found any large springs, nor are those that occur at all numerous. When measurements shall have been made it will doubtless be found that only a comparatively small quantity of the rainfall is shed as visible or available water. The fracturing of the bed rock, so far as observable on the surface, has been far more extensive along the southern extremity of the San Jacinto and the northern end of the Toro Range than elsewhere. The fissuring of the bed rock makes "water mining," as a means of increasing the visible run-off, possible. This sort of "mining" consists in driving tunnels into the mountains at various localities. The water obtained, often large volumes, is merely the intercepted downward flow through existing fissures which if not thus tapped would sink to depths below the level of the plains, where it would be unrecoverable except in the event of its flowing into an existing artesian basin. The upper basins of the San Jacinto are the only localities in the reserve which afford extensive reservoir sites, and of these the South Fork Basin is the most eligible and has already been utilized for such purposes. At the point where the stream leaves the basin it discharges through a narrow gorge, across which a dam 135 feet in height has been erected. This has resulted in backing the water up over a portion of the plateau, forming a lake about 2 miles long and one-third to one-half mile wide. This dam furnishes the only means in existence at the present time of gaging the entire flow from bed rock to surface, from any of the San Jacinto forks. The amount of actual discharge through the gates of the dam during a year is doubtless known to the corporation owning the property, but for obvious reasons is not made public. In the month of March, when the locality was visited by me, the water was permitted to flow through one gate only. The discharge was 480 miners' inches, which just sufficed to keep the lake at a constant level. This quantity, then, plus the evaporation from the surface of the lake, represents the entire drainage from the South Fork of San Jacinto River flowing as a visible run-off at that time of year; or, in other words, the water-shedding capacity of 55,000 acres in that locality of the reserve near the end of the rainy season (Pl. CLVI).

AGRICULTURAL, GRAZING, AND MINING AREAS.

The agricultural lands in the reserve are situated in the upper basins of the San Jacinto forks, on Cohuila Mesa, and on the intermediate areas connecting Cohuila and Toro mesas at the head of Coyote Creek. They amount to about 35,000 acres. In this category are included only such tracts as are sufficiently free from bowlders to permit of cultivation without the preliminary labor of clearing away the loose surface rocks. They are all situated below the 5,300-foot contour. There are none available for cultivation on the North Fork of the San Jacinto; 900 or 1,000 acres is the limit on the Middle Fork; 4,000 acres are on the South Fork, while the balance is situated on the mesas. All the agricultural lands require irrigation; and owing to this circumstance not more than 5,000 or 6,000 acres out of the 35,000 can be utilized. There is not nearly enough water originating on the reserve areas to suffice for the irrigation of the land within its boundaries that could ultimately be utilized for purposes of agriculture. In addition to the amount classed above as agricultural there are small flats of 10 to 20 acres each in the larger canyons which, in some cases where springs are found adjacent, are more or less thoroughly cultivated. The area actually under cultivation in the basin of the South Fork of San Jacinto is less than 200 acres; there is none in the Middle Fork; on the mesa between Coyote and Toro creeks there is less than 10 acres, while on Cohuila Mesa, along the creek of that name, there are 1,500 or 1,600 acres more or less thoroughly tilled, including the lands worked by the Indians around Cohuila Agency. The crops which are raised consist mostly of barley and alfalfa on the mesas, while in the upper basin of the South Fork of the San Jacinto one or two small apple orchards have been planted. The small flats in the lower canyons of the San Jacinto produce chiefly garden truck. There is no agricultural land on the eastern slope of either the San Jacinto or Toro ranges, nor is there any on Piñon Mesa.

The soil is composed mostly of a more or less finely-comminuted gravel or sand of granitic origin, mixed, at the surface, with small percentages of black mold, the residue of decayed brush and timber growth. On the eastern slope calciferous rocks occur and the soil here is mixed with lime. On Cohuila Mesa much of the soil consists of a gray or black, strongly alkaline mud, often white with a thick efflorescence, probably of sodium sulphite. The thick layer of decaying pine needles, twigs, and rotten prostrate tree trunks which collectively constitute the top and moisture-retaining mulch on the forest floor in the woods of Washington and Idaho is entirely lacking. The steeper and higher slopes in the vicinity of San Jacinto Peak are bare, rocky crags to a considerable extent.

The grazing capacity of the reserve is extremely limited. A sparse grass growth occurs on the humid and subhumid tracts and along the stream banks. Whatever grass growth existed in the past on the brush-covered slopes has long ago been eaten out. The largest grazing areas are found in the upper basin of the South Fork of San Jacinto and on Cohuila Mesa. The tracts producing grass on this latter plateau are mostly included within the Cohuila Indian Reservation and are under fence. With the exception of small areas on the Middle Fork, at Strawberry Flat, the grass lands situated elsewhere long ago passed into the hands of private owners and are also inclosed. The herbage produced by the pasture lands consists mostly of rush (*Juncus balticus*) and a few species of coarse sedge, or, where sheep have repeatedly grazed in the past, a thin growth of alfilaria has sprung up. No sheep are pastured in the reserve now, but bands of horses and cattle, numbering collectively between 1,500 and 2,000 head, run at large over the small tracts of unfenced grass land and through the brush. The areas which consist of grass land free from brush and timber comprise 6,000 acres.

There are two known mineral-bearing areas in the reserve. One is on the west slope of the San Jacinto Range, near its southern end; the other is situated along the eastern slope of Toro Mountain. Both are gold bearing, but are not developed very much as yet. The mineral claims upon which most work has been done are at Kenworthy, in the upper basin of the South Fork of San Jacinto. In addition to these two areas there are the eastern slope of San Jacinto Range and the Piñon Mesa, both of which are certainly auriferous, but are not worked in any locality up to the present.

BRUSH AND FOREST GROWTH.

Aside from the grassy tracts, which are small in extent, the vegetation on the reserve occurs under two chief aspects, namely, a brush growth and a forest growth.

THE BRUSH OR CHAPARRAL.

The growth which is usually designated chaparral, from a Spanish word signifying scrub oak, is by far the most conspicuous portion of the vegetation on the reserve areas, and covers much the larger portion of the same. While it differs somewhat in its complexion with varying altitudes, owing to changing percentages of its component species, there is yet a sameness of aspect running through it all, so much so that in general terms the chaparral of the southern California region can be defined as a brush growth composed of many species of shrubs, some deciduous leaved, but the majority evergreens, covering all semiarid tracts. It is a growth which varies from extremely dense to thin or open, but rarely forms very large, uninterrupted patches. The dense portions are commonly separated by narrow lanes, which are either wholly free from brush, or bear a scattered growth so thin as to offer no serious obstacles to travel; the dense portions, however, are often wholly impenetrable without the aid of the ax. Occasionally, at altitudes approaching subhumid conditions, isolated trees or small groves of them rise from out the midst of the mass of brush, but the bulk of the chaparral is always composed of frutescent species.

