TWENTIETH ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

1898-99

CHARLES D. WALCOTT
DIRECTOR

IN SEVEN PARTS

PART V—FOREST RESERVES

HENRY GANNETT, CHIEF OF DIVISION

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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.

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

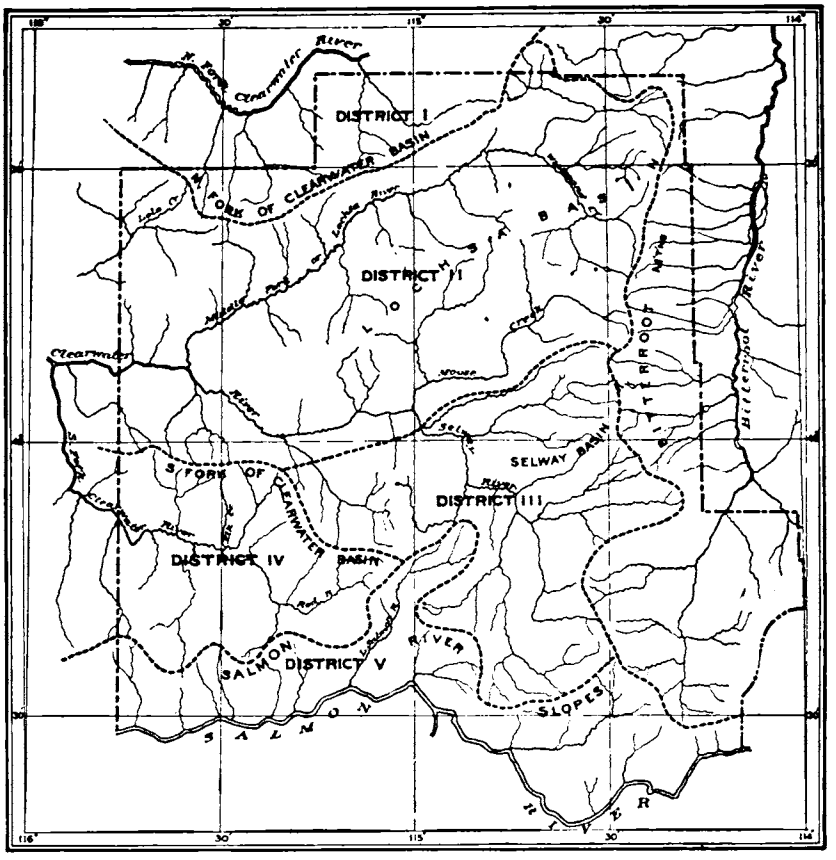


FIG. 1.—Bitterroot Forest Reserve, showing districts used in description.

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 exclu-

sively 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 Bitter-roots. 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.

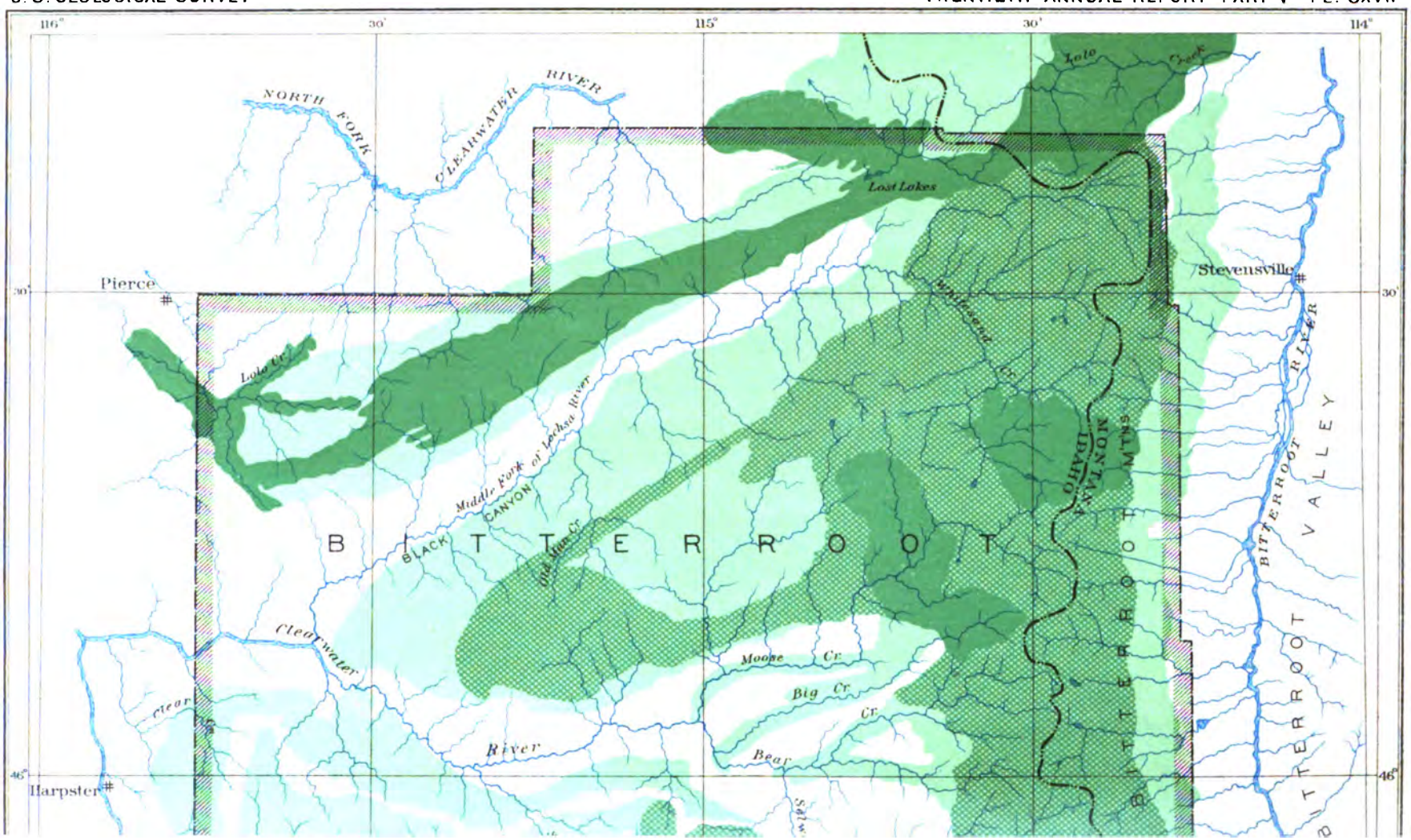
The species forms about 6 per cent of the forest growth in the reserve, and the total stand is 422,200,000 feet.

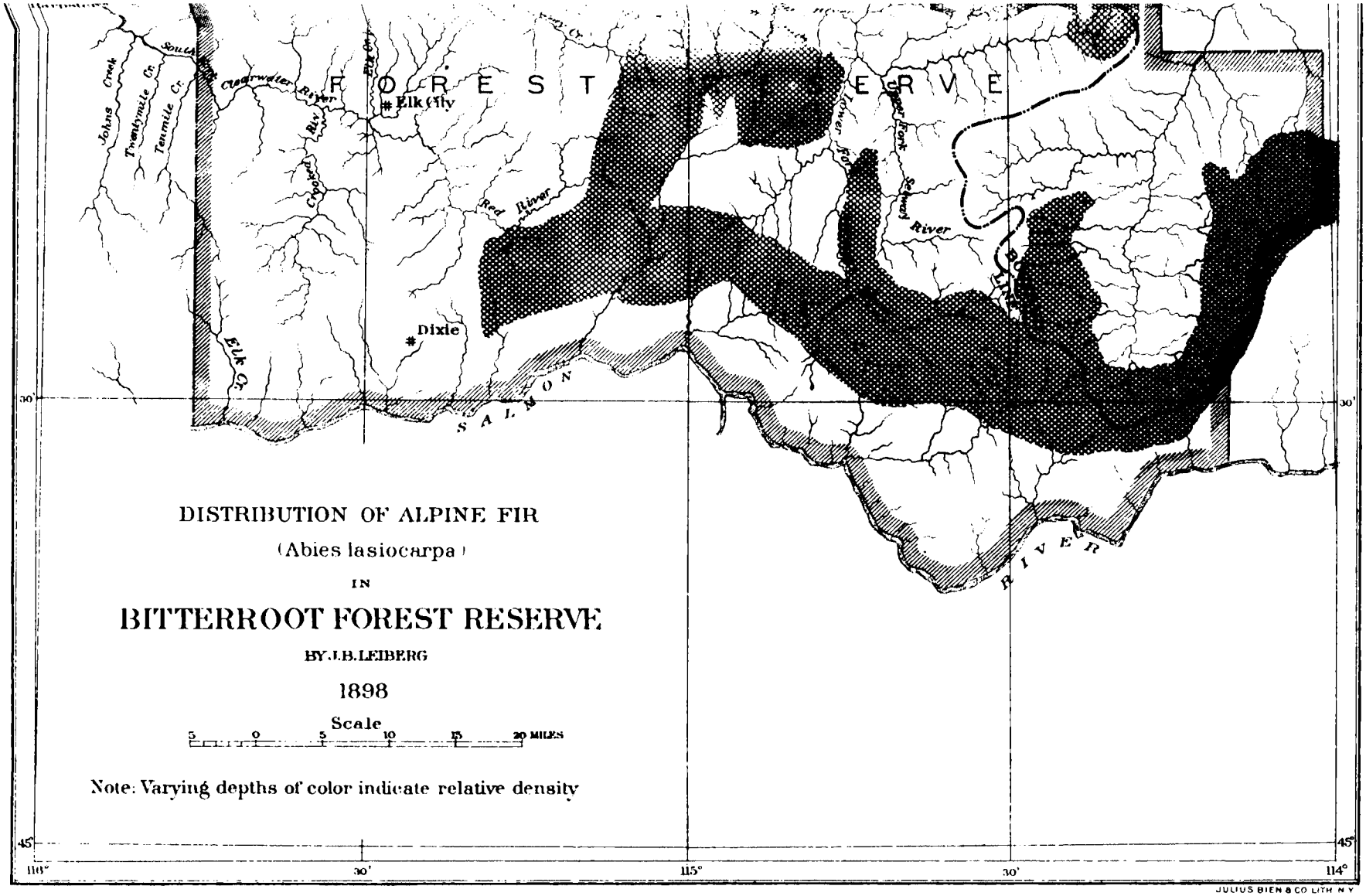
ABIES LASIOCARPA (Hook.) Nutt. (Alpine fir).

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 per-

fect 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 junc-

tion 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.

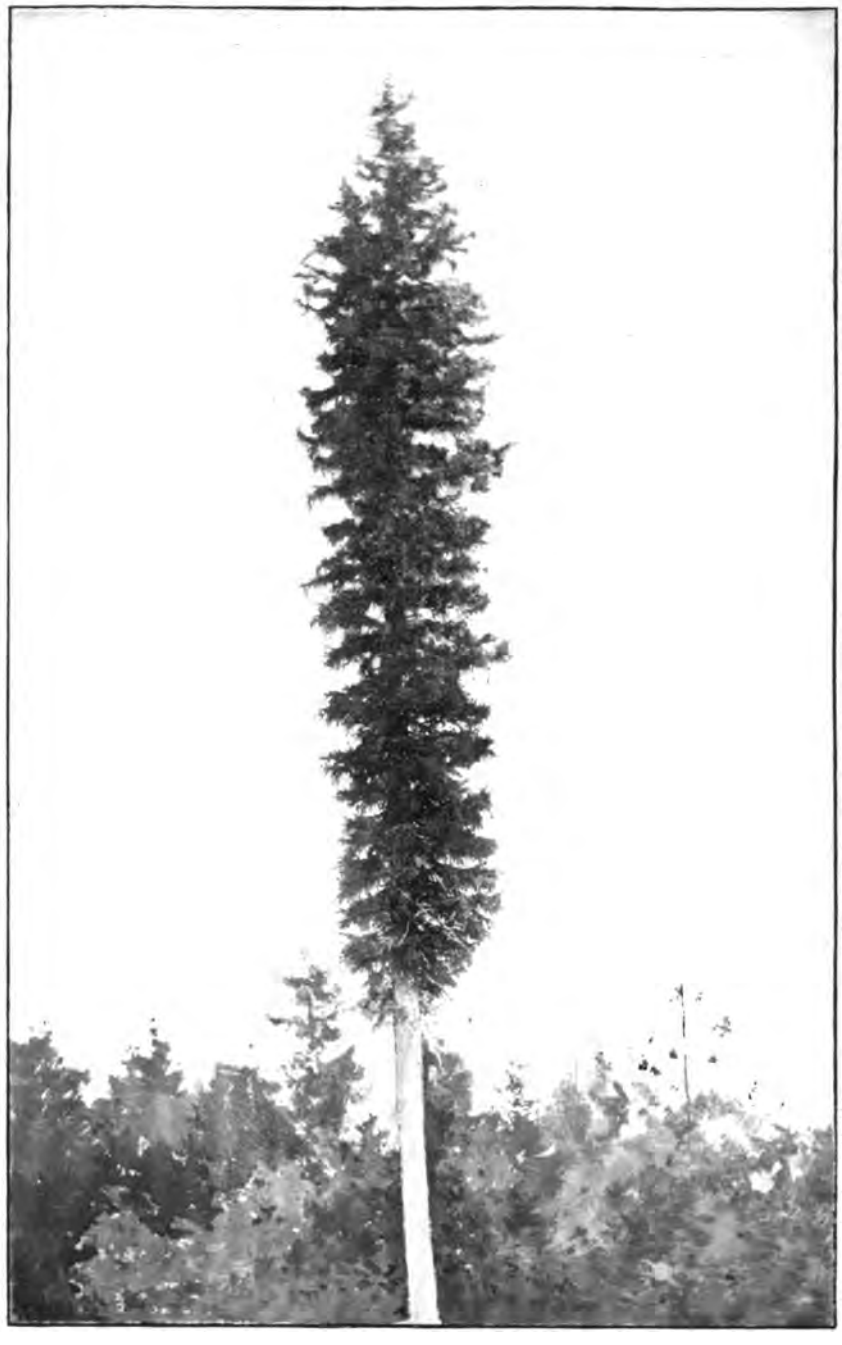
In the reserve the tree occurs as an old growth and as a second growth after forest fires. The old growth is mostly confined to the ridges and slopes in the basin of the South Fork of Clearwater and the Salmon River divide, but veteran individuals also occur mixed with the lodgepole-pine growth in the 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.

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).

