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DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE
LEWIS AND CLARKE FOREST RESERVE, MONTANA

BY

H. B. AYRES

EXTRACT FROM THE TWENTY-FIRST ANNUAL REPORT OF THE SURVEY, 1899-1900
PART V, FOREST RESERVES—HENRY GANNETT, CHIEF OF
DIVISION OF GEOGRAPHY AND FORESTRY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

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LEWIS AND CLARKE FOREST RESERVE, MONTANA

BY

H. B. AYRES

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JAM OF LOGS IN BLACKFOOT RIVER.

LEWIS AND CLARKE FOREST RESERVE, MONTANA.

By H. B. AYRES.

BOUNDARIES.

The boundaries of this reserve, as established by Executive order of February 22, 1897, are as follows:

Beginning at the point on the south boundary of the Blackfeet Indian Reservation where said boundary line is intersected by the range line between ranges eight (8) and nine (9) west principal meridian, Montana; thence southwesterly along the south boundary to the southwest corner of said reservation and northwesterly along the west boundary thereof, as defined and described in the act of Congress approved June tenth, eighteen hundred and ninety-six, entitled "An act making appropriations for current and contingent expenses of the Indian Department and fulfilling treaty stipulations with various Indian tribes for the fiscal year ending June thirtieth, eighteen hundred and ninety-seven, and for other purposes," to the point where the unsurveyed range line between ranges twelve (12) and thirteen (13) west will intersect said boundary line; thence southerly along said unsurveyed range line to the point for the northeast corner of township twenty-nine (29) north, range thirteen (13) west; thence westerly along the unsurveyed township line to the point for the northwest corner of said township; thence southerly along the unsurveyed range line to the point for the southwest corner of section eighteen (18), said township; thence westerly along the unsurveyed section line to the point for the northwest corner of section nineteen (19), township twenty-nine (29) north, range fourteen (14) west; thence southerly along the unsurveyed range line to the point for the southwest corner of said township twenty-nine (29) north, range fourteen (14) west; thence westerly along the unsurveyed seventh (7th) standard parallel north to the point for the southeast corner of township twenty-nine (29) north, range seventeen (17) west; thence northerly along the unsurveyed range line to the point for the northeast corner of said township; thence westerly along the unsurveyed township line to the point for the northwest corner of section three (3), said township; thence northerly along the unsurveyed section line to the point for the northeast corner of section four (4), township thirty (30) north, range seventeen (17) west; thence westerly along the unsurveyed township line to the point for the northwest corner of section three (3), township thirty (30) north, range nineteen (19) west; thence southerly along the unsurveyed and surveyed section line, subject to the proper offset on the seventh (7th) standard parallel north, to the southeast corner of section twenty-one (21), township twenty-eight (28) north, range nineteen (19) west; thence easterly along the unsurveyed section line to the point for the southeast corner of section twenty-four (24), said township; thence southerly along the unsurveyed and sur-

veyed range line to the southeast corner of township twenty-seven (27) north, range nineteen (19) west; thence easterly along the surveyed and unsurveyed township line to the point for the northwest corner of section three (3), township twenty-six (26) north, range eighteen (18) west; thence southerly along the unsurveyed section line to the point for the southwest corner of section thirty-four (34), said township; thence westerly along the unsurveyed and surveyed township line to its intersection with the east shore of Flathead Lake; thence southerly along the shore of said lake to the north boundary of the Flathead Indian Reservation; thence easterly along the north boundary to the northeast corner of said reservation and southerly along the east boundary thereof to the point where said boundary line will be intersected by the unsurveyed fourth (4th) standard parallel north; thence easterly along said unsurveyed parallel to the point for the southeast corner of township seventeen (17) north, range seven (7) west; thence northerly along the unsurveyed range line to the point for the northeast corner of said township; thence westerly along the unsurveyed township line to the point for the northwest corner of said township; thence northerly along the unsurveyed range line to the point for the northeast corner of township eighteen (18) north, range eight (8) west; thence westerly along the unsurveyed township line to the point for the southeast corner of township nineteen (19) north, range nine (9) west; thence northerly along the unsurveyed and surveyed range line between ranges eight (8) and nine (9) west, subject to the proper offsets on the fifth (5th), sixth (6th), and seventh (7th) standard parallels north, to the point of intersection with the south boundary of the Blackfeet Indian Reservation, the place of beginning.