The chaparral, as a solid growth, is closely coexistent with the semiarid tracts of the reserve, the exception being the Piñon Flats on the eastern side of the uplift, where it is absent, except as detached clumps or isolated individuals. It is estimated to cover 530,000 acres, or somewhat over 70 per cent of the reserve area. Below the 5,000-foot contour on the western side the growth is quite uniform, broken only by the thin lines of oaks, cottonwoods, and sycamores which follow the courses of the streams from the upper basin to the level of the plains, or near the above contour line, by small groves or outlying individuals of western yellow pine, big-cone pine, or big-cone fir. Above the 5,000-foot contour the chaparral is not so uniform. At this altitude, on the northern slopes of San Jacinto Range and nearly as far south as the head of the South Fork of San Jacinto River, where it reaches the subhumid tracts of the reserve and the forested areas, it is broken in its continuity by patches of timbered land, while at the 5,700-foot contour the growth is reduced to scattered clumps throughout the forest, ceasing altogether at elevations of 10,500 feet. South of the head of the South Fork of San Jacinto River the chaparral growth of Cohuila Mesa sweeps across the reserve in a broad sheet through the gap between the San Jacinto and Toro ranges, and spreads out north and south along the eastern slopes of the ranges. Owing to the influence of the desert, the lower edge of the subhumid curve lies as high as 8,000 feet on the ridges bordering the gap, and the chaparral following this curve covers the mountain slopes with a nearly uniform growth up to that elevation. On the east the extension of the brush is limited by the desert areas. While on the western slope the chaparral extends downward to the plain's level, on the eastern side its downward extension, except as isolated clumps of bushes separated by broad intervals of bare ground, ceases at the 3,000-foot contour.

The chaparral in the reserve is composed of 50 or 60 species of shrubs, which vary from semiarborescent forms 8 to 12 feet high to suffrutescent kinds but a foot or two in stature. Most of them occur in such scant quantities as to be scarcely noticeable, and 12 to 14 species make up the bulk of the growth. In the occurrence of the species there is observable a sort of zonal grouping, not very definite, however, except above the 7,000-foot contour, where certain kinds cease altogether. The largest number of species occurs on the western slope, the greater dryness of the eastern being inimical to the growth of many.

In the lists of chaparral shrubs given herewith a zonal division for the western slope has been made at the 5,000-foot contour, in order to show the varying percentages of the species on the semiarid and subhumid tracts. On the eastern slope the division line also has been drawn at the 5,000-foot contour, with lists showing the composition below the 3,500-foot level, where true desert conditions prevail, and above the 6,500-foot contour, where the subhumid tracts begin.

Composition of chaparral on the western slope of San Jacinto Reserve below the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	50
Adenostoma sparsifolium	25
Arctostaphylos glauca	1
Arctostaphylos manzanita	2
Artemisia tridentata	Inconsiderable.
Baccharis viminea	Inconsiderable.
Ceanothus crassifolius	Inconsiderable.
Ceanothus cuneatus	1
Ceanothus divaricatus	8
Ceanothus pinetorum	Inconsiderable.
Cercocarpus betulæfolius	1
Chrysoma pinifolia	Inconsiderable,
Encelia farinosa	Inconsiderable.
Eriodyction californicum	Inconsiderable.
Eriodyction tomentosum	Inconsiderable.
Garrya veatchii	.005
Lycium andersonii	Inconsiderable.
Pentstemon antirrhinoides	.005
Pluchea sericea	Inconsiderable.
Prunus ilicifolia	Inconsiderable.
Quercus undulata	9
Rhamnus crocea	Inconsiderable.
Rhamnus ilicifolia	Inconsiderable.
Rhamnus rubra	Inconsiderable.
Rhus diversiloba	Inconsiderable.
Rhus ovata	.005
Rhus trilobata	Inconsiderable.
Ribes sanguineum	Inconsiderable.
Simmondsia californica, scarcely	1

Composition of chaparral on the western slope of San Jacinto Reserve above the 5,000-foot contour.

	Per cent.
Adenostoma fasciculatum	23
Adenostoma sparsifolium	8
Arctostaphylos glauca	Inconsiderable.
Arctostaphylos manzanita	20
Arctostaphylos patula	35
Castanopsis chrysophylla	5
Ceanothus divaricatus	5
Cercocarpus betulæfolius	Inconsiderable.
Fremontodendron californicum	Inconsiderable.
Prunus ilicifolia	Inconsiderable.
Quercus undulata	3

The large percentage of *Adenostoma fasciculatum* and *A. sparsifolium* is owing to the long upward curve of the semiarid belt at the south end of the San Jacinto Range. Excluding this tract the list will stand as follows, which then represents the composition of the shrub growth in the forested areas exclusively:

	Per cent.		Per cent.
Adenostoma fasciculatum	2	Castanopsis chrysophylla	5
Adenostoma sparsifolium	1	Ceanothus divaricatus	10
Arctostaphylos manzanita	35	Quercus undulata	6
Arctostaphylos patula	40		

Composition of chaparral on the eastern slope of San Jacinto Reserve between the 5,000-foot and 3,500-foot contours.

	Per cent.
Adenostoma fasciculatum	20
Adenostoma sparsifolium	55
Arctostaphylos glauca	Inconsiderable.
Arctostaphylos manzanita	1
Ceanothus cuneatus	Inconsiderable.
Ceanothus divaricatus	2
Ceanothus pinetorum	4
Ceanothus vestitus	Inconsiderable.
Cercocarpus betulæfolius	6
Covillea tridentata	Inconsiderable.
Dendromecon rigidum	Inconsiderable.
Eriodyction angustifolium pubens	Inconsiderable.
Isomeris arborea	Inconsiderable.
Juniperus californica (as shrub)	5
Kunzia glandulosa	Inconsiderable.
Pentstemon antirrhinoides	Inconsiderable.
Prunus ilicifolia	Inconsiderable.
Quercus undulata	5
Rhamnus ilicifolia	Inconsiderable.
Rhus ovata	1
Ribes quercetorum	Inconsiderable.