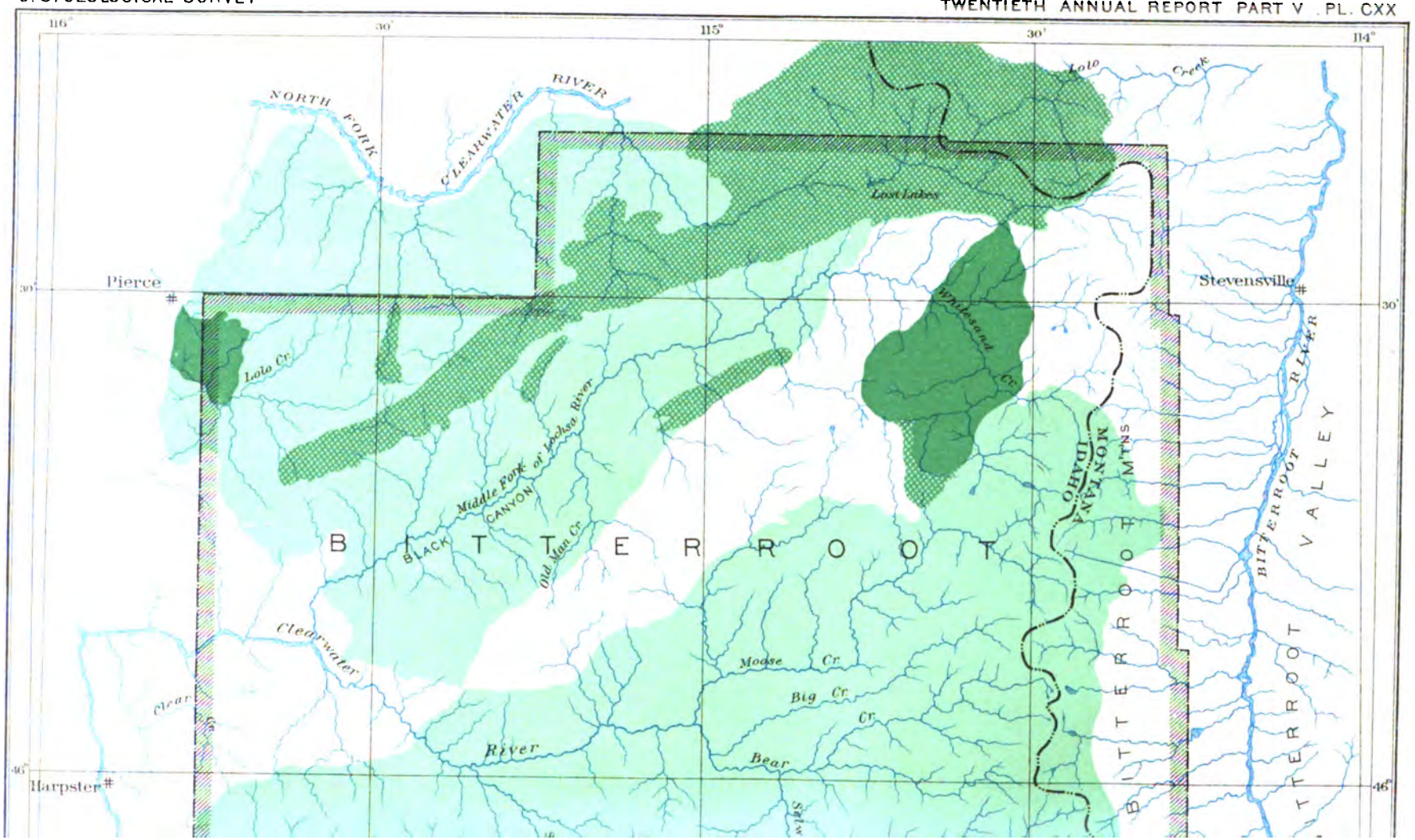
The Engelmann spruce, the only one of the genus within the reserve, is here of wide distribution (Pl. CXX). It occurs everywhere at all elevations, with the exception of certain tracts along the crest of the main Bitterroot Range, where essentially alpine conditions prevail. The species thrives best, however, between elevations of 4,000

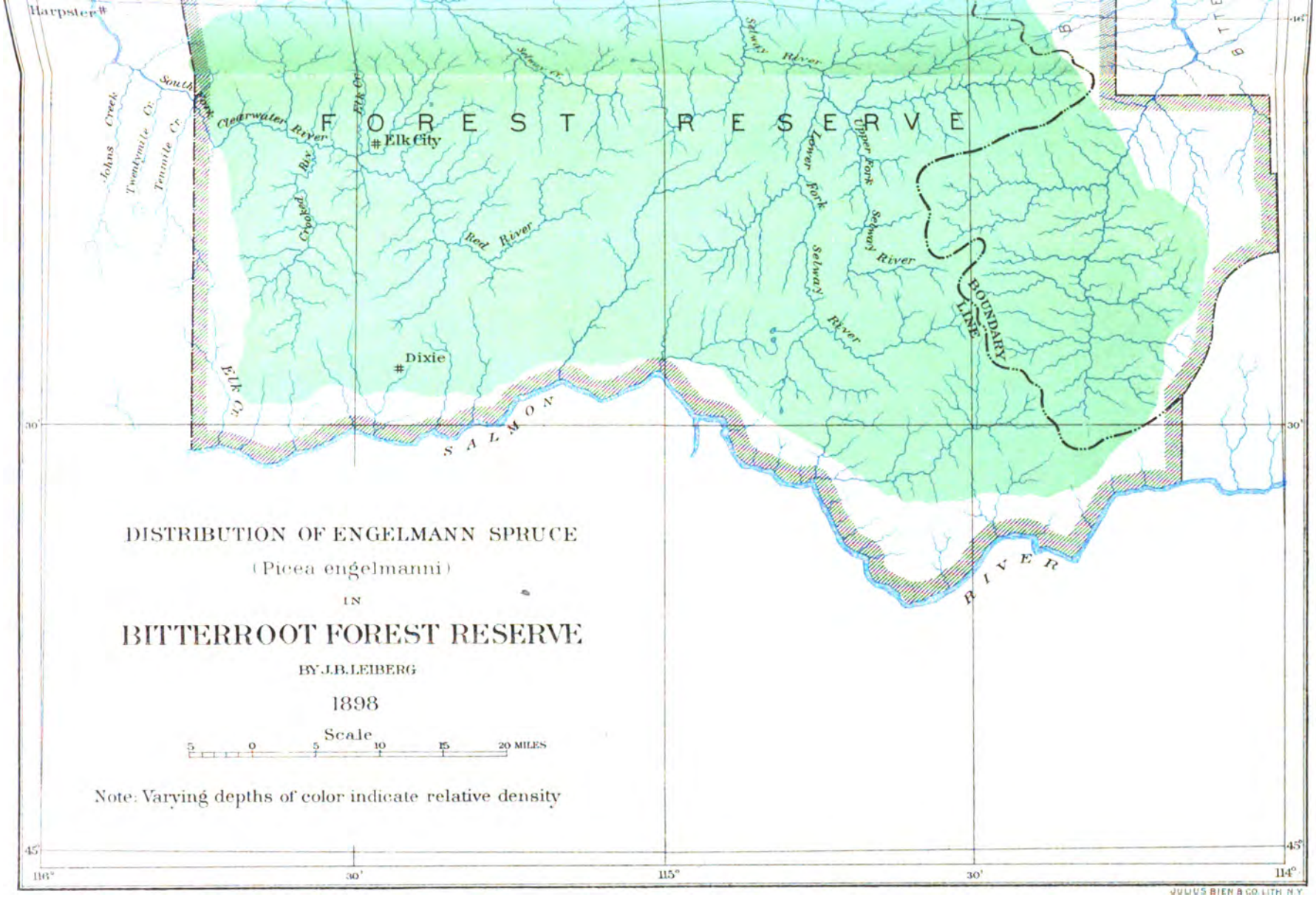
and 7,000 feet, on slopes and in valleys where the required humidity is present.

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,





DISTRIBUTION OF ENGELMANN SPRUCE

(Picea engelmanni)

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.

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.

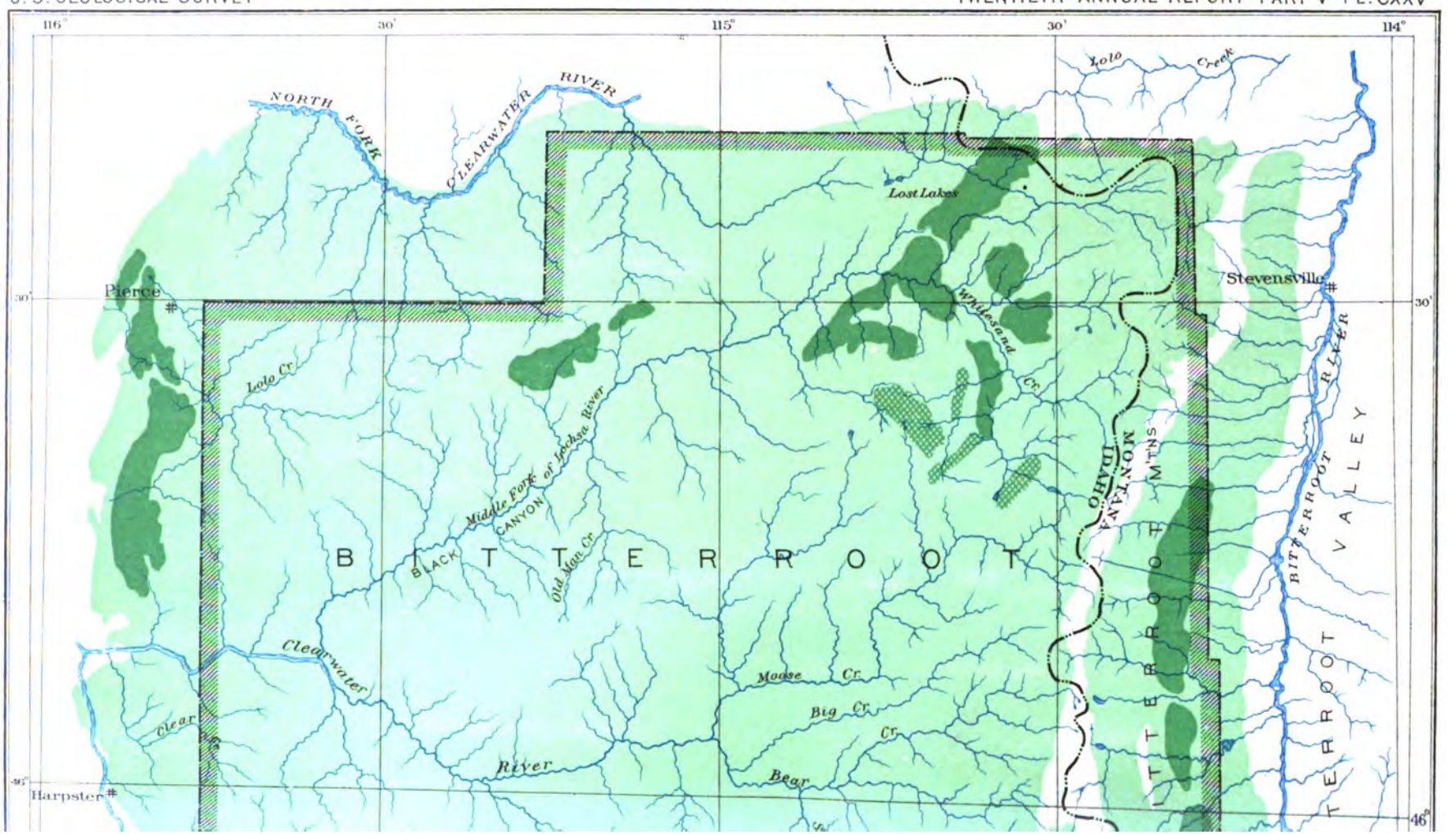
The lodgepole pine is not strictly a merchantable-timber tree. It is sawn in small quantities at Elk City and at Dixie in the reserve, chiefly because nothing better is to be had. The lumber obtained is of very poor quality. Owing to the rapid decay of the wood when placed in close contact with damp 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.

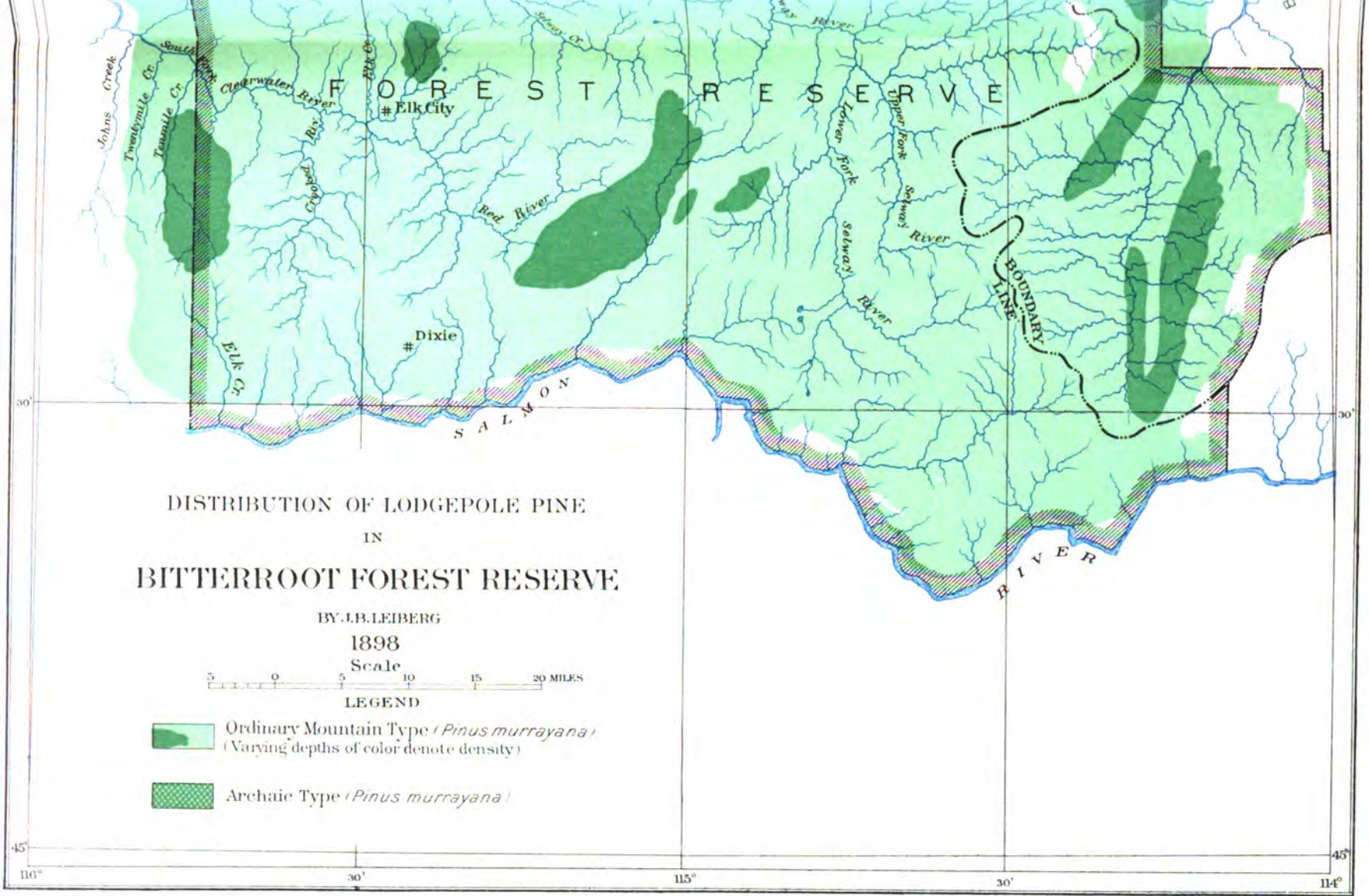
The species forms about 43.2 per cent of the forest growth of the reserve and occurs approximately on 2,400 square miles of its area, a large proportion, estimated at 15 per cent, being a mere sapling growth. The stand of the archaic type, inclusive of trees from 8 to 14 inches basal diameters, is 38 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

Scale

5 0 5 10 15 20 MILES

LEGEND

Ordinary Mountain Type (*Pinus murrayana*)
(Varying depths of color denote density)