TOPOGRAPHY.

The area of the reserve is 4,572 square miles, or 2,926,000 acres. It occupies the whole breadth of the Rocky Mountains, excepting the narrow western slope of Mission Ridge, the summit of which forms the greater part of the western boundary. The Rocky Mountains here consist of four parallel ranges, usually sharp and distinct, the western two especially so, with long, narrow valleys between them (Pl. IV, A). These valleys are drained principally by northward-flowing streams, but the eastern range is cut across about the middle of the eastern boundary by Sun River, which drains a great portion of the next valley west of the eastern range into the Missouri River. The North Fork of Dearborn River also drains the southeastern portion of the reserve to the eastward. Across the whole reserve from McDonald Peak on the west to Mount Dearborn on the east is a transverse divide, forming a watershed between the streams flowing north into the Flathead River and those flowing south into the Blackfoot River. The principal peaks of the main ranges are between 7,000 and 10,000 feet in altitude, while the main valleys are between 3,000 and 5,000 feet.

The reserve is naturally divided by the mountains into four large areas: First, the portion which is drained eastward, having an area of about 1,600 square miles; second, that drained northward by the Middle Fork of Flathead River, having an area of about 576 square miles; third, the long valley of the South Fork of Flathead River, which is continuous with the valley of the North Fork of Blackfoot River, the two having an area of about 1,860 square miles; fourth,

VIEW FROM THE MOUNTAIN RANGE.

VIEW FROM THE MOUNTAIN RANGE.

3. HEAD OF NORTH FORK OF SUN RIVER, AGAINST WALL OF CONTINENTAL DIVIDE

4. SEVERE BURN ON MOUNTAIN SIDE

the Swan-Clearwater Valley, more regular in outline and with broader bottom and lower altitude, having an area within the reserve of about 728 square miles. The valley of Swan River is continuous with that of the Clearwater, being separated only by a low morainic divide.

ROCK.

Limestone is of extensive occurrence, nearly all the summits, both of the peaks and ridges, being composed of it. Much of it is fossiliferous (Pls. IV, *B*, and V, *A*). Most of it is said to be of good quality for building stone.

Interbedded quartzites are occasionally seen, and green schistose rocks are found in the canyons. One especially good exposure of schist is in the lower canyon of the North Fork of Teton Creek.

Igneous rock, bearing traces of copper, occurs on Upper Smith Creek, southwest of Augusta, and extends southwestward. A dark igneous rock is also found extending northward from the warm springs on Sun River.

Black shale is abundant in the valley of the North Fork of Sun River. A bright-red arenaceous shale extends from near the warm springs southward to the headwaters of Ford Creek.

Cretaceous rocks form the eastern foothills. Tertiary coal-bearing rocks are found in the lower portion of the valley of the South Fork of the Flathead.

Few mining prospects are found within the reserve. Those seen were on Smith Creek and in the lower portion of the valley of the South Fork of Flathead River. Quartz is nowhere abundant.

Outside of the reserve, but not far from the boundary, copper claims are located on the North Fork of Blackfoot River, and on Smith Creek, below White's mill. Some other claims were staked during 1898 on Summit Creek, not far above Java.

Lignite coal is found on the South Fork of Flathead River, some 30 miles from its mouth.

East of the Continental Divide the strata dip southwestward, and west of the divide the general dip is northeastward.

SOIL.

In general the soil is shallow. The region has been glaciated in comparatively recent time and but a small amount of soil has accumulated. The rock of the region being principally limestone, one expects the soil derived from it to be productive where physical composition, moisture, and climate are favorable to plant growth. Travel through the region proved this to be true, for in all the well-moistened and sheltered localities having a fair depth of loam a luxuriant growth of vegetation was found. Thrifty vegetation is by no means a simple

index of the character of the soil on which it grows, but, considering the other factors influencing the growth of plants, it is an easy means of discovering the value of the soil.