Composition of chaparral on the eastern slope of San Jacinto Reserve below the 3,500-foot contour.

	Per cent.
Ceanothus cuneatus	Inconsiderable.
Ceanothus pinetorum	20
Covillea tridentata	4
Dendromecon rigidum	Inconsiderable.
Isomeris arborea	Inconsiderable.
Juniperus californica (as shrub)	60
Kunzia glandulosa	3
Quercus undulata	8
Yuccas, agaves, and deciduous-leaved species not recognizable	5

The shrubby growth in the subhumid tracts on the eastern slopes is practically identical with that given in the list covering the forested tracts on the western slope.

The chaparral growth is of great importance, far more so than any other form of vegetation in the reserve. Especially is this the case on the steeper slopes, where it keeps in place the sandy and gravelly detritus which would otherwise slide into the canyons and be carried out on the plains. When the soil which covers the slopes of the San Jacinto Mountains becomes soaked with water, as it does during the rainy season, it is more like very wet mortar in consistency than anything else, and if unobstructed slips readily downward. The widely-spreading roots of the chaparral are obstacles to the movements of the water-soaked soil, and while admittedly they exert no influence in preventing slips or slides of the bed rock, they certainly contribute more largely than any other cause to stability of the surface. The chaparral likewise prevents a too free or rapid evaporation of soil moisture, the dense mass of foliage and the interlacing branches screening the ground effectually. The brush growth is inimical to the existence of a turf on the tracts which it covers. The soil there is free from herbaceous vegetation except small, scattered, low herbs. This permits the waters to sink into the soil as soon as they reach it, and prevents all or but a minimum surface run-off.

The chaparral areas are such by reason of climatic conditions. They do not owe their origin to the destruction of preexistent forests and subsequent deficient reforestation. The shrubs which compose them are such as are adapted to semiarid environments, under which none of the species of trees which now form the commercial forest growth on the San Jacinto Mountains could exist. If at any time in the past forests covered the chaparral areas it was at a period so remote that no trace whatever of them exists at the present time. Yet it must be admitted that, so far as can be judged from superficial appearances, there seems no good reason why certain of the nut-pine species of trees should not have found a lodgment on the lower and middle chaparral tracts on the western slopes of the San Jacinto Mountains. While the single-leaf piñon, which abounds on the eastern slope, may require for its growth a higher degree both of soil and atmospheric aridity than occurs on the western declivities, it might be supposed that the Parry piñon would extend its range downward into these treeless areas. This tree abounds in the brush growth on the mesa between the Cohuila and Toro plateaus, ranging from elevations of 6,500 feet to 3,000 feet, and appears to extend far southward toward the desert on one hand and Smiths Range on the other, but does not spread toward the west or north, where exist the largest chaparral areas in the reserve. The scattered trees of oaks and big-cone fir occurring here and there in the brush owe the possibility of their growth on such tracts to local conditions of water supply. If the chaparral tracts in the western portion of the reserve are ever to support a forest growth, artificial planting must be resorted to, and species of trees will have to be found capable of enduring the semiarid conditions prevalent on those slopes. So far as now known none of the species of trees native to the region will meet these conditions successfully (Pls. CLVI and CLVII).

Aside from its capacity of maintaining stability of the surface on steep-angled slopes, the chaparral has various economic uses. The two species of *Adenostoma* are used for fuel. When the portion above the soil is of too slender growth to be of any value the roots are grubbed out and burned. In almost every town on the plains the roots of *Adenostoma fasciculatum* are regularly sold as fuel. *Adenostoma sparsifolium* frequently attains a height of 10 feet, with basal diameters of 5 or, in some cases, 6 inches. On Cohuila Mesa, where it is exceptionally plentiful, fence posts are made from its trunks, and large quantities are cut for firewood. The scrub oaks are dealt with in the same manner. None of the chaparral shrubs appear to be of any value for pasturage, though cattle were observed quite frequently on Piñon Mesa, browsing on the leaves and twigs of *Adenostoma sparsifolium*, doubtless driven thereto by hunger, and not eating them from choice.

THE FOREST.

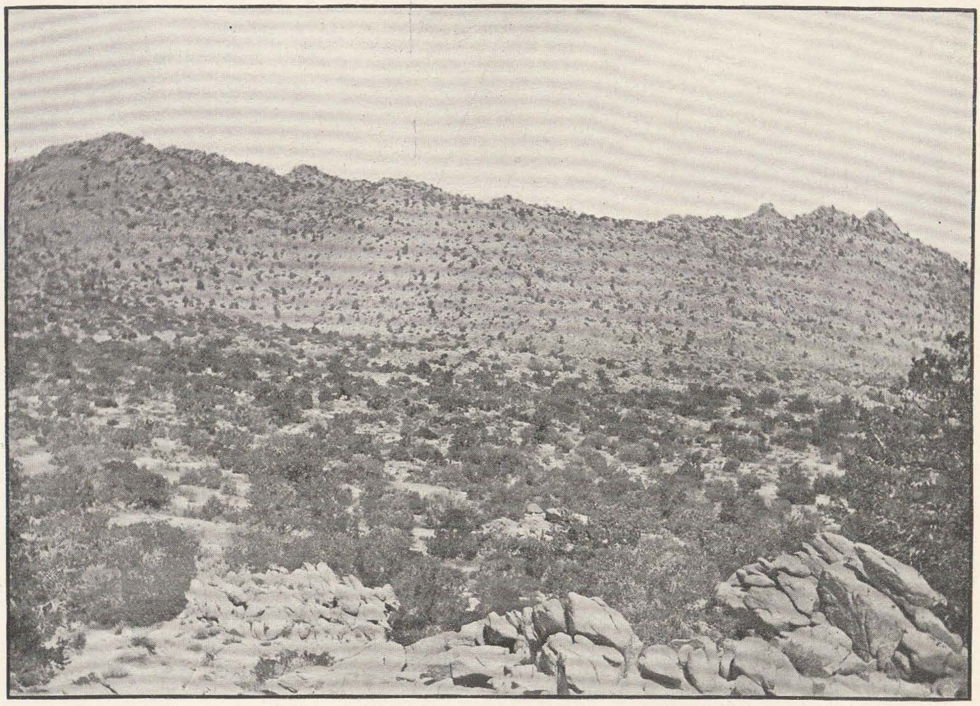
The following list of trees growing in the San Jacinto Forest Reserve comprises 28 species, of which 4 are occasionally mere shrubs, depending on local environments. It is probable that the list is not exhaustive, lacking some of the willows and other deciduous-leaved species, whose foliage was not developed at the time of year in which the reserve was visited, and which therefore remained unnoticed. The enumeration of coniferous trees is, however, complete.