Archaic Type (*Pinus murrayana*)

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

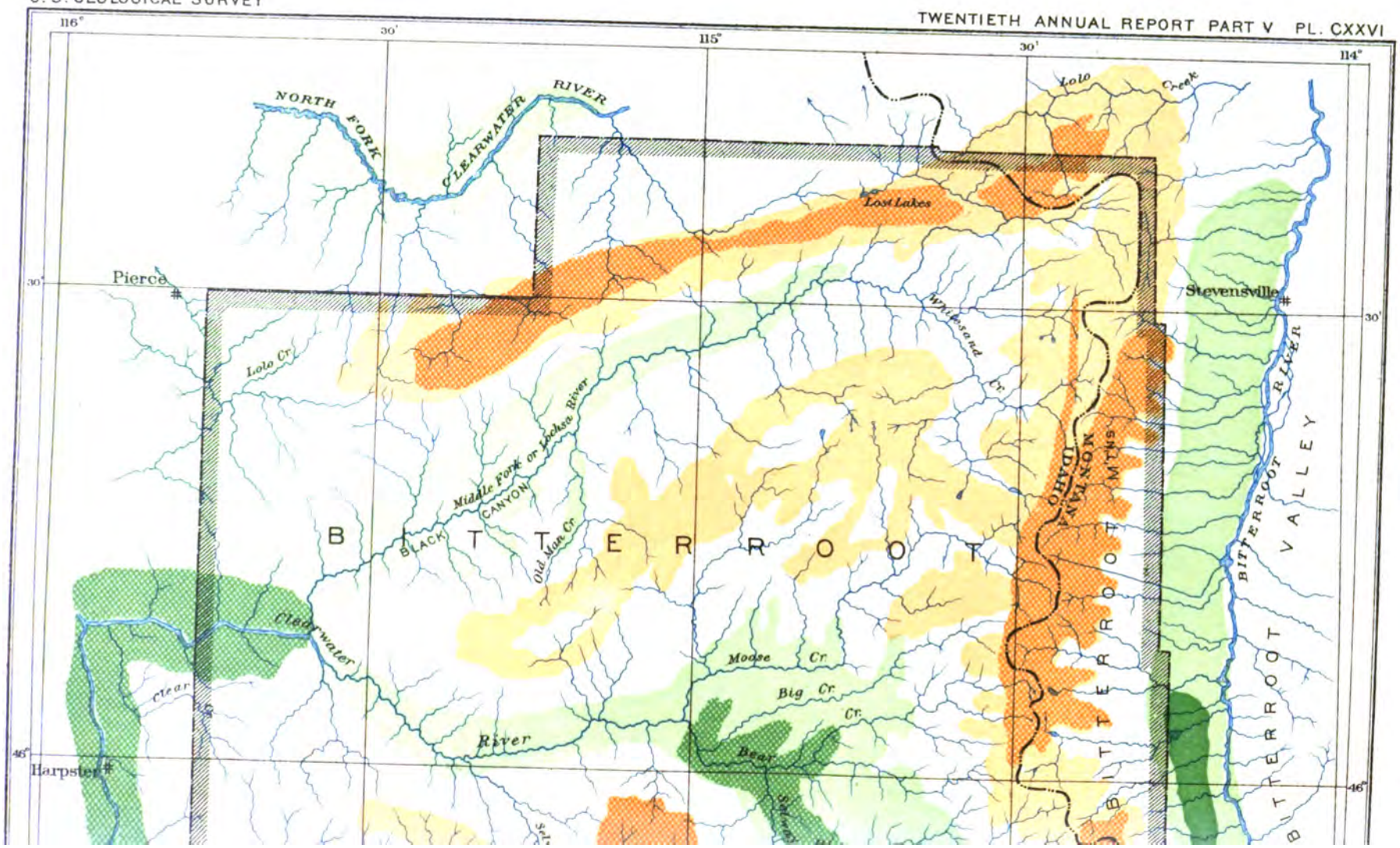
that nowhere, even in the heaviest stands, is there the quantity of merchantable timber per acre that is possible under a scientific method of forest management, and the same remark applies to all the other species of trees and types of forest growth in the reserve, without any exception.

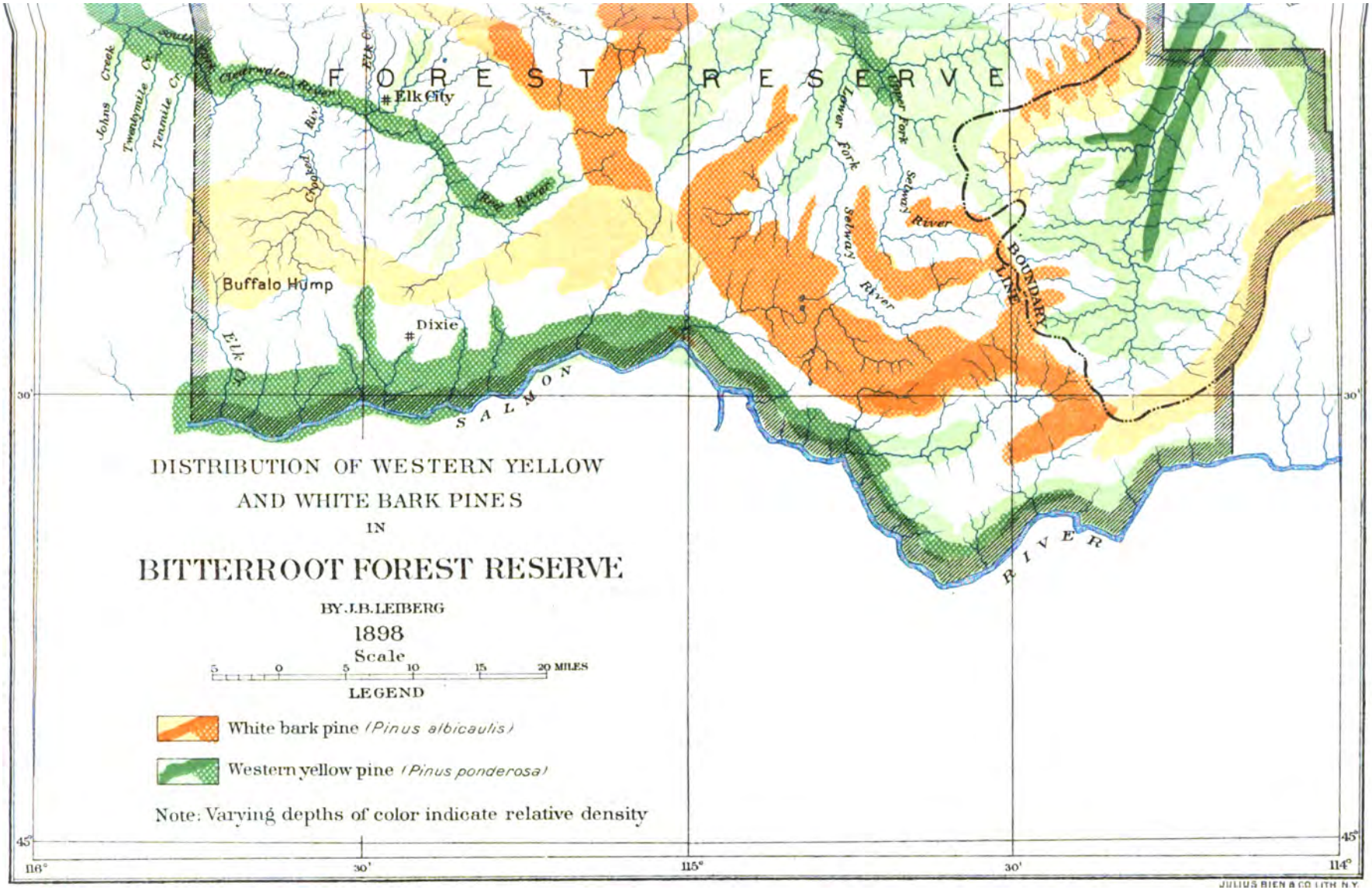
The yellow pine possesses excellent fire-resisting qualities; far above that of any of the other species of conifers in the reserve. This is due to its habitat on dry hillsides, where but little litter accumulates, and to the protection afforded by the thick bark, which does not burn very readily while 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.





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).

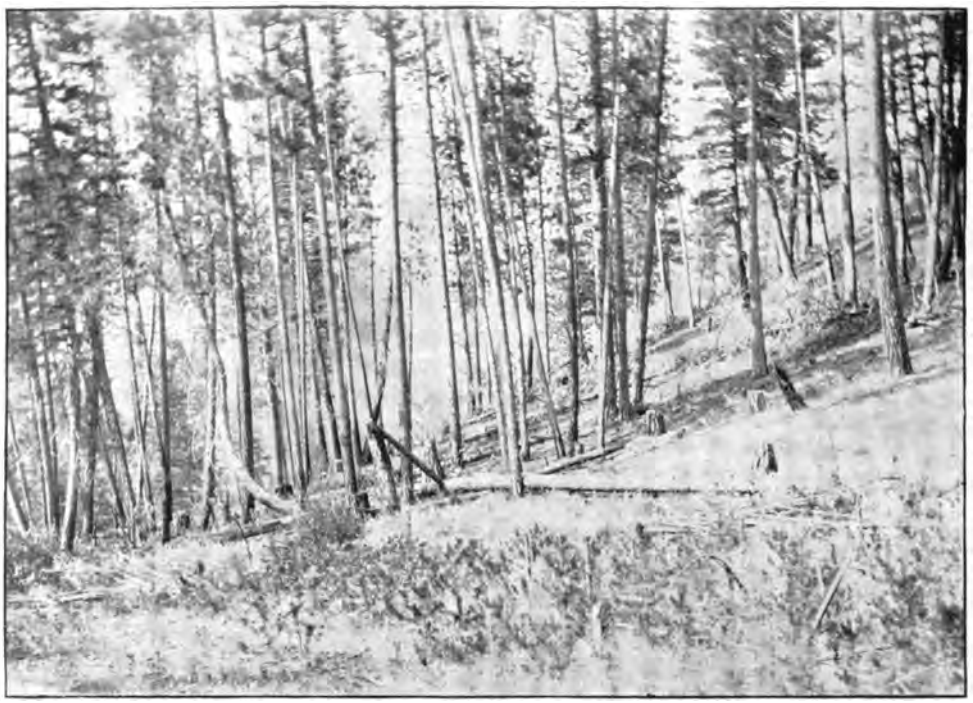
The red fir is found in great abundance throughout the reserve below the subalpine areas (Pl. CXXXI). Its altitudinal range extends to elevations of 5,800 feet in the districts north of Nez Perces Pass, and to elevations of 6,500 to 7,000 feet in the Selway Basin and on the Salmon River slopes. It is 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.

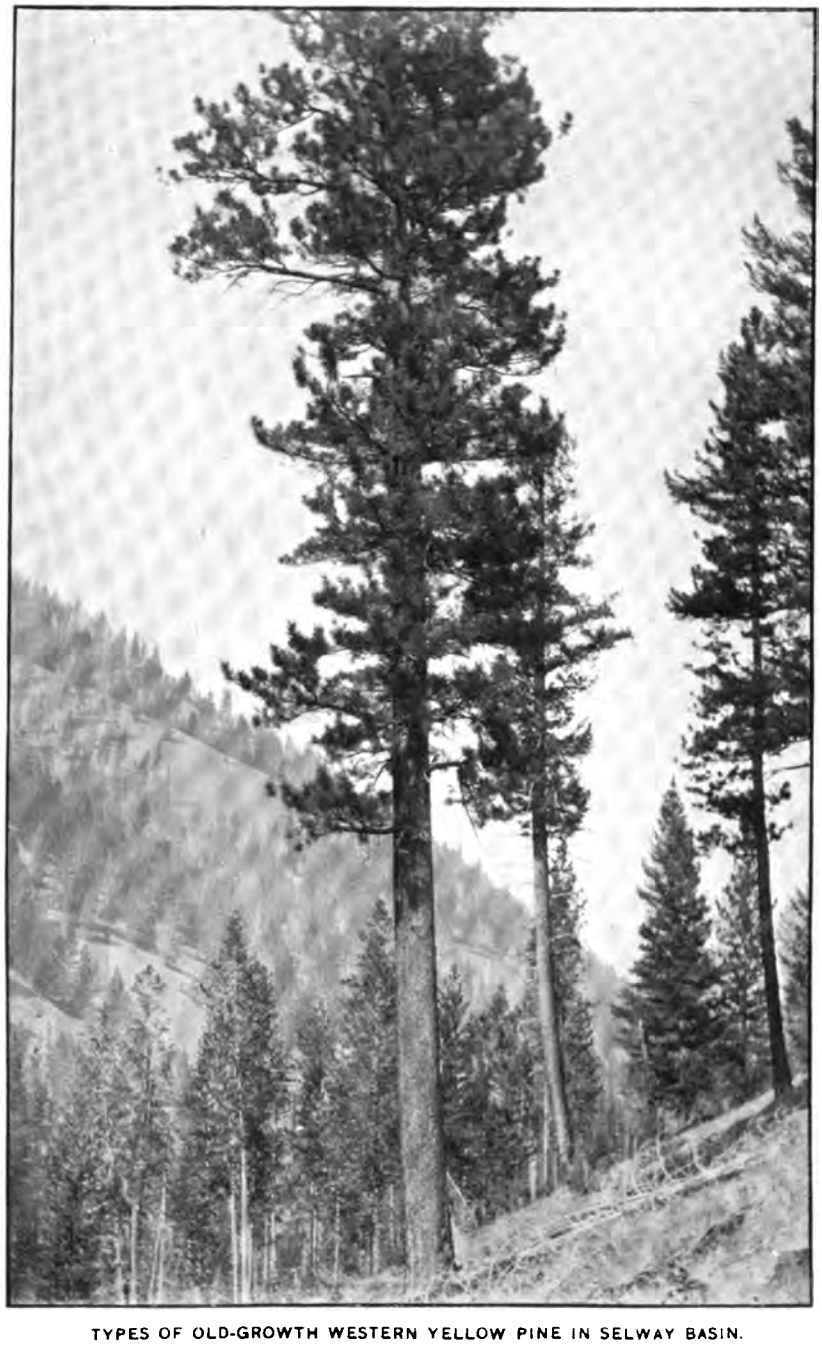
The character of its growth on the different areas varies considerably. In the Lolo and the Lochsa basins it is generally undersized; the trunks taper too rapidly, a common defect in the species as it grows in the Bitterroot Mountains, and the living branches of the crown begin near the ground, leaving 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 the 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.