In the higher regions, or those above 6,000 feet, a large proportion of the surface is entirely destitute of soil, as it has been washed down the mountain sides as fast as formed. The middle slopes vary greatly as to soil, and while in some of the basins or on the more moderate slopes there is an accumulation of loam, many strips on the mountain sides are nearly bare. Even where slopes are moderate there are many very steep and even precipitous places where nothing but rock is exposed. The valleys contain a great deal of gravel, morainal material brought down from the mountains by glaciers and worked over by water in more recent times. Clay was seen in many of the river bluffs and in terraces along the sides of the valleys. The distribution of clays and gravels is so irregular that it would be impracticable to make a satisfactory map of them.

HUMUS.

Humus is generally light, varying according to the fertility of the soil and favorable climatic conditions. The eastern slope has been burned so much that there is little humus left, except in the lower foothills (Pl. VI, *A*). The summits of the mountain ridges have, of course, very little humus, as not much vegetation grows there. The river bottoms here, in contrast with bottom lands in low countries or regions of moderate slope, have so much gravel and sand that they do not produce a rank growth of vegetation; consequently there is but little humus on them.

In general, the earth is but slightly covered with humus, even the unburned woods seldom having a depth of more than 2 or 3 inches. There are exceptions, of course, in damp places along small streams, in springy places, and in the isolated sloughs.

In the banks of small streams that have changed their courses several feet of black earth sometimes appear. This, however, is an alluvial deposit washed down from the hills by the streams, and is not to be considered as humus.

LITTER.

While varying somewhat with the fertility of the soil, the amount of litter depends greatly upon the occurrence and the intensity of fire. It is scant on all the higher land, where the soil is thin, climate severe, and vegetation restricted, but it is found on burned areas, on mountain sides, and in valleys (Pl. V, *B*).

On the burned areas shown on the accompanying map (Pl. III) there is very little material except the trunks of trees killed by fire, but these in many cases amount to a large number.

A. BURNT MOUNTAIN SIDE NOT RESTOCKED.

New vegetation of grass, lupine, rose, service berry, paint weed, etc.

B. HANNON'S RANCH AND VALLEY OF STOREHOUSE CREEK.

A. MISSION RANGE, FROM HOLLAND'S RANCH.

B. YELLOW PINE, NEAR HOLLAND'S RANCH, UPPER SWAN RIVER VALLEY

The forested region not visited by recent fires has a very small amount of deadwood, usually very much less than is found on the burns, but here is much more of the fine litter, such as leaves, twigs, and moss.

Except for deadwood, the amount of litter is light east of the Continental Divide, and heavy in the unburned portion of the valley of the Middle Fork of Flathead River, where the old forest is being slowly replaced by new. It is moderately abundant in the valley of the South Fork of Flathead River, which is patched with burns. The lower half of the Swan River Valley is in about the same condition, but the upper half has been much burned and has a dense network of fallen trees over a large part of the surface.

AGRICULTURAL AND GRAZING LANDS.

Excepting that angle of the reserve reaching northeastward into the plains, with Birch Creek as its northern boundary, and having an area of about 90 square miles, there is no strictly agricultural land within the reserve. In each of the main valleys some vegetables and hay could be grown, but the product could not compete successfully with that produced under more favorable conditions.

While agricultural land is scarce, there are several favorable locations for small ranches (Pl. VI, *B*). These areas, excepting along the eastern foothills, are isolated and difficult of access and subject to deep snows in winter, which would make it necessary for the rancher to put up much hay. Natural hay is found in some quantity in willow bottoms, or sloughs, and some prairies would yield a good crop of hay under cultivation. On the North Fork of Sun River is a prairie having an area of about 10 square miles, on which there is but little natural hay, but the land could easily be irrigated, and timothy could be grown.

South of Sun River the valleys of Beaver Creek and of the South Fork of the North Fork of Sun River have considerable areas of grass land. All through the foothills bordering the plains and in the narrow valleys between the ridges south of Ear Butte are, perhaps, 100 square miles of land on which there is more or less grass, but it is rather difficult of access and undesirable for grazing on account of the deadwood killed by fires. This area, with the eastern foothills northward, has once been nearly all wooded, but frequent incursions of fire from the plains have reduced and even exterminated much of the forest, which has been succeeded by a mixture of grasses and weeds.