List of trees in the San Jacinto Forest Reserve.

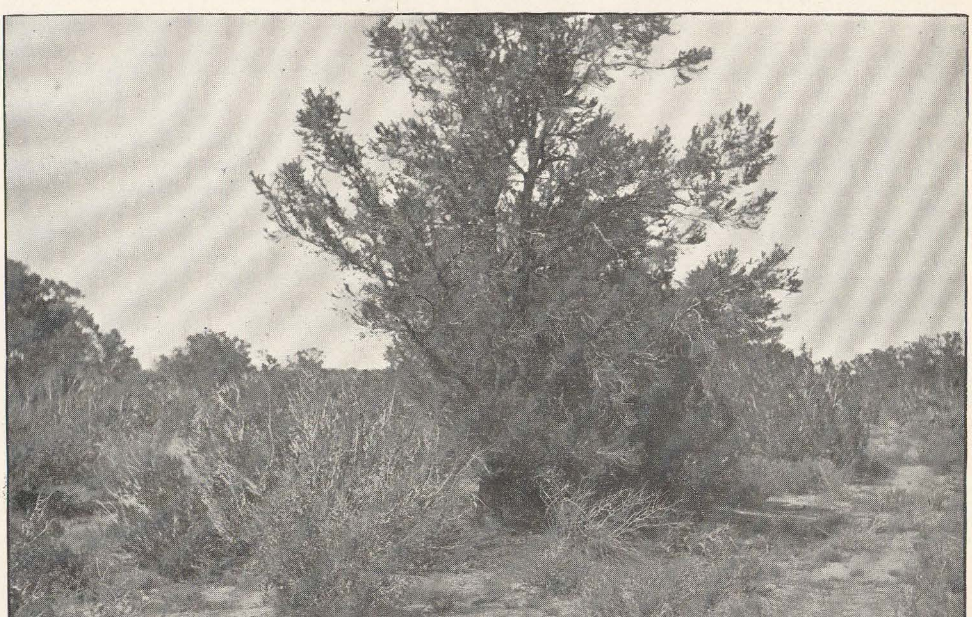
CONIFEROUS TREES.

Abies concolor	White fir.
Juniperus californica	California juniper.
Libocedrus decurrens	Incense cedar.
Pinus coulteri	Big-cone pine.
Pinus flexilis	Limber pine.
Pinus lambertiana	Sugar pine.
Pinus monophylla	Single-leaf piñon.
Pinus murrayana	Lodgepole pine.
Pinus ponderosa	Western yellow pine.
Pinus quadrifolia	Parry piñon.
Pseudotsuga macrocarpa	Big-cone fir.

White-bark pine (*Pinus albicaulis*) may occur, but was not seen by me. *Pinus jeffreyi*, sometimes regarded as a proper species, sometimes classed as a variety, is excluded from this and all subsequent lists in these reports. Whatever may be its status elsewhere, on the areas of the three Californian reserves covered by this report *Pinus jeffreyi* as a species is not at all distinguishable from *Pinus ponderosa*.



A.



B.

TORO OR PIÑON MESA, SAN JACINTO RESERVE.

NONCONIFEROUS TREES.

Evergreen species:	
Cercocarpus ledifolius	Mountain mahogany.
Rhus ovata	Sumach.
Quercus chrysolepis	Canyon live oak.
Quercus wislizeni	Highland live oak.
Yucca arborescens	Tree yucca.
Deciduous-leaved species:	
Alnus rhombifolia	Mountain alder.
Chilopsis linearis	Desert willow.
Fraxinus velutina	Leather-leaf ash.
Fremontodendron californicum	Fremontia.
Juglans rupestris	Western walnut.
Platanus racemosa	California sycamore.
Populus fremonti	Fremont cottonwood.
Populus trichocarpa	Black cottonwood.
Prosopis juliflora	Mesquite.
Quercus californica	California black oak.
Quercus morehus	Morehus oak.
Salix lasiandra	Western black willow.

The arborescent growth on the western slopes of the San Jacinto Reserve below the 4,500-foot contour occurs as small aggregates of oaks and sycamores in sheltered recesses of the mountain spurs, or as thin lines of trees fringing the stream banks and occasionally following the water courses a mile or two into the plains. At altitudes below 3,000 feet the species of trees which compose the chief portion of the growth are:

Composition of forest in San Jacinto Reserve below 3,000-foot contour.

Alnus rhombifolia	Mountain alder.
Platanus racemosa	California sycamore.
Populus trichocarpa	Black cottonwood.
Quercus californica	California black oak.
Quercus chrysolepis	Canyon live oak.
Salix lasiandra	Western black willow.

The coniferous growth begins at elevations of 3,000 feet. At first it consists of scattered trees of big-cone pine (*Pinus coulteri*) and big-cone fir (*Pseudotsuga macrocarpa*), and is distributed on the more moist and sheltered slopes among the chaparral. As the hills gain in altitude the big-cone pine begins to form small groves, while the big-cone fir fills the bottoms and northern slopes of the ravines and canyons with an open growth, sometimes interspersed with thick masses of sycamores and oaks. At 3,500 feet altitude isolated trees of western yellow pine (*Pinus ponderosa*), occur in sheltered localities, and at 4,000 feet elevation, on the mesa areas, at the head of Coyote Creek, Parry piñon (*Pinus quadrifolia*) exists as thin lines of forest, scattered open groves, or merely as single trees surrounded with chaparral.

Between the 4,500-foot and the 5,000-foot contour lines the arborescent growth begins to form forest with the following species as the principal components:

Composition of forest in San Jacinto Reserve between 4,500-foot and 5,000-foot contours.

Libocedrus decurrens	Incense cedar.
Pinus coulteri	Big-cone pine.
Pinus ponderosa	Western yellow pine.
Pseudotsuga macrocarpa	Big-cone fir.
Quercus californica	California black oak.
Quercus chrysolepis	Canyon live oak.
Quercus morehus	Morehus oak.
Quercus wizlizeni	Highland live oak.