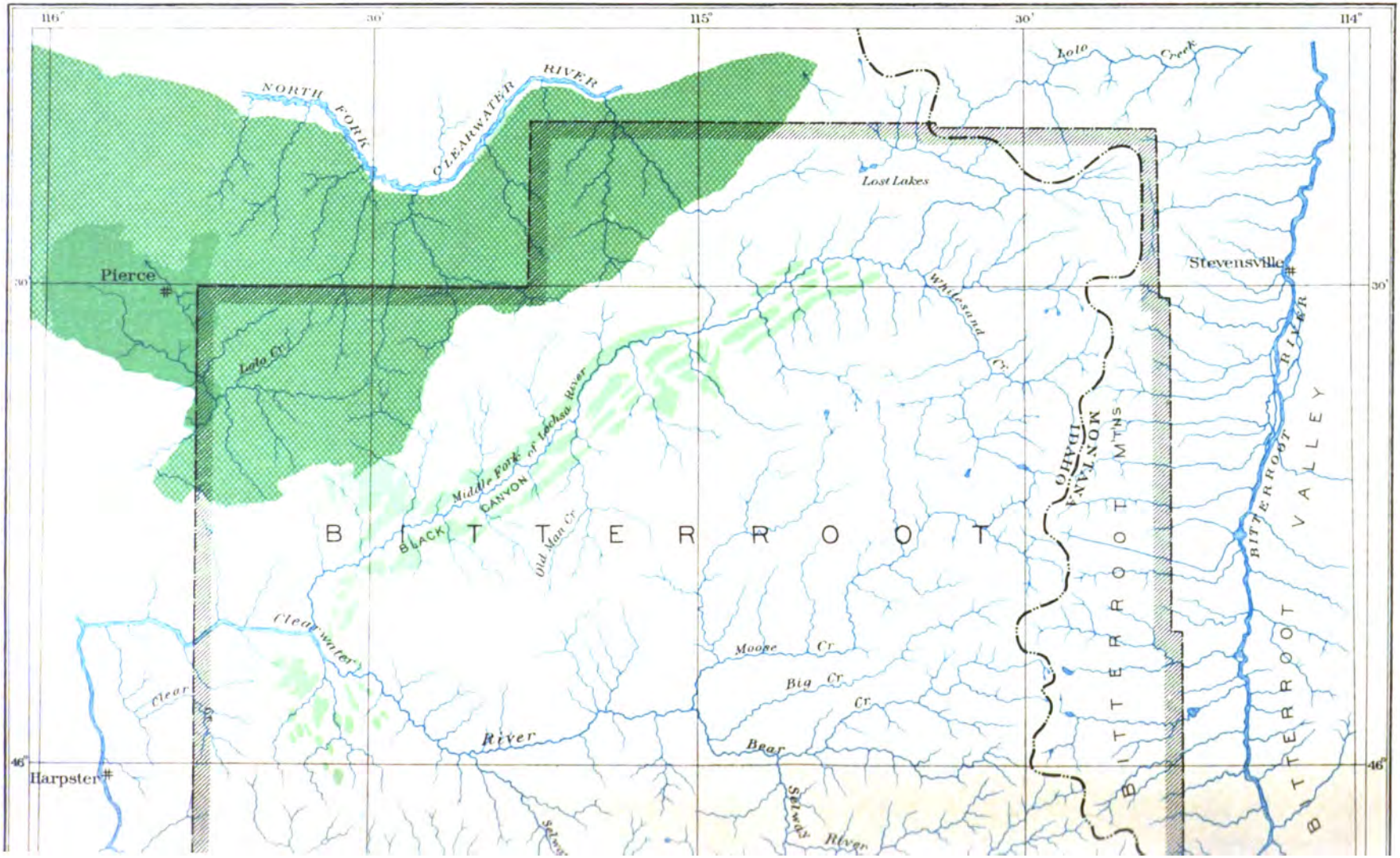
The alpine hemlock in the reserve occurs chiefly as an old growth; the second growth is small in quantity and the young growth is still less. The old growth is overmature, 30 per cent of it being rotten at the core; the second growth is in good condition; the young growth is bushy and thin, without any 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).

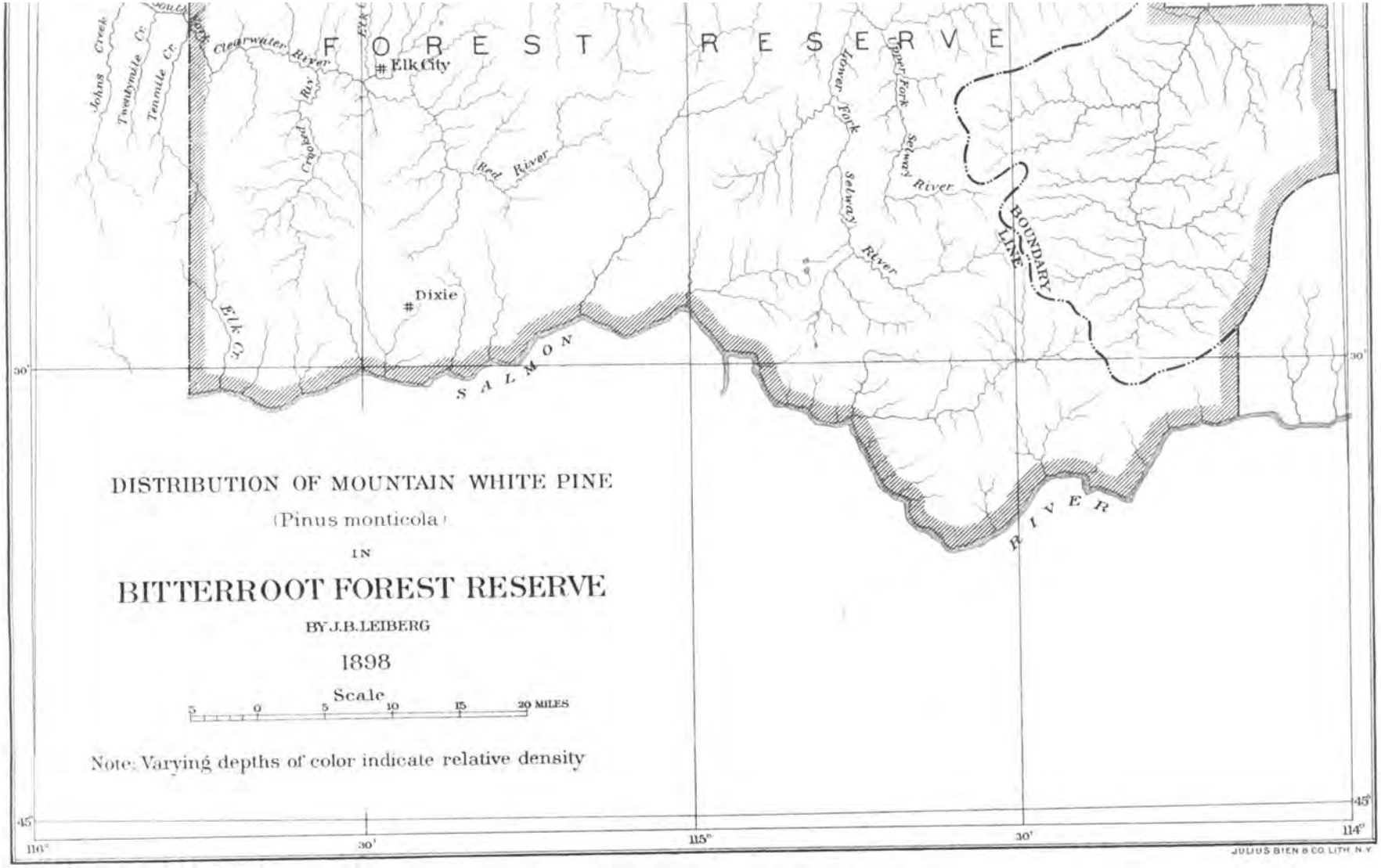
In this region the species has not been sawn, therefore nothing is known regarding the quality of its wood and the lumber therefrom. In appearance the wood is fine grained and of greater density than that of the other nonresinous conifers in the reserve. It is not unlikely that the species would prove 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.

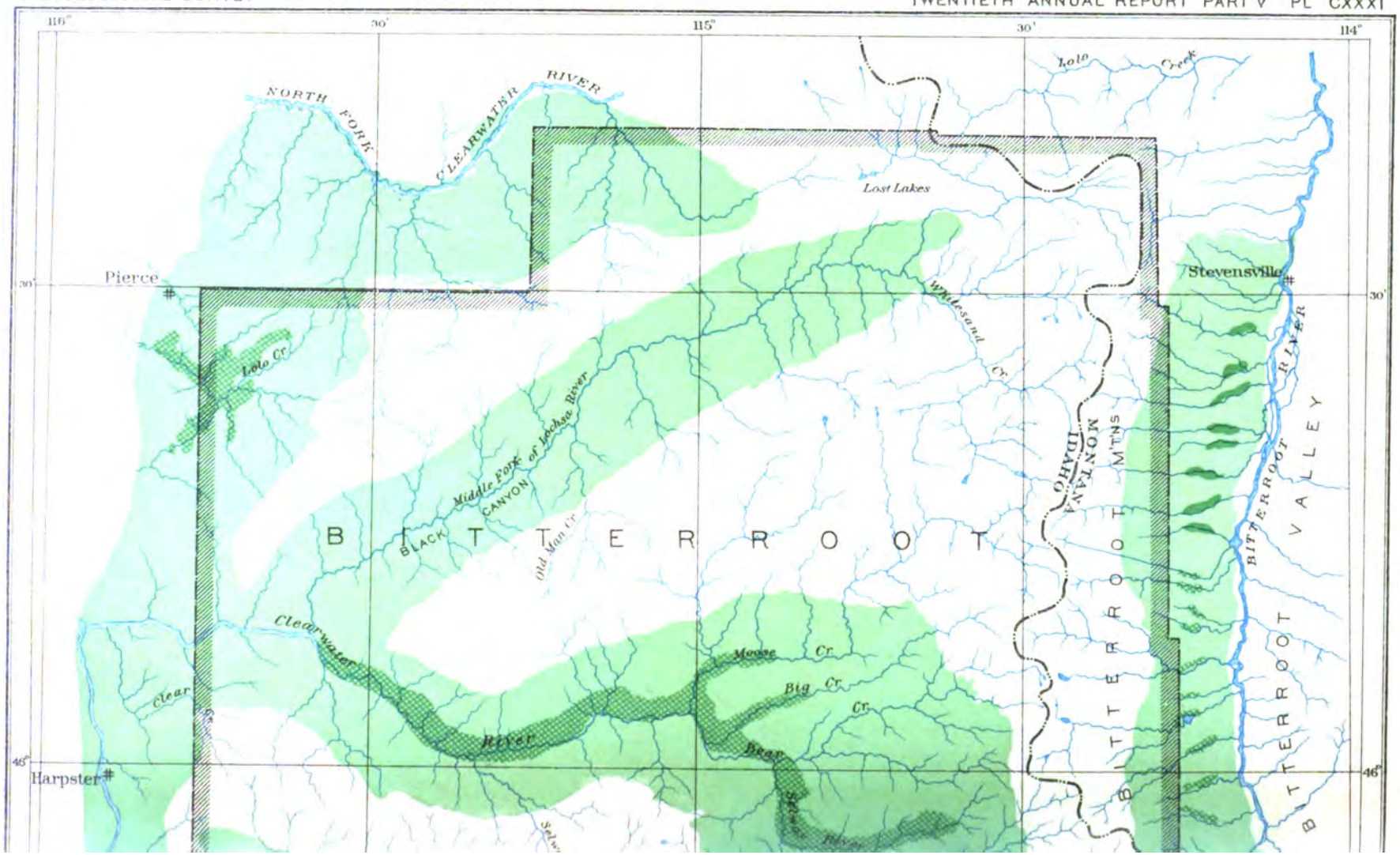
Much the larger percentage of forest as it now exists on the reserve owes its composition and aspect to the determining influences of widespread forest fires during the past 200 years, and for this reason the age limit affords by far the most convenient method of arranging the various stands in a general 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.

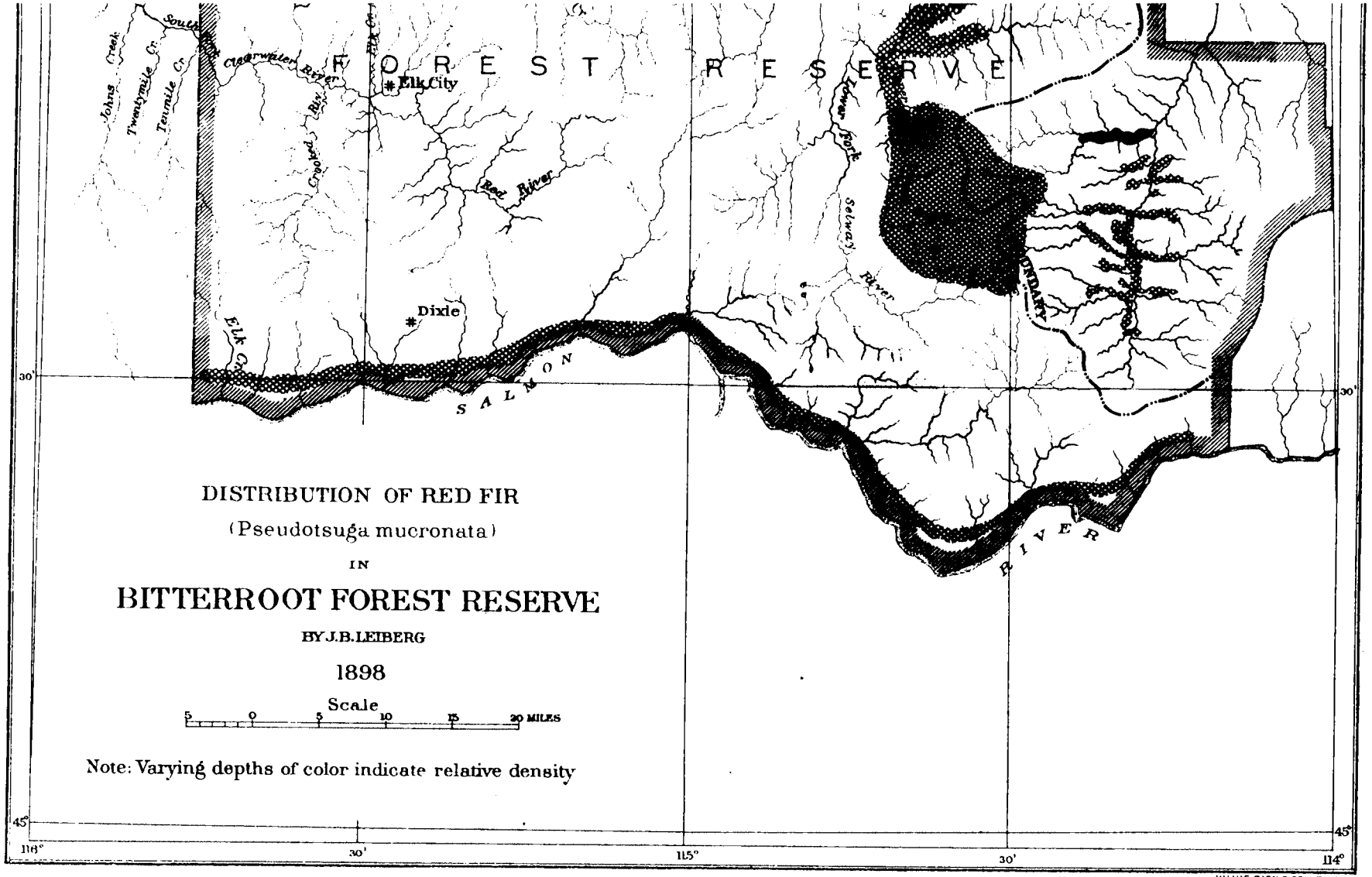
Old growths occur as scattered stands in many places in the reserve. Collectively they occupy a lesser area than any of the others. Most of the species of conifers in the reserve are represented in them, and

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.