In the valley of the Middle Fork of the Flathead only one area of grass land was seen, and that was a willow bottom along a stream tributary to the Big, or East Fork. This area seemed to be about a mile long and a quarter to half a mile wide.

Near the head of Willow Creek is a large willow bottom with bunch-grass prairie on the hills bordering it. Mr. Donahue has a ranch on this bottom stocked with about 100 head of cattle.

Below the mouth of Willow Creek is an area of 800 to 1,000 acres of grass land, much of which is fire made, affording excellent summer grazing. Hay could easily be grown here by irrigation. A short distance above the mouth of White River is an area of about 300 acres of prairie. Here and there, in passing down the South Fork, small areas of grass were found on the most gravelly portions of the river bottom.

In the Clearwater Valley, about the head of Clearwater Lake and about the other lakes of the chain between this lake and the summit, are meadows of sedge, or flat grass, with small areas of upland grass. The grass and hay land in the Clearwater drainage amounts to perhaps 500 acres.

Over the divide, in the Swan River Valley, on Holland Creek, are some 200 acres of natural prairie land, with fair grazing also under the adjacent scattered timber. This land is occupied as a ranch (Pl. VII. 1).

About 8 or 10 miles below this ranch is a morainic region of gravel hills and ridges, with intermediate sloughs, on which there is much grass of inferior quality (Pl. IX, 1). The abundance of hay may, however, offset the inferior quality of pine grass and induce some one to try ranching there.

Above the mouth of Jim Creek, on the trail to Crow Creek Pass, is a prairie of some 500 acres, part of which is irrigable and well adapted to hay.

At the head of Swan Lake are about 500 acres of hay land, but there is very little grazing land in that vicinity. Numerous small areas of grass land occur elsewhere in this valley, but none of them warrant an attempt at stock raising.

On the mountain ridges, approaching timber line, are many grassy basins and parks, and many ridges are scantily covered with a fine blue bunch grass (*Festuca ovina*?). This mountain grass land is probably due to the prevalence of snow, which prevents growth of trees. The lingering snow leaves hardly more than two months of the year available for pasturage. Most of such areas are practically inaccessible for stock and are of no present use as grass land. In the entire reserve there are probably 200 square miles of grass land.

LEWIS AND CLARK FOREST RESERVE
MONTANA

Showing distribution of Larch, Western larch, and Patton hemlock
Prepared under the direction of Henry Gannett, Geographer in charge

BY H. HAYRES

Scale
Sketch contours
1899

- LEGEND
- LYALL LARCH (Larix laricina)
 - WESTERN LARCH (Larix occidentalis)
 - PATTON HEMLOCK (Tsuga pattoniana)

THE FOREST.

SPECIES.

The trees growing within the reserve are as follows:

Trees growing within Lewis and Clarke Forest Reserve, Montana.

Botanical name.	Common name.	General distribution.
<i>Pinus ponderosa</i>	Yellow pine	Swan-Clearwater Valley and South Fork of Flathead.
<i>Pinus monticola</i>	White pine	Lower Swan River, South Fork and Middle Fork of Flathead.
<i>Pinus murrayana</i>	Lodgepole pine....	Everywhere below 7,000 feet.
<i>Pinus albicaulis</i>	Nut pine	West of Continental Divide above 6,000 feet.
<i>Pinus flexilis</i>	Limber pine	East of Continental Divide.
<i>Picea engelmanni</i>	Engelmann spruce..	Everywhere.
<i>Picea alba</i>	White spruce	Teton Creek.
<i>Larix occidentalis</i>	Western larch	West of Continental Divide.
<i>Larix lyallii</i>	Mountain larch	Colonies on highest ranges.
<i>Pseudotsuga taxifolia</i> ..	Red fir	Everywhere below 7,000 feet.
<i>Abies lasiocarpa</i>	Balsam	Everywhere.
<i>Abies grandis</i>	Silver fir	Lower Swan and Flathead valleys.
<i>Thuja plicata</i>	Cedar	Do.
<i>Tsuga heterophylla</i>	Hemlock	Do.
<i>Tsuga pattoniana</i>	do	Do.
<i>Populus angustifolia</i> ...	Cottonwood	Along lower streams.
<i>Populus tremuloides</i> ...	Aspen	Patches below 7,000 feet.
<i>Populus balsamifera</i> ...	Balm of Gilead.....	Eastern foothills.