The above are interspersed with small groves or scattered patches of mountain mahogany (*Cercocarpus ledifolius*) and occasional trees of sugar pine (*Pinus lambertiana*). At an altitude of 6,000 feet the number of coniferous species is increased by the addition of white fir (*Abies concolor*) and sugar pine (*Pinus lambertiana*). These trees grow at 5,000 feet elevation also, but do not contribute any noticeable proportion to the general forest growth below the 6,000-foot contour line. At this elevation the stands of Parry piñon (*Pinus quadrifolia*), big-cone fir (*Pseudotsuga macrocarpa*), and highland live oak (*Quercus wizlizeni*) thin out and soon disappear. At 7,000 feet altitude the growth of big-cone fir (*Pinus coulteri*), California black oak (*Quercus californica*), canyon live oak (*Quercus chrysolepis*), and Morehus oak (*Quercus morehus*) form an inconsiderable proportion of the forest, and at a few hundred feet above the 7,000-foot level these cease altogether. At the 9,500-foot contour line the following species mostly disappear:

Species not found above 9,500-foot contour in San Jacinto Reserve.

Abies concolor	White fir.
Libocedrus decurrens	Incense cedar.
Pinus lambertiana	Sugar pine.
Pinus ponderosa	Western yellow pine.

The sugar pine persists as low, stumpy trees 200 to 300 feet above the 9,500-foot level. At this elevation lodgepole pine (*Pinus murrayana*) and limber pine (*Pinus flexilis*) begin to grow. They increase rapidly in numbers with gain in elevation, and above the 9,800-foot contour line constitute nearly the entire arborescent growth, a few stunted specimens of white fir occurring here and there.

There are two pronounced lines of typal demarkation in the forest growth on the western slope of the San Jacinto uplift, and within the entire reserve area, covering all the slopes, there are three of these lines. The first, beginning at the lowest altitudes, consists of the growth composed of the two piñons, viz: Single-leaf piñon (*Pinus monophylla*) and Parry piñon (*Pinus quadrifolia*).

These form substantially the forest of the semiarid tracts, the lines of timber in the chaparral on the western slope being regarded, as they truly are, merely in the nature of downward extensions of the forests which cover the subhumid tracts, such extensions being made possible through local conditions of moisture supply. The piñon forests occur on the eastern, western, and southern slopes of the reserve, and together cover 50,000 acres. The larger tract exists on the eastern slope, on Toro or Piñon Mesa, and on the northeastern declivities of the Toro Range. The smaller of the two comprises the southwestern slopes of Toro Range and the mesa at the head of Coyote Creek and its tributary canyons.

The piñon forest forms an open growth. It is never dense. The trees stand at considerable distances apart, varying from 5 to 100 to the acre, only in rare instances exceeding the latter number. On Piñon Mesa the spaces between the trees are either bare of vegetation or sparsely covered with patches of brush oak (*Quercus undulata*) or juniper scrub, more or less mixed with suffrutescent cacti, low or arborescent yuccas, several species of small desert shrubs, and one or two kinds of agave. There is no turf whatever covering the ground (Pl. CLVII).

The piñon forest on the western slope is of a much thinner growth than on the eastern. The species composing it, the Parry piñon, appears not to form compact growths anywhere in the reserve. Most of it is made up of scattered trees standing in a dense chaparral of scrub oaks *Adenostoma sparsifolium* and sagebrush (*Artemisia tridentata*).

The forest growth on the semiarid tracts is of little commercial value. Its entire economic importance lies in the quantity of fuel it is capable of furnishing and in the large edible seeds more or less collected by the Indians for food.

The composition of the piñon forest is as follows:

Composition of piñon forest in San Jacinto Reserve.

ON THE EASTERN SLOPE.

	Per cent.
Pinus monophylla (single-leaf piñon)	99
Ash, cottonwood, oaks, willows, and yuccas	1

ON THE SOUTHERN AND WESTERN SLOPES.

	Per cent.
Pinus monophylla (single-leaf piñon)	8
Pinus quadrifolia (Parry piñon)	90
Quercus chrysolepis (canyon live oak), quercus wislizeni (highland live oak), cottonwoods, and willows	2

On the eastern slope the piñon belt begins at an elevation of 2,500 feet. Scattered trees may occur below this level, but not in any considerable quantity. Between the 3,500-foot and the 4,800-foot contour lines the stands attain their maximum density. On the San Jacinto Range, above the 4,800-foot level, the growth thins out and soon ceases, while on the Toro Range it ascends to elevations of 7,000 feet.

In the ravines throughout the belt there are small quantities of the following arborescent species:

Composition of forest in ravines in San Jacinto Reserve.

Chilopsis linearis	Desert willow.
Fraxinus velutina	Leather-leaf ash.
Populus fremonti	Fremont cottonwood.
Quercus wislizeni	Highland live oak.
Rhus ovata	Sumach.

On the western slope the piñon tracts commence between the 3,000-foot and 4,000-foot contour lines. Apparently the Parry piñon requires more moisture and a lower temperature than the single-leaf piñon, as its heaviest growth is near and somewhat above the 5,000-foot contour. On the San Jacinto Range the Parry piñon extends to elevations of 7,500 feet in exceptional localities.