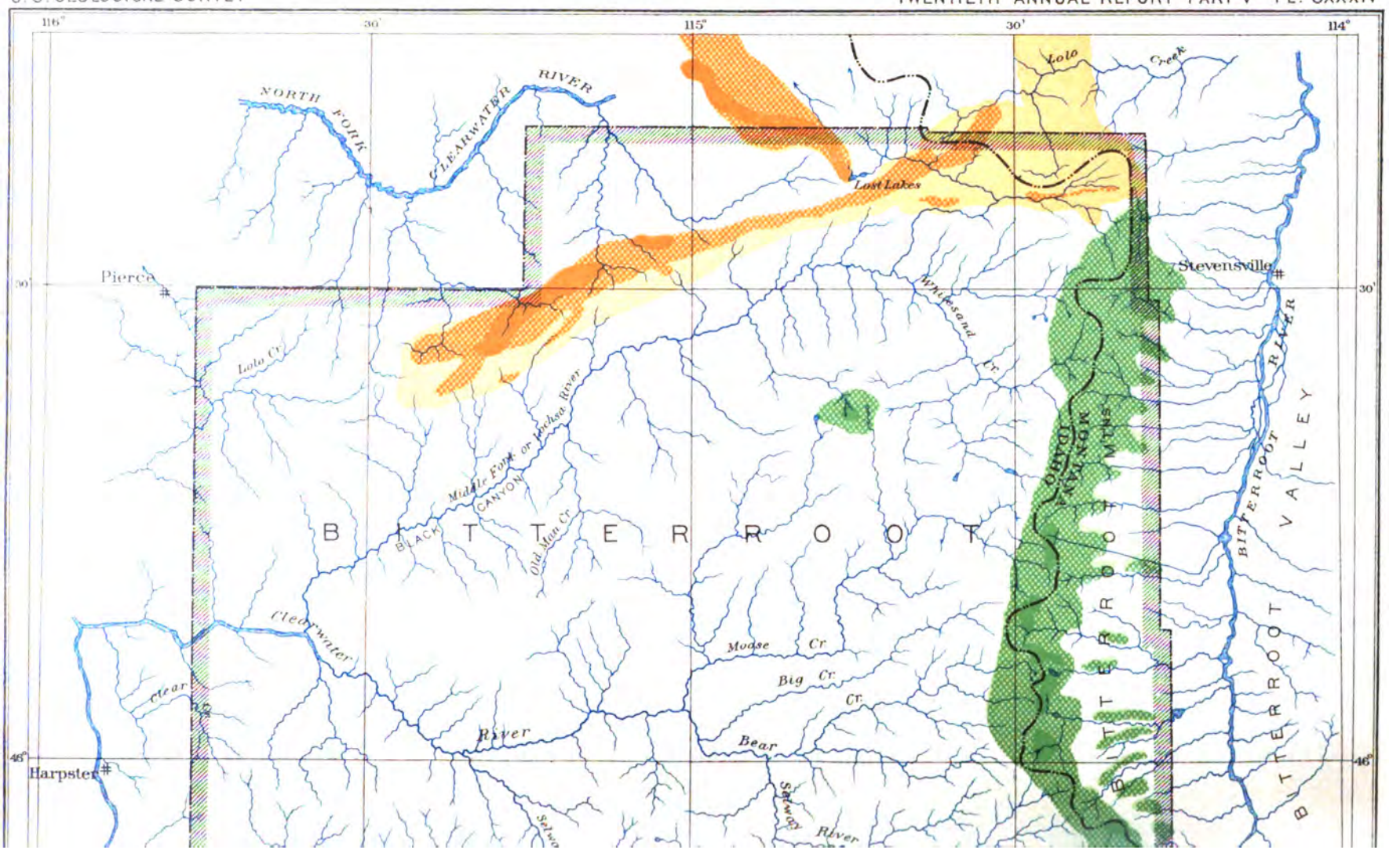
The ratios in which the various species occur that compose the mixed forests of the second growths in any particular locality are subject to infinite variations when small tracts are in question, but there is generally a sort of balance throughout the areas of an entire district, depending on the average altitude, age of the burns, and the humidity conditions that prevail. In the Upper Selway Basin, where

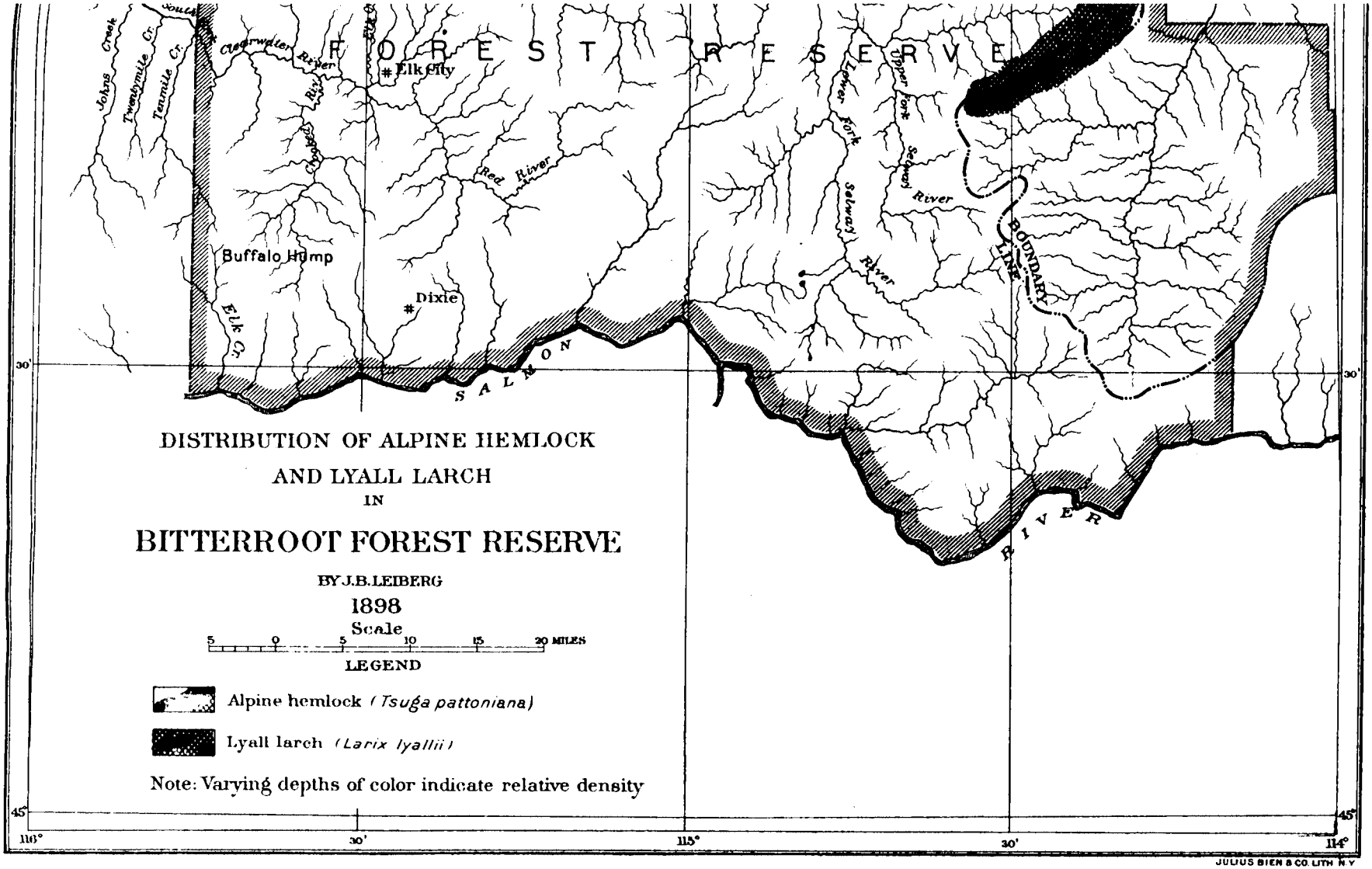
the precipitation is evidently less than on tracts farther westward, many of the second-growth stands ars composed of red fir to the extent of 70 per cent. In other parts of the basin, where humidity conditions are different, red and great silver firs occur in equal proportions. In the Lolo Basin, on 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.

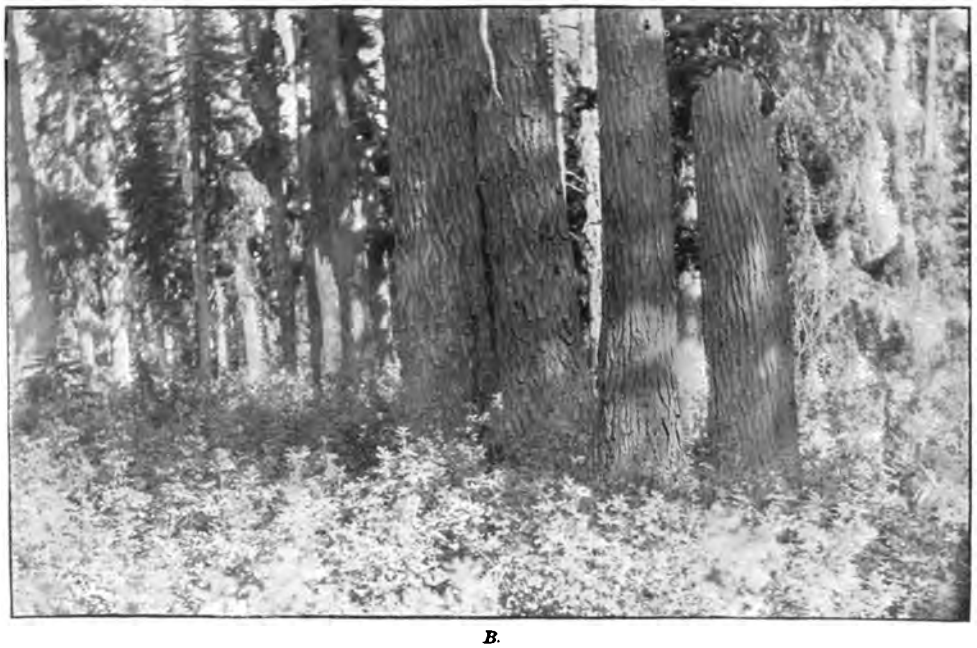
In the northern portions of the State these zones are definable in their altitudinal relations with a considerable degree of exactness. They also are fairly well differentiated in the areas adjacent to the main range of the Bitterroots north of Nez Perces Pass, but elsewhere in the reserve their elevational 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

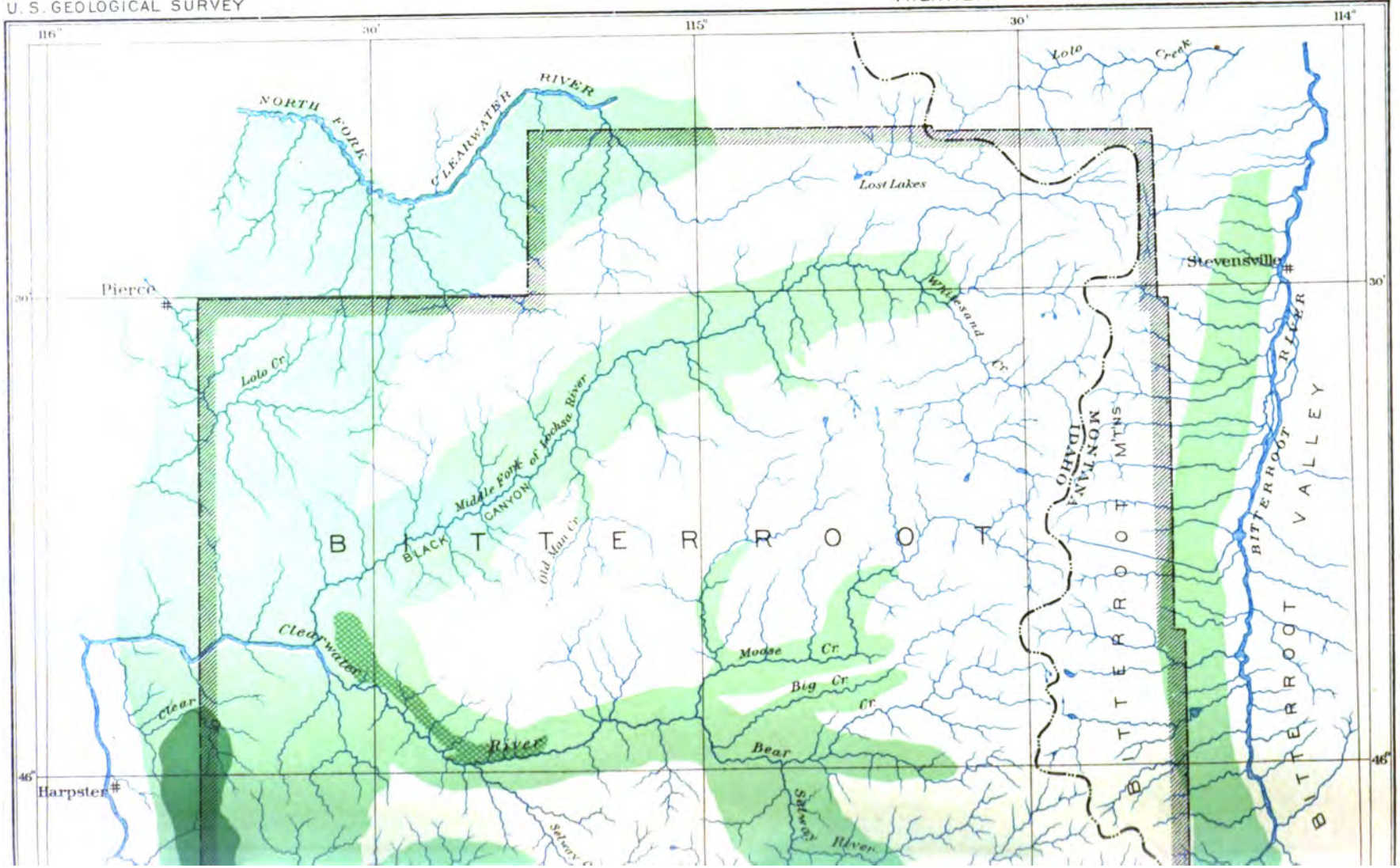
on northern and western declivities. Sometimes it attains elevations of 7,000 feet, as on the rocky slopes of Grave Mountains, but this is merely due to local temperature conditions. A large percentage of the most valuable timber in the reserve occurs in this zone, and the areas covered by it are usually 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:

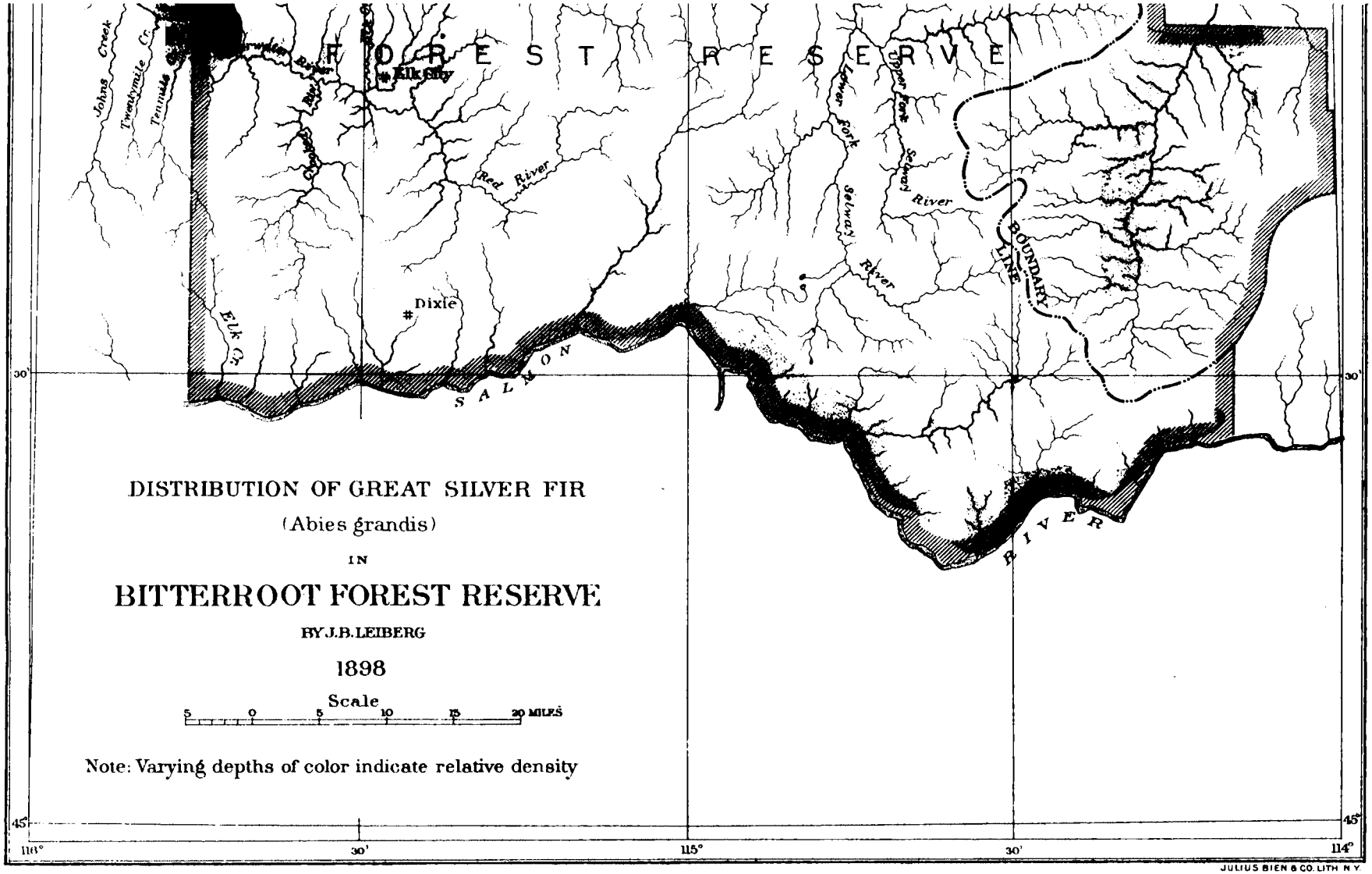
Pinus ponderosa	Western yellow pine.
Abies grandis	Great silver fir.
Pseudotsuga mucronata	Red fir.
Pinus murrayana	Lodgepole pine.
Betula occidentalis	Western birch.
Betula papyrifera	Paper birch.
Populus trichocarpa Populus balsamifera	Cottonwood.
Populus tremuloides	Aspen.

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.
Lyall tamarack.
Alpine hemlock.
Pacific arbor vitæ.
Mountain white pine.

There is the clearest evidence that the western tamarack, mountain white pine, and Pacific arbor vitæ extended south of their present





DISTRIBUTION OF GREAT SILVER FIR

(Abies grandis)

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.

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.

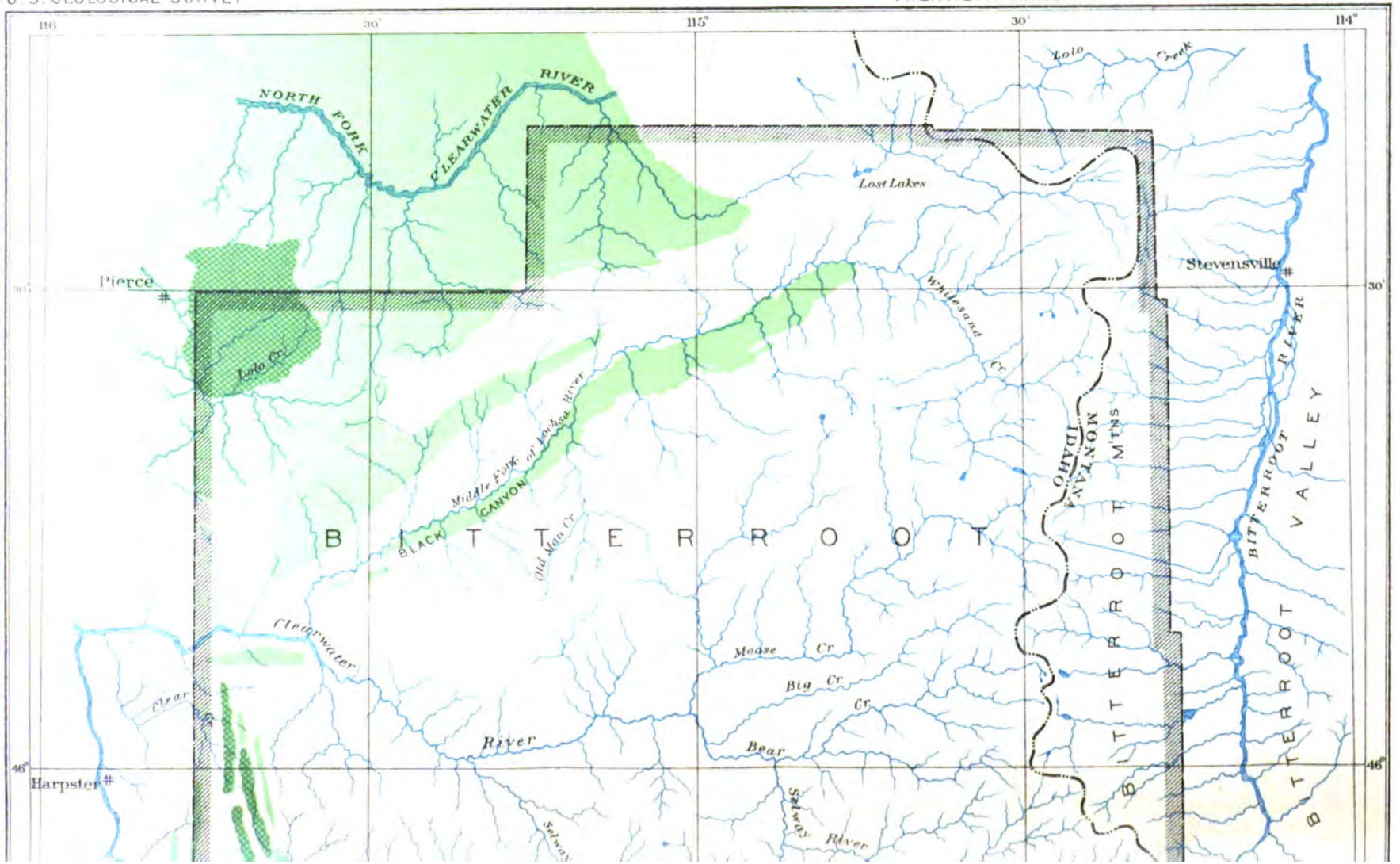
IV. South Fork of Clearwater Basin.

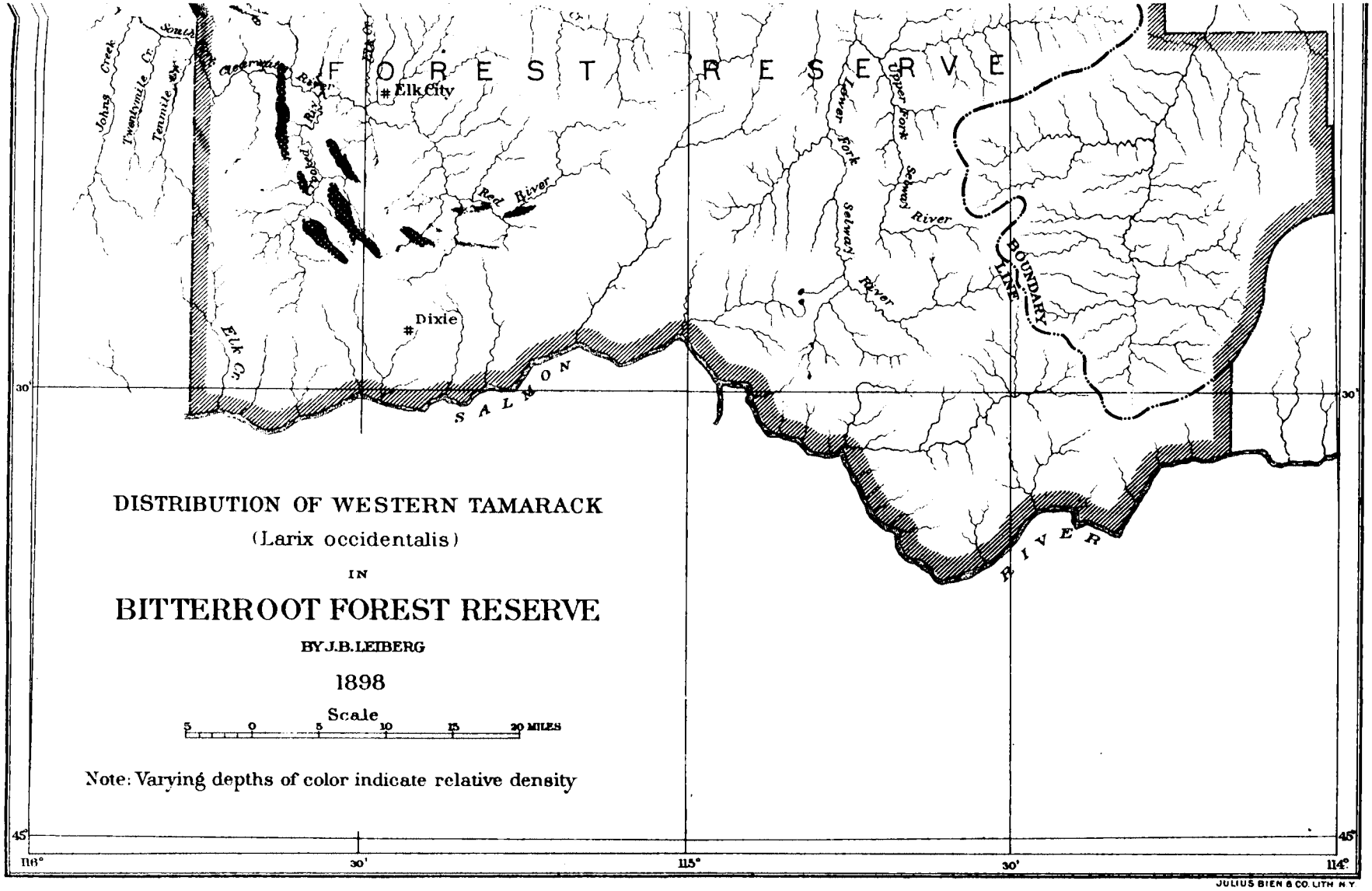
V. Salmon River slopes.

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.

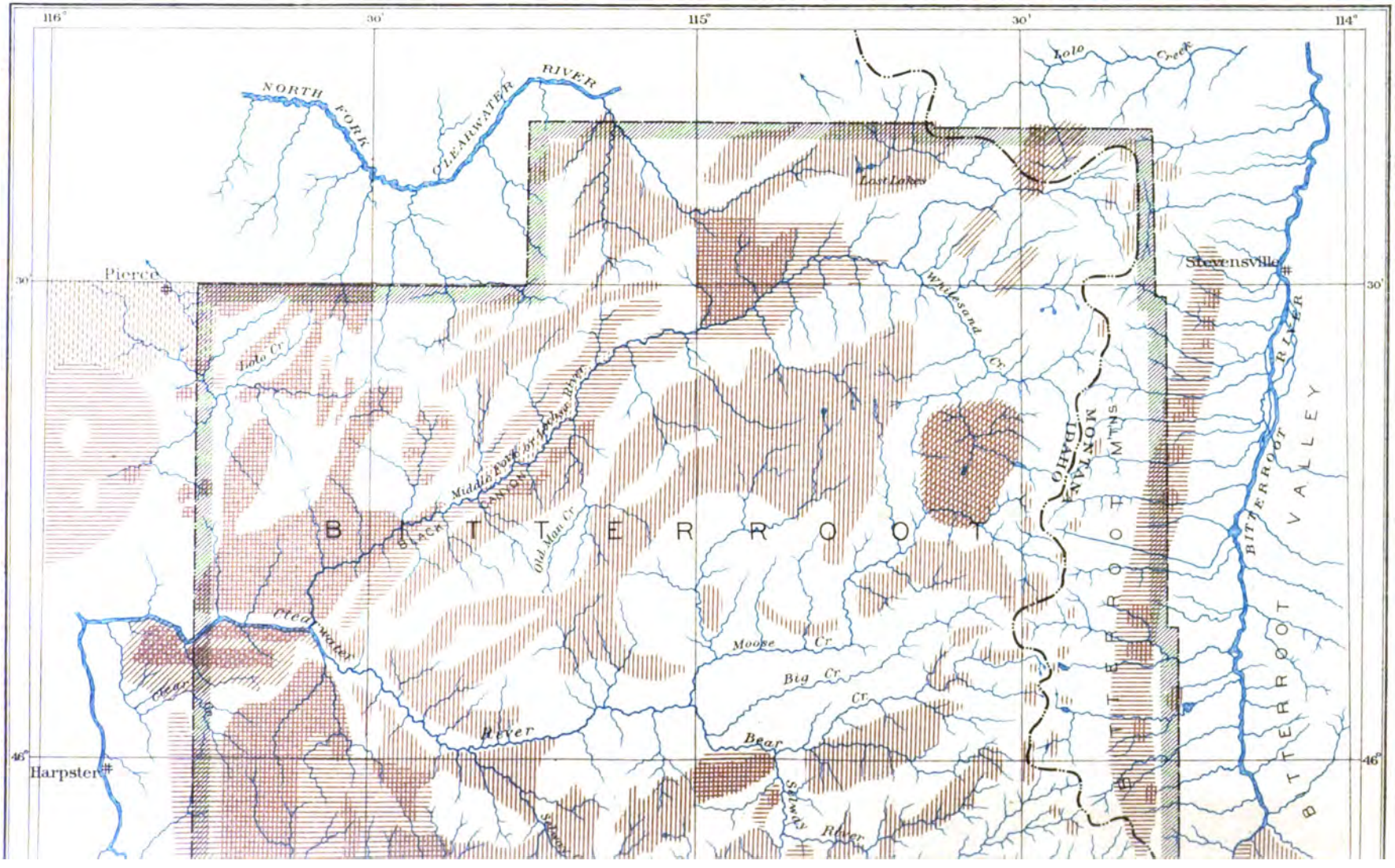
The alpine-fir type of forest is chiefly represented by the white-bark pine and the lodgepole pine. West of the Little Salmon Valley the lodgepole pine is the more common; to the east the white-bark pine predominates. The alpine fir and Engelmann spruce are not plentiful, except in the valleys of the larger tributary canyons. None of the trees of the alpine-fir type grow to commercial size in this district.