DISTRIBUTION.

Yellow pine is found throughout the valley of the South Fork of Flathead River and in the Swan and Clearwater valleys below 3,500 feet (Pl. IX, *B*). White pine occurs in the Lower Swan River Valley, in the lower portion of the valley of the South Fork of Flathead River, and probably in the lower portion of the Middle Fork Valley, at elevations below 4,000 feet. Lodgepole pine is general in distribution below 6,000 feet. Nut pine is found on all the high land west of the Continental Divide above 5,000 feet. Limber pine is confined to the eastern foothills below 7,000 feet (Pl. X, *A*). Engelmann spruce is generally distributed and is found at all altitudes, but most abundant on the mountain sides. White spruce, somewhat difficult to distinguish from Engelmann spruce because of intermediate forms, occurs on the South Fork of Teton Creek. Larch

is the principal timber tree in the Swan-Clearwater Valley. It is less abundant in the valley of the South Fork of Flathead River, and its farthest appearance to the eastward is in the valley of the Middle Fork of Flathead River. Mountain larch is found in colonies here and there on the higher mountains. An unusually fine forest (for this species) is near Camp Creek Pass, between Sun River and Willow Creek, on the very summit of the Continental Divide. A few trees are found also on the summit of the range just north of Pend Oreille Pass, between the West Fork of the South Fork of Flathead River and the Clearwater Valley. Red fir is found throughout the reserve below 6,000 feet. Balsam, like Engelmann spruce, is found at all altitudes, but is most abundant between 4,000 and 6,000 feet. Silver fir appears in the lower portion of the Swan River Valley, on the South Fork of Flathead, on the Middle Fork of Flathead, and a few trees are seen near the head of the North Fork of Sun River. Cedar has the same distribution, but is confined to the damp places along streams and in the bottoms of ravines. Hemlock has the same habitat and approximately the same distribution as cedar. Mountain hemlock is found only at the summit of the pass between Swan River and Clearwater River, in a clump of small trees about 8 feet high. Cottonwood is generally distributed along the streams in the medium and lower altitudes. Aspen is found almost everywhere below 6,000 feet, except in dense forests. Balm of Gilead occurs in the eastern foothills.

SIZE AND QUALITY.

Yellow pine, while thoroughly abundant in the Upper Swan and Clearwater valleys, is not as large and vigorous as in the lower and more fertile lands of the Flathead Valley, where it is sometimes 6 or 7 feet on the stump and 100 feet or more high. Within the reserve it is seldom more than 3 feet in diameter and 90 feet high. It is frequently fire scarred and otherwise defective.

White pine is seldom sound, and in addition to the common dry rot, much of it is dying. The dead trees are almost worthless for timber.

Lodgepole pine, one of the hardiest trees, while seldom more than 20 inches on the stump and 100 feet high, is usually straight, sound, and comparatively free from large knots.

Nut pine, while hardly to be considered for log timber at present on account of its inaccessibility, is sometimes large enough for saw logs, and may possibly be in future local demand.

Limber pine is remarkably crooked and knotty where exposed, as on the eastern foothills. On the mountain sides it is frequently found fairly straight and clear in sheltered places, reaching a diameter of about 28 inches and a height of 50 feet or more. Such good trees are exceptional.

A. UPPER SWAN RIVER VALLEY.

B. YELLOW PINE ON SHORE OF PLACID LAKE.

A. MOUNTAIN SIDE LOOKING EAST FROM CAMP CREEK PASS.

B. OPENING IN YELLOW-PINE FOREST ON JOCKO TRAIL, 1 MILE NORTH OF PLACID LAKE.

Engelmann spruce, besides having an even distribution, is the most useful tree. With lodgepole pine and red fir it forms the dense forest of pole timber on the exposed but well-moistened slopes, and with balsam makes large log timber in the higher gulches. Some trees about 34 inches in diameter and 125 to 130 feet high were seen.

Of white spruce, only a few small trees were surely identified.