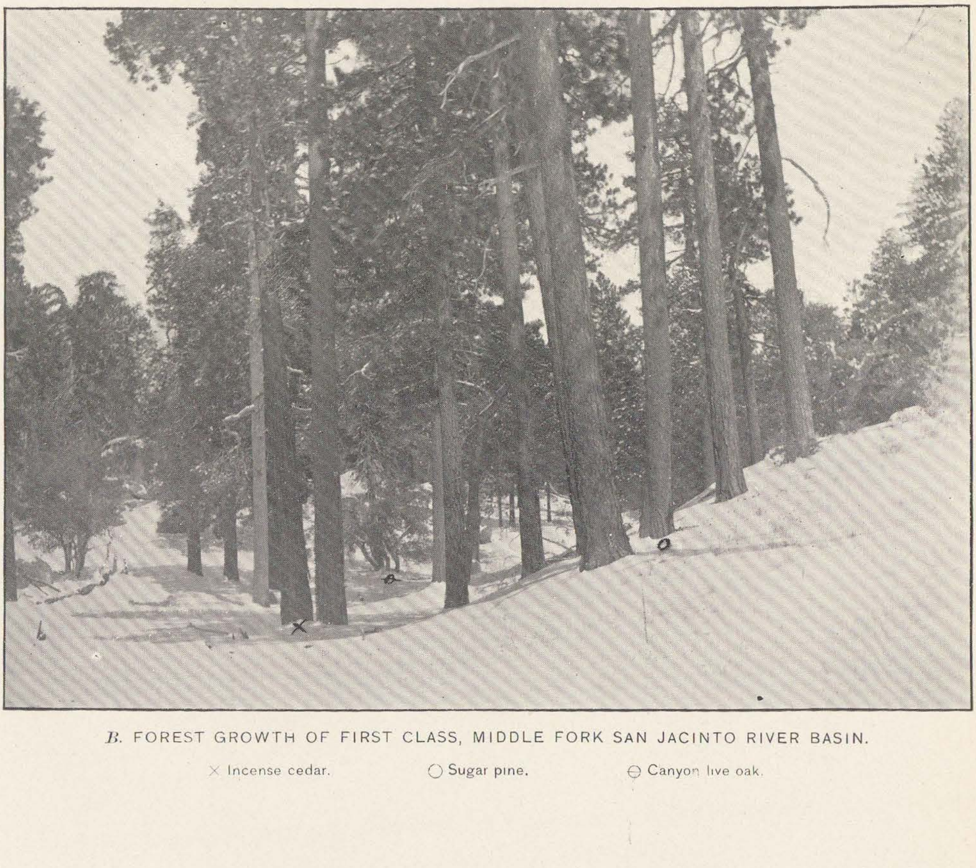
The second type of forests is that which occurs on the subhumid tracts. Its chief development is between the 5,000-foot and 9,000-foot contour lines. It corresponds exactly to the type of forest of the Columbia River Basin, designated the western yellow-pine type, which, however, has an altitudinal range chiefly below the 4,500-foot contour line in that region. Its principal components in the reserve are the western yellow pine and white fir. The areas carrying this type of forest comprise, in the aggregate, 82,560 acres, and occur on the eastern, western, and northern slopes of the San Jacinto Range, on the summit and eastern slope of the Cohuila Range, and on the northern and southern slopes of the Toro Range. The various tracts are situated as follows:

Areas of forest of western yellow-pine type in San Jacinto Reserve.

	Acres.
North slope of San Jacinto Range	5,840
West slope of San Jacinto Range	55,880
East slope of San Jacinto Range	4,000
Cohuila Range	3,640
Toro Range	13,200
Total	82,560

The areas covered with the western yellow-pine type of forest contain the commercially-valuable timber of the reserve. The stands are usually open, never very dense unless the spaces between the conifers happen to be occupied by patches of oak or mountain mahogany, which occasionally occur below the 8,000-foot contour line. The heaviest growth of timber of this type exists between altitudes of 5,500 and 7,500 feet. The proportions of the different trees that make up the forest of this type vary somewhat with altitude. The following tables exhibit the percentages between the 3,000-foot and 8,500-foot contours (PL. CLVIII).

A. FOREST GROWTH OF SECOND CLASS, COMPOSED OF YELLOW PINE, SAN JACINTO RESERVE.



B. FOREST GROWTH OF FIRST CLASS, MIDDLE FORK SAN JACINTO RIVER BASIN.

× Incense cedar. ○ Sugar pine. ⊖ Canyon live oak.

Composition of forest of the western yellow-pine type in the San Jacinto Reserve between the 3,000-foot and 6,000-foot contours.

	Per cent.		Per cent.
Libocedrus decurrens	3	Quercus californica	1.5
Pinus coulteri	6	Quercus chrysolepis	2.5
Pinus lambertiana	2	Quercus morehus, Quercus wislizeni, cottonwoods, mountain mahogany, sycamore, and willows	1
Pinus ponderosa	80		
Pseudotsuga macrocarpa	3		

Composition of forest of the western yellow-pine type in the San Jacinto Reserve between the 6,000-foot and 8,500-foot contours.

	Per cent.		Per cent.
Abies concolor	30	Pinus ponderosa	30
Libocedrus decurrens	8	Quercus californicus, Quercus chrysolepis, Cercocarpus ledifolius	2
Pinus lambertiana	25		
Pinus murrayana	5		

With reference to commercial value the forest of western yellow-pine type in the reserve may be divided into two classes. One comprises the stands where trees of sufficient development for logging purposes predominate; the other consists of growths where but few trees possess a proper length of clear trunk to fit them for saw logs. The stands of the first class contain 32,560 acres, distributed as follows:

Areas of western yellow-pine type of first class in San Jacinto Reserve.

	Acres.
North slopes of San Jacinto Range	3,840
Basin of North Fork of San Jacinto River	9,840
Basin of Middle Fork of San Jacinto River	7,680
Cohuila Range and Upper South Fork of San Jacinto River Basin	3,200
Toro Range, including southern slopes	8,000
Total	32,560

The timber in these stands generally averages more than 1,000 feet B. M. per acre. Their greatest density is not above 14,000 feet B. M. per acre, and that only on small areas in the basins of the north and middle forks of the San Jacinto River, containing the largest quantities of sugar pine. The timber is fair to prime in quality, with few defects, except in the incense cedar. The defects are due to old burns and consist of fire scars on the basal portion of the trunks. The stands of the second class comprise about 50,000 acres, distributed as follows:

Areas of western yellow-pine type of second class in San Jacinto Reserve.

	Acres.
North slopes of San Jacinto Range	2,000
East slopes of San Jacinto Range	4,000
Basin of North Fork of San Jacinto River	6,800
Basin of Middle Fork of San Jacinto River	4,560
Cohuila Range, with detached portions on Cohuila Mesa, and basin of Upper South Fork of San Jacinto River	27,440
Toro Range	5,200
Total	50,000

The areas of the second class carry an open growth, with less than 1,000 feet B. M. per acre. The trees stand scattered, with an undue proportion of crown and lateral branches. But little is strictly commercially-valuable timber except for purposes of firewood (Pl. CLIX).

Three species of conifers supply all the timber which is sawn by the mills in the reserve at the present time. They are as follows, with the percentage of each to the entire cut:

Conifers furnishing mill timber in San Jacinto Reserve.