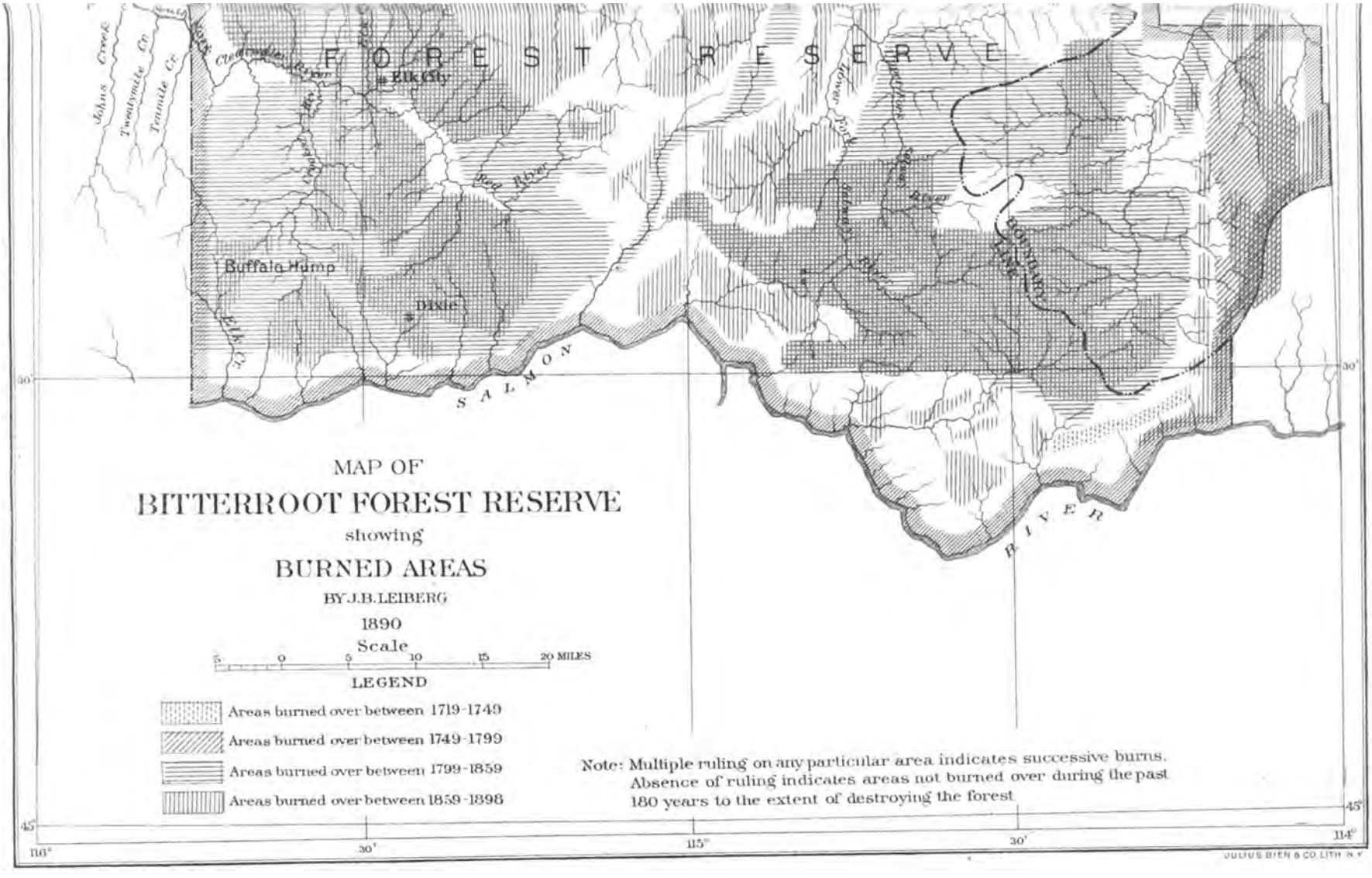
The mountain white-pine type of forest is represented by the western tamarack. It occurs on the main Salmon divide, around the head of Crooked River, and extends thence eastward a distance of 10 or 12 miles. The acreage occupied by the western tama ack in the district is insignificant.

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

JULIUS BIEN & CO. LITH. N.Y.

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:

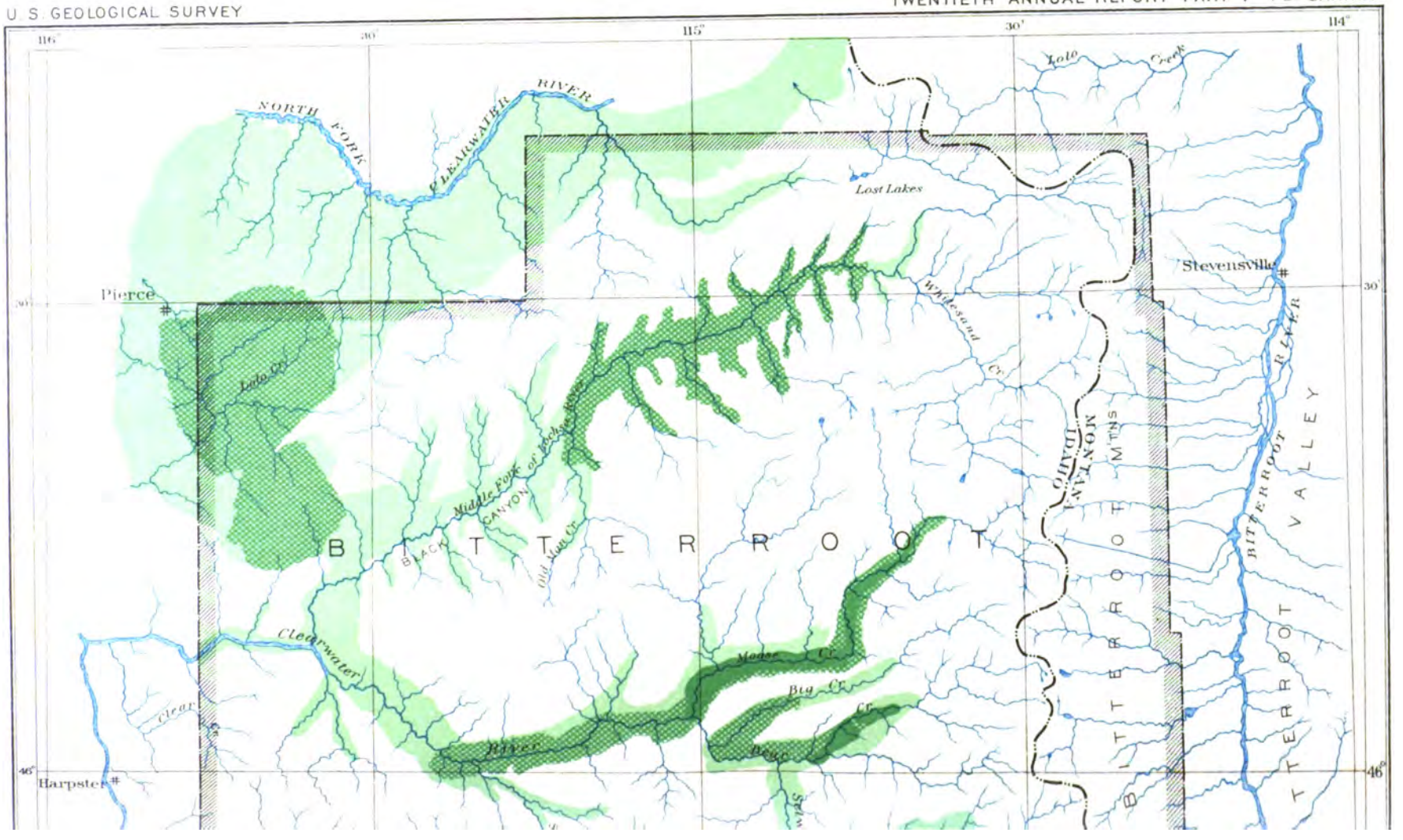
	Acres.
Burned second growths and old growths, proportion not ascertainable...	1,250,000
Burned young growths	150,000
Total	1,400,000

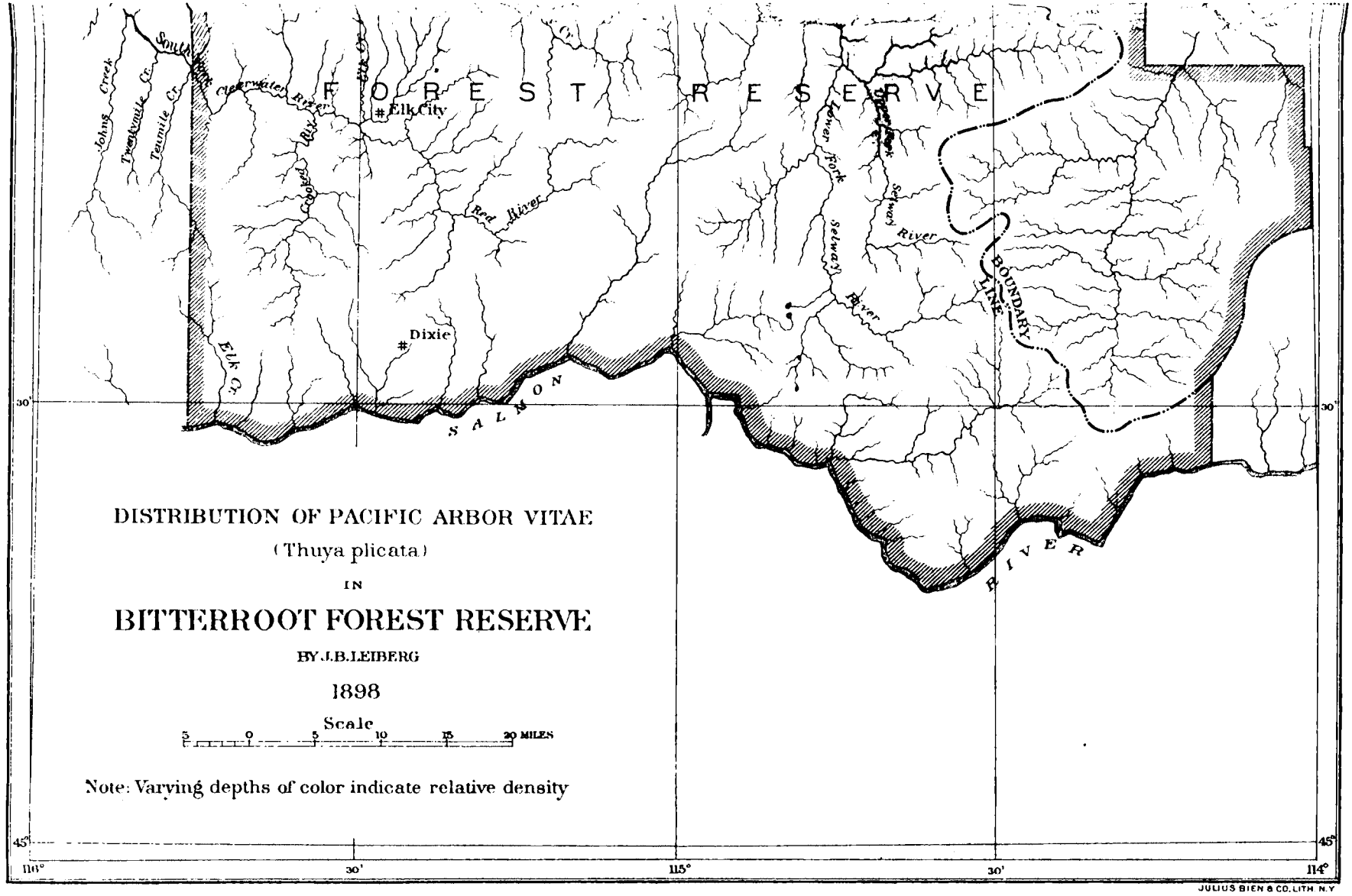
If an average is struck, based upon the number of years included in above estimates, it will be found that during the Indian occupancy there were fire losses of 11,350 acres per annum, while during the time that the white man has been in possession 35,000 acres per annum have been destroyed, or a yearly 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

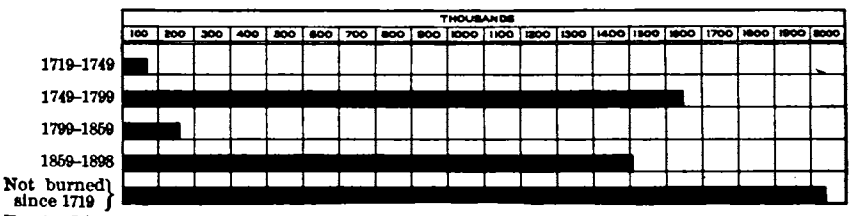


FIG. 2.—Diagram showing areas burned, in acres, in Bitterroot Forest Reserve within different periods.

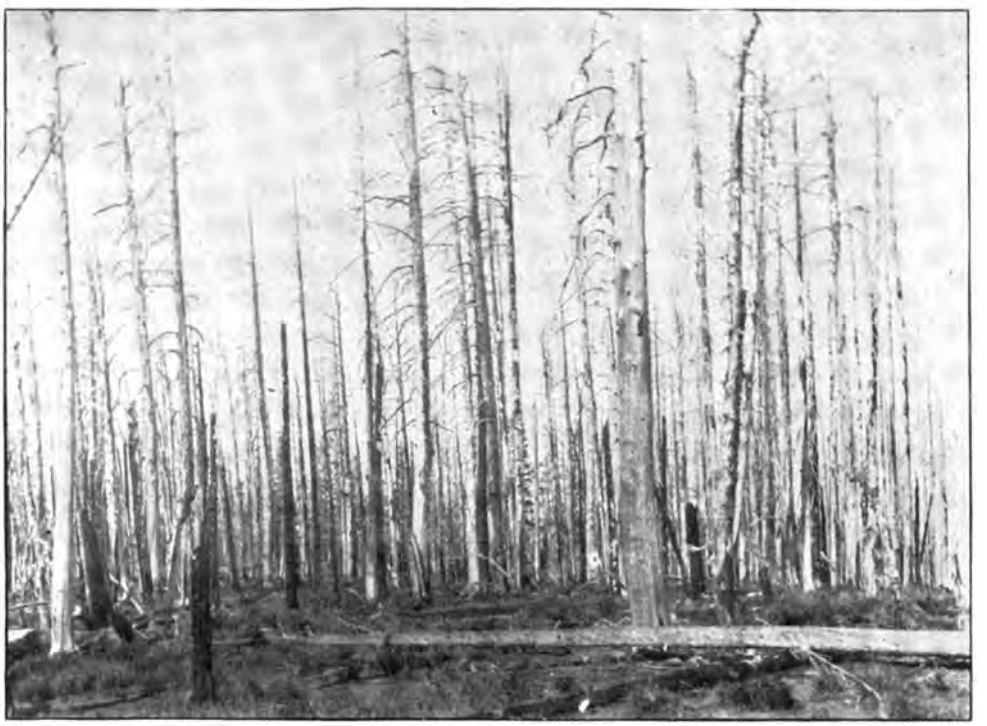
springing up there, which constitute a favorite browse for them. Large tracts of forest doubtless were burned with intent of thus causing the game to congregate in considerable numbers in some particular localities.

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.