	Per cent.
Libocedrus decurrens (incense cedar)	1
Pinus lambertiana (sugar pine)	4
Pinus ponderosa (western yellow pine)	95

The sugar pine would be more extensively used were it easier of access. As yet hardly any has been cut except the scattered trees of the species in the lower edge of the forest belt. Its heaviest stands occur at elevations between 6,000 and 7,000 feet, where the nature of the slopes makes logging somewhat difficult. The incense cedar is hardly ever sawn, being chiefly worked up into shakes (hand-split shingles). The white fir and big-cone fir are rejected, the big-cone fir on account of its knotty wood, the white fir because of its sappy and coarse timber. Both of the species should supply box lumber, a use to which the crown portions of the yellow-pine logs are now put. None of the oaks or sycamores are sawn. The sycamore in the reserve is of small growth. The California black oak has an extremely deficient development of its main trunk as regards length, commonly branching a few feet from the ground, and the branches are large, crooked, and gnarled. The canyon live oak is too small and the highland live oak occurs too sparsely to be considered by the lumberman.

In the estimates of the merchantable timber in the reserve the following species of conifers are included:

Merchantable-timber species in San Jacinto Reserve.

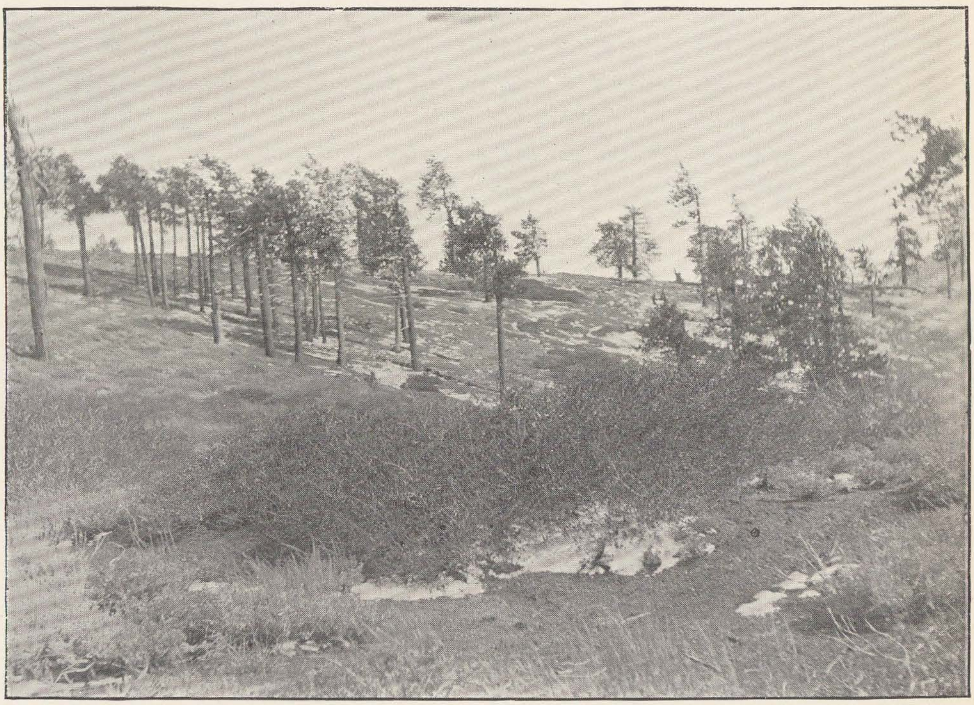
Abies concolor	White fir.
Libocedrus decurrens	Incense cedar.
Pinus lambertiana	Sugar pine.
Pinus ponderosa	Western yellow pine.
Pseudotsuga macrocarpa	Big-cone fir.

The estimates are made upon a basal diameter of 14 inches, a size that is commonly logged here. In fact, stuff that will not measure more than 10 inches at the base is worked up, provided the taper is not too rapid. Trees of the above-named species measuring less than 10 feet in length of clear trunk are excluded.

Estimate of merchantable timber in San Jacinto Reserve.

	Feet B. M.
On forest tracts of first class, easily accessible, timber fair to prime in quality	97,110,000
On forest tracts of second class, difficult of access or wholly inaccessible, timber poor in quality	16,000,000
Total	113,110,000

A. NONCOMMERCIAL TIMBER GROWTH, COHUILA RANGE (THOMAS MOUNTAINS), SAN JACINTO RESERVE.



B. FOREST OF SECOND CLASS, COHUILA RANGE (THOMAS MOUNTAINS), SAN JACINTO RESERVE.

This quantity is distributed as follows:

Merchantable-timber areas in San Jacinto Reserve.

	Feet B. M.
North slopes of San Jacinto Range	15,590,000
Basin of North Fork of San Jacinto River	40,600,000
Basin of Middle Fork of San Jacinto River	22,880,000
Cohuila Range and basin of South Fork of San Jacinto River	9,000,000
Toro Mountain, including south slopes	25,040,000
Total	113,110,000

The proportion of timber furnished by each of the species of conifers included in the list of merchantable forest trees is as follows:

Amount of merchantable-timber species in San Jacinto Reserve.

	Feet B. M.
Abies concolor	8,300,000
Libocedrus decurrens	4,500,000
Pinus lambertiana	12,310,000
Pinus ponderosa	83,000,000
Pseudotsuga macrocarpa	5,000,000
Total	113,110,000

The sawmills in the reserve, having but a limited quantity to draw on, are disposed, from force of necessity, to handle the timber in the most economical manner possible. They therefore utilize the trees far up in the crown, where the diameter dwindles to 8 inches or less. Estimated on this basis, the quantity of merchantable timber would amount to at least 200 million feet B. M., as many trees which have no clear trunk would be quite as serviceable as the crowns of the larger and clearer individuals.

The forest type of the third class corresponds to the zone designated as the alpine fir in the northern Rocky Mountains and Cascades. It occurs in the San Jacinto Reserve mostly above the 9,000-foot contour line and ascends to the highest summits. It consists mostly of two species:

Pinus flexilis	Limber pine.
Pinus murrayana	Lodgepole pine.

Its extent is nearly coincident with the limits of the humid tracts, and comprises 8,960 acres, situated as follows:

	Acres.
Main San Jacinto Range	5,500
Cohuila Range	900
Toro Range	2,560
Total	8,960

The areas on the Cohuila Range carry no *Pinus flexilis*, while those on Toro Range are mixed with stands of *Abies concolor*. The forest of this type is valueless as to timber fit for saw logs. Not only are the trees too short and stunted in growth, but the wood of the two species which form the bulk of the stands is intrinsically worthless for lumber in this region. It has, however, a fuel value, which is likewise the case with the piñon on the semiarid tracts. The quantity of fuel which these two types of forest are capable of yielding depends to a considerable extent upon the diligence of the wood chopper. I estimate that the piñon forest on the reserve will yield about 150,000 cords and the stands of timber of the third type, lodgepole pine and limber pine, about 50,000 cords, or a total of 200,000 cords of wood for the areas carrying forest not capable of yielding saw timber. In addition, there is a certain quantity of timber with fuel value on the tracts carrying commercial forests. The amount is uncertain, but probably is about one-half of the quantity for the noncommercial forest areas, or 100,000 cords.

Timber cutting in the San Jacinto Reserve for sawmill purposes dates back between 15 and 20 years. It has been extensive, in comparison with the total area of merchantable timber, in the upper basins of the north and middle forks of the San Jacinto River. Three sawmills have been in operation—one in Strawberry Valley, in the basin of the Middle Fork; and two in the North Fork Basin. The one in Strawberry Valley is owned by the Native Lumber Company. It is run occasionally and the product is hauled by wagon to San Jacinto, where it is marketed or distributed by rail to other points. The immediate neighborhood of these mills has been logged to the extent of 75 to 80 per cent. Most of the tracts carrying timber fit for lumbering purposes appear to have passed out of the hands of the Government, and are owned either by private individuals or by the Southern Pacific Company. There has been no cutting of the piñon forest. The chaparral on Cohuila Mesa and on adjoining tracts is being cut for firewood.

Dimensions of the principal forest trees in San Jacinto Reserve.

Species.	Diameter.	Height.	Clear trunks.
	Feet.	*Feet.*	*Feet.*
Abies concolor	$1\frac{1}{2}$ to 3	40 to 90	None to 30
Libocedrus decurrens	2 to 4	50 to 90	None to 20
Pinus coulteri	$\frac{5}{6}$ to $1\frac{2}{3}$	20 to 50	None.
Pinus flexilis	1 to $2\frac{1}{2}$	15 to 25	None to 12
Pinus lambertiana	$1\frac{1}{2}$ to 4	50 to 90	13 to 30
Pinus monophylla	$\frac{2}{3}$ to $1\frac{1}{3}$	15 to 45	None.
Pinus murrayana	1 to 3	20 to 40	10 to 15
Pinus ponderosa	2 to 5	60 to 150	20 to 50
Pinus quadrifolia	$\frac{2}{3}$ to $1\frac{1}{3}$	15 to 40	None.
Pseudotsuga macrocarpa	1 to 4	40 to 80	None to 15
Quercus californica	2 to 6	40 to 70	None.
Quercus chrysolepis	1 to $1\frac{1}{2}$	20 to 50	None to 10 to 15
Quercus morehus	$\frac{1}{2}$ to 1	15 to 35	None to 10
Quercus wislizeni	$1\frac{1}{2}$ to 3	30 to 50	10 to 15

FOREST FIRES.

Fires have run through the commercially-valuable forest everywhere. The piñon tracts and isolated localities around San Jacinto Peak have escaped. The damage resulting from the fires has not been extensive. I would place it at less than 1 per cent. The firs, lodgepole pine, and incense cedar have sustained more damage than the western yellow pine or the sugar pine. The oaks rarely exhibit any signs of fire injury. The absence of humus and the small quantity of litter on the ground make the occurrence of hot and lasting fires in the forest impossible.

The chaparral has suffered more severely than the forest from fires, but the damage is merely temporary. The shrubs that form the growth are all perennials and are rarely root killed. After having the top portion burned out or killed by fire, a new growth soon springs up. The manzanitas and *Adenostoma fasciculatum*, or "grease wood," as it is sometimes called, are occasionally exterminated by the fire following the roots to their ends. Trees standing in dense chaparral are commonly killed when the surrounding brush is burned. The big-cone fir and Coulter pine are the most exposed in this respect. It is very probable that the entire area of chaparral on the western slope of the reserve has been repeatedly destroyed by fire. Within the past eight or ten years 14,000 to 15,000 acres of brush growth, in small tracts, situated in various portions of the reserve, have been burned, but with the exception of 100 or 150 acres the tracts are rapidly recovering their former status.

Fires burning in the forest are easily controlled, but brush fires are often difficult to subdue. The dense masses of interlacing branches communicate the flames from one clump of brush to another. The natural lanes existing throughout the chaparral are too narrow to serve as efficient fire breaks. The quality of the soil appears never to be injured by fires, owing to an insufficiency of inflammable material in the top layer of soil.

Reproduction of the commercially-valuable forest is generally rapid and abundant between elevations of 4,800 and 8,000 feet, whether the old growth has been destroyed by fire or the ax. The same species and in about the same proportions reoccupy the ground. In the piñon forest reproduction is evidently slow. As neither fire nor the ax have devastated any portions, it can not be known what its subsequent behavior would be. It is very evident, however, that the stands are not increasing in density. One sees but few seedlings of the piñon species anywhere in the reserve.

RESERVE BOUNDARIES.

It is evident that the boundaries of the reserve on the western side can be readjusted with advantage. There is on Cohuila Mesa a large tract which carries no forest and affords no surplus water for irrigation of the plains below. The region consists of a flat or rolling plateau, intersected by detached ranges of rocky hills. It gives rise to but one stream of any consequence, Cohuila Creek, the waters of which are, or can be, wholly used up on the mesa by the Indians living on the Cohuila Indian Reservation, or by the settlers west thereof, in the irrigation of their lands. The creek is fed by springs originating in the chaparral covered plateau. A portion of the mesa is occupied by the lands embraced within the Cohuila and Ramona Indian reservations, which lie wholly within the boundaries of the Forest Reserve.

The entire area of the mesa should be cut off from the reserve. It is valuable neither for its timber nor for its chaparral, nor for the water it originates or conserves. The recommendation is here made that all of the present reserve areas *west* of a line drawn southward from Hemet dam through the crest of Cohuila or Thomas Range, and extended from the southern termination of this range, at the head of the South Fork of San Jacinto, in a southerly direction, to an intersection with the southern boundary of the reserve, be excluded from the San Jacinto Forest Reserve. The tract which would be affected by the proposed change comprises approximately 170,000 acres.

In the absence of surveys fixing the southern boundary line of the reserve, definite changes can not be recommended here. If, when surveyed, it should be found that the southern slopes of Toro Mountain fall outside the reserve areas, the line should be thrown far enough south to include these slopes with the basin of Santa Rosa Creek. It is quite feasible to direct the water in this stream, which now flows into Coyote Creek, and is lost in the desert, into the valley of the South Fork of San Jacinto, and thus considerably augment the volume of water available for irrigation purposes in the Hemet dam.

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