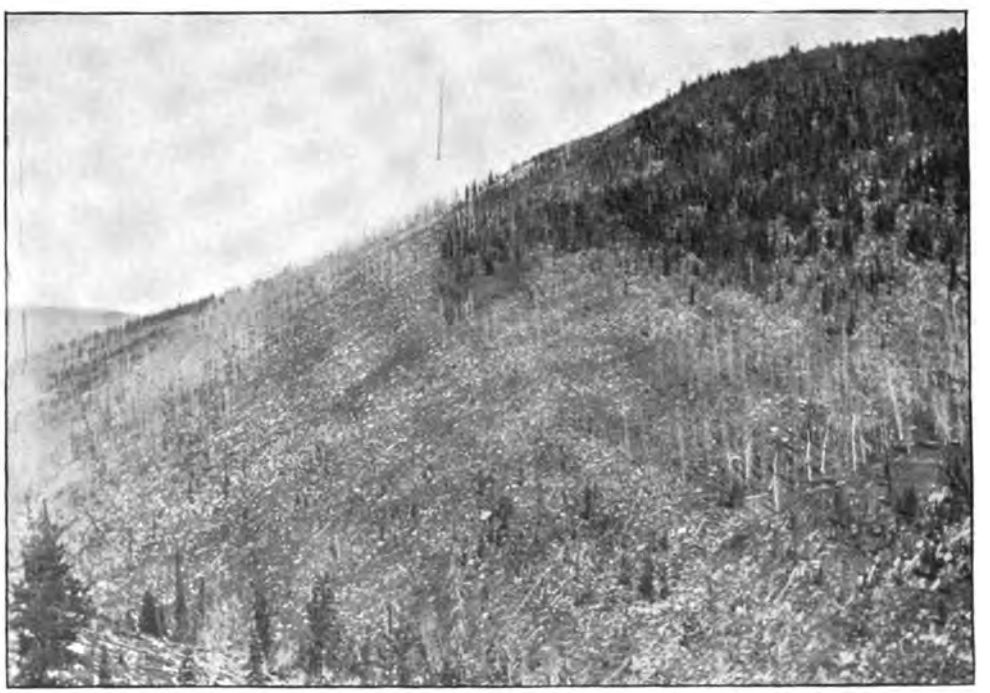
That the responsibility for fires of modern date lies mostly with the prospectors admits of no doubt. To this class belong the greater number of travelers in the Clearwater basins; hunters and trappers are in the minority, and as regards trappers, they pursue their vocation only during the seasons when 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).

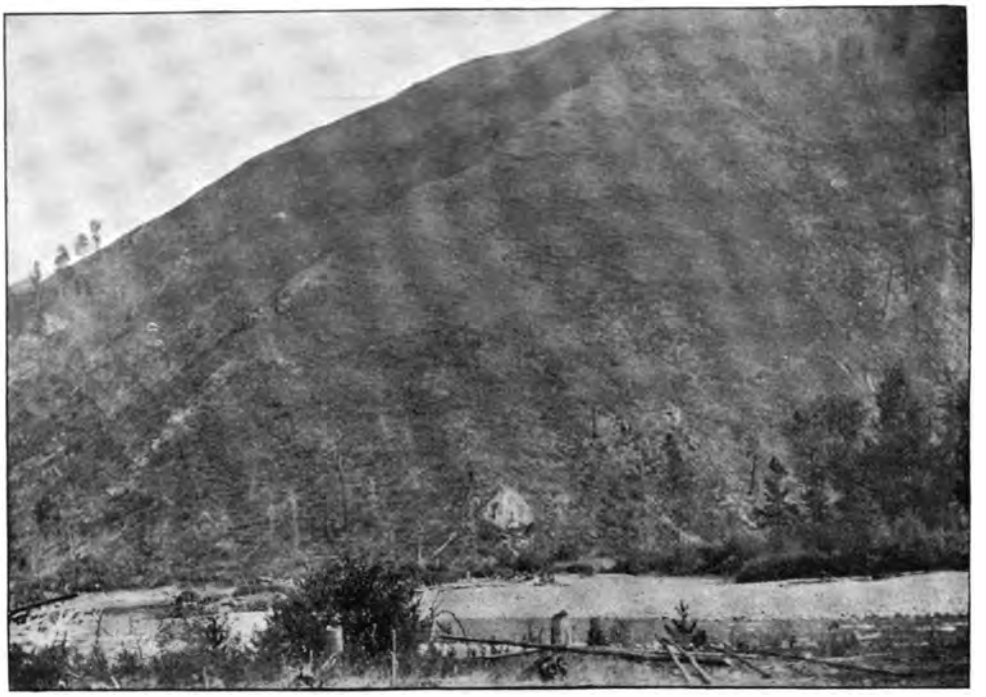
The time required for a renewal of timber growth on burned tracts in the Clearwater basins is dependent upon a variety of conditions. In the zone of alpine fir, on northern slopes, it is fairly rapid, an interval of ten to twenty years sufficing for the firm establishment of a good stand of seedlings. 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.

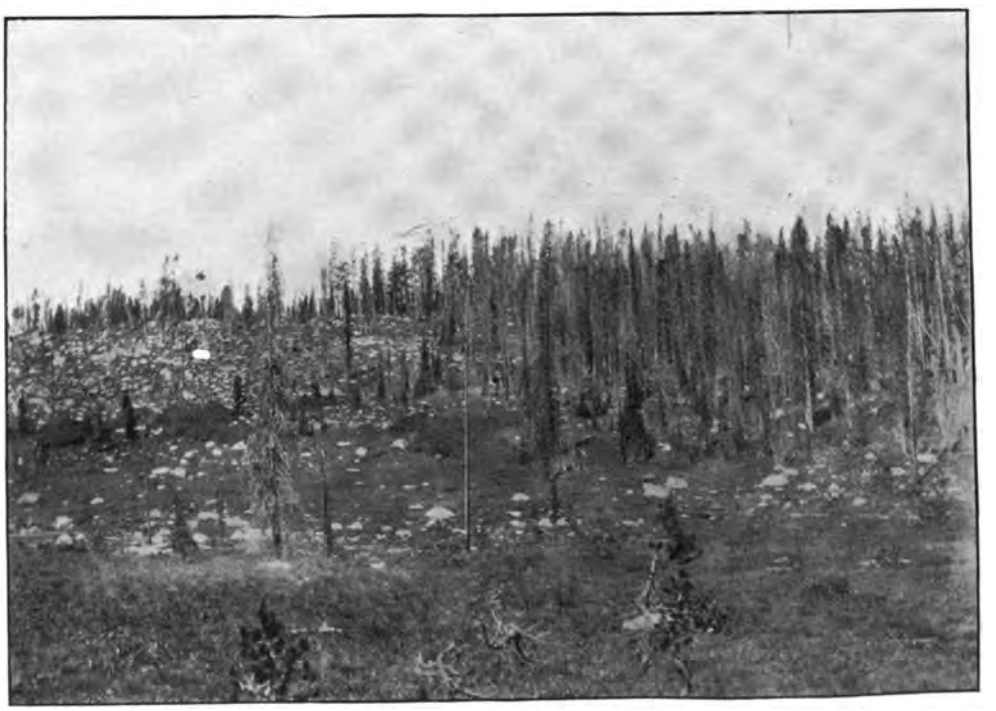
Reforestation in the mountain white-pine zone is more rapid, active, and certain, because the soil humidity is much greater, due to the reception of the accumulated seepage from the zone above. Both here and in the zone of alpine fir a brush growth is usually the preliminary step to reforestation, provided 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.

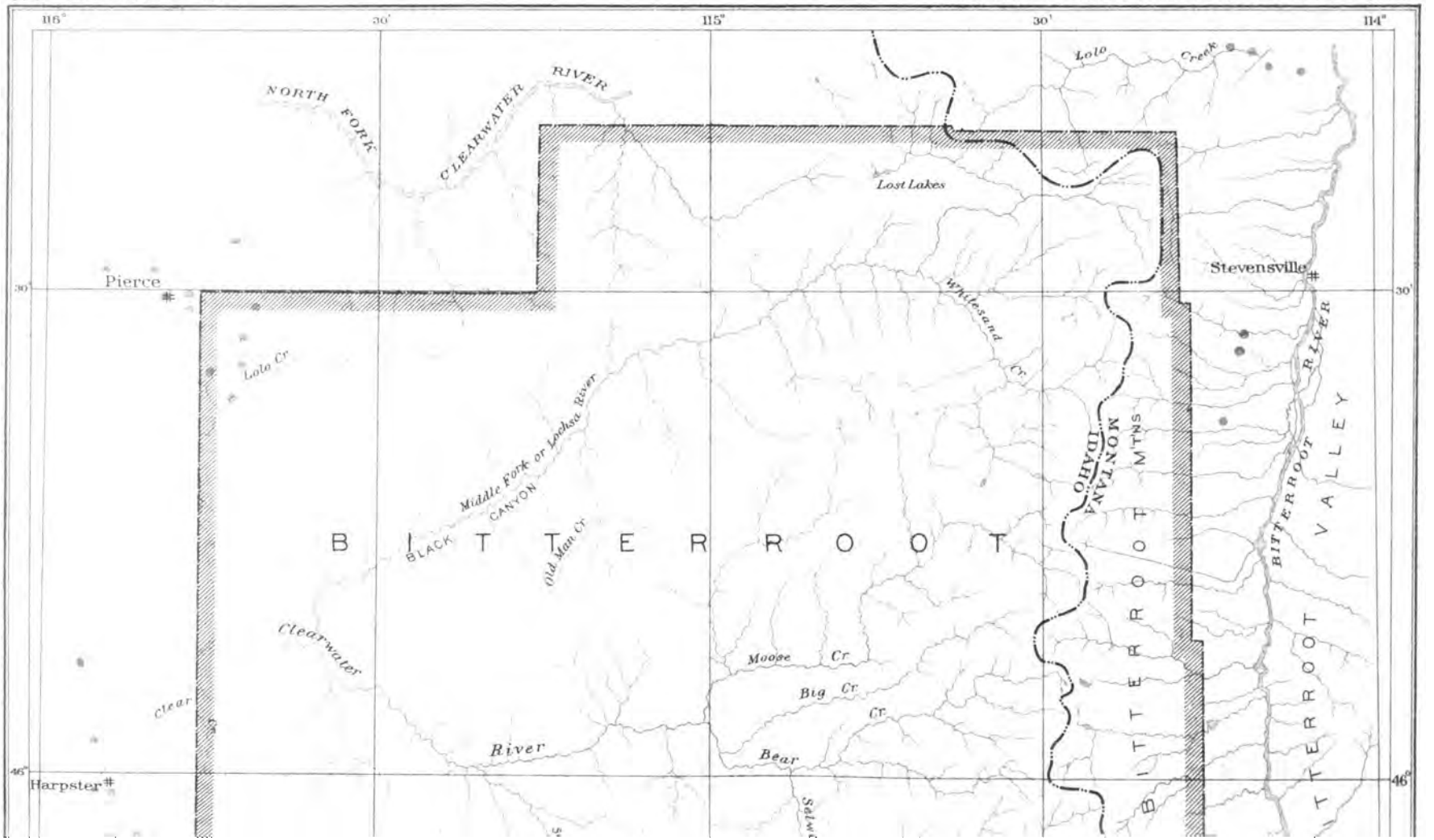
TAXUS BREVIFOLIA forma RADICANS.

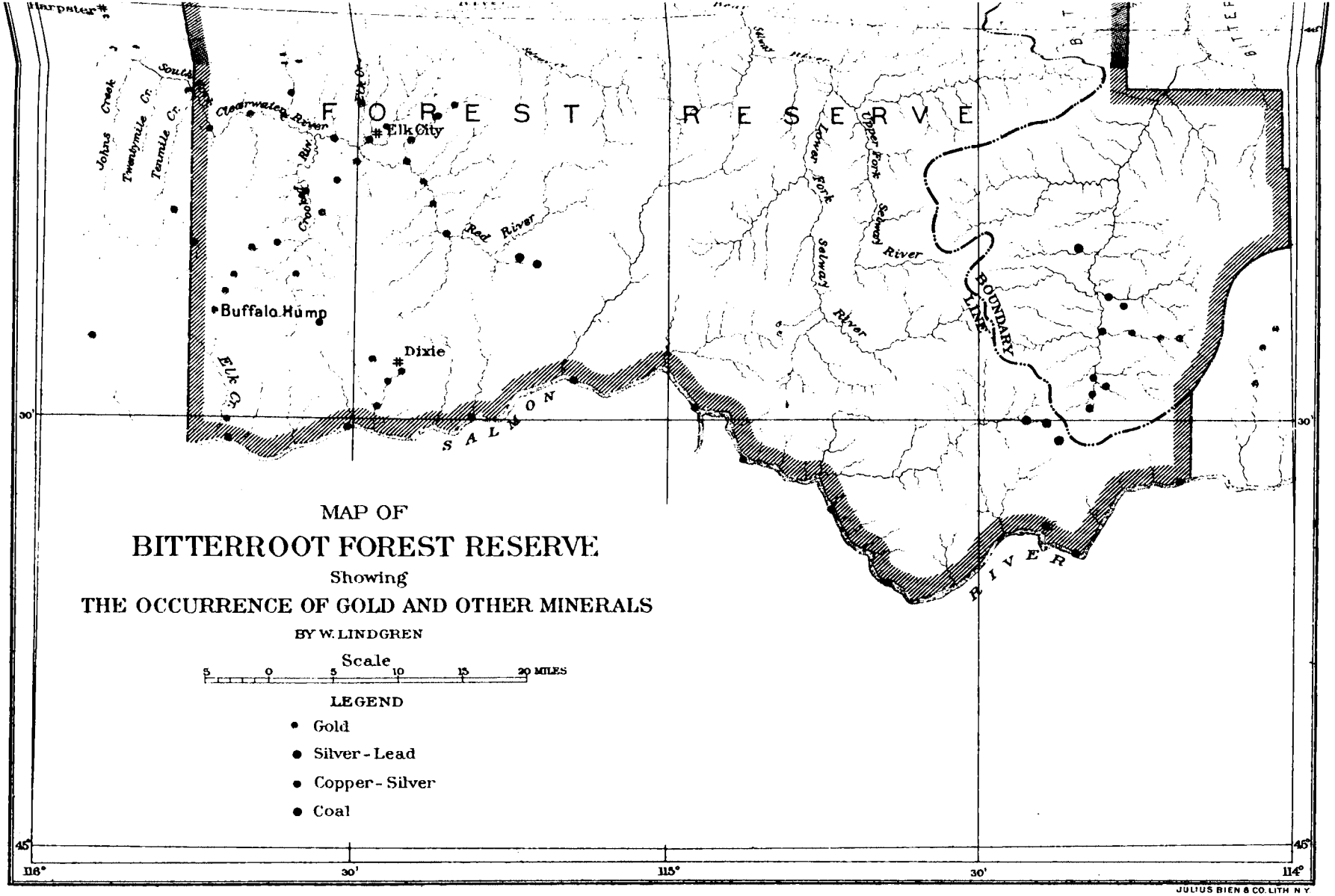
A creeping and trailing shrub, extensively rooting and spreading, with long, supple, ascending branches. The shrub is found throughout the reserve on both the east and west side of the main range of the Bitterroots, at all elevations below 8,500 feet. It is especially common on ridges between Grave Mountains 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 Mon-

tana 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.

	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

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