Western larch, the most abundant timber tree of the valleys, like the yellow pine, is smaller than in the Flathead and Stillwater valleys. There it is about 4 feet in diameter and 180 feet high. In this reserve it is seldom more than 30 inches in diameter, none being seen over 3 feet, and it is seldom over 125 feet high. It is more knotty, but it seems to be quite as sound as in the lower country (Pl. XI, A).

Red fir becomes more defective to the eastward. It reaches out on the plains somewhat, but there, except in sheltered places, it is hardly able to raise an upright stem. In the foothills it is bushy. Ascending the mountains, it is found in some basins as large as 30 inches on the stump and 80 feet high, but so defective with dry rot that it makes very poor timber for the sawmill. West of the Continental Divide it improves both in size and quality, but is still subject to dry rot, and many dead stubs are found in the forest without evidence of fire or other very plain cause of their death. The most hardy trees are on rocky mountain slopes, where the roots can reach constant water, but such trees are isolated, short, and knotty, and seldom suitable for log timber.

Mountain larch, probably of no commercial importance, is found 15 inches in diameter and 70 feet high. Though not cut and carefully examined the trees seemed generally sound.

Balsam is never a large tree, at least none were seen more than 15 inches in diameter and 70 feet in height. It is usually defective in the butt and full of small knots.

Cedar is found 3 feet in diameter and 80 feet high, but this size is unusual. The tree was nowhere abundant, yet small areas of it occur, and it may be of some commercial value for poles, posts, or shingles.

Aspen is not notably different here from the aspen of other regions. It is occasionally large enough for log timber, but is seldom over 10 inches in diameter and 60 feet high. Where much exposed it is reduced to mere brush.

The other trees, silver fir, hemlock, cottonwood, and balm of Gilead, are small and so isolated as to be of no commercial importance.

ESTIMATES.

Any attempt to estimate 4,800 square miles of very irregularly patched and broken forest in four months must have a somewhat unsatisfactory result. While the closest estimates are expected to come within 10 per cent of the actual amount, these can only be hoped to lie within 50 per cent, but they are all believed to be less than the actual amount.

These estimates are made on the basis of practice in the Lake States, viz, estimating as log timber every stick that will make a log 12 feet long, 6 inches in diameter at small end, and scaling two-thirds of a full scale.

In making the estimate it was of course necessary to pass many square miles by with only a cursory view from a mountain or hilltop. Small representative areas were examined in detail, and on these the general estimate was based. These estimates are as follows:

Estimate of timber in Lewis and Clarke Forest Reserve, Montana, by areas.

Locality.	Feet B. M.	Cords.
Eastern slope	63, 000, 000	1, 579, 000
Middle Fork of Flathead	154, 000, 000	1, 500, 000
South Fork of Flathead.....	442, 360, 000	5, 130, 000
Swan-Clearwater.....	1, 985, 000, 000	4, 660, 000
Total.....	2, 644, 360, 000	12, 869, 000

Estimate of timber in Lewis and Clarke Forest Reserve, Montana, by species.

	Feet.
Larch	1, 265, 444, 000
White pine	26, 547, 200
Yellow pine	235, 388, 800
Red fir	647, 690, 000
Spruce	350, 622, 000
Lodgepole pine	118, 668, 000

YOUNG GROWTH.

On the areas shown as recently burned the young growth is quite small and has been described under the head of reproduction. On the older burns it is common to find a dense stock of saplings; but these, as a rule, are principally lodgepole pine, especially on the slopes east of the Continental Divide. Engelmann spruce and red fir have made their appearance on some of these old burns, but rather subordinate to lodgepole pine. In rapidity of growth they are inferior, and in numbers they constitute but a small proportion of the new forest.

J. LARCH, YELLOW PINE, AND RED FIR, WITH SPARSE SEEDLINGS.

K. YELLOW PINE FREQUENTLY AND LIGHTLY BURNT.

.1. MILL ON SMITH CREEK, SOUTHWEST OF HAYSTACK BUTTE

B DEADWOOD PARTLY CUT, SOUTH FORK OF TETON CREEK

On the tracts that have been unburned for many years seedlings have sprung up as the old trees have died and fallen, so that these old forests are composed of trees of all ages, and in them the saplings too small for log timber constitute a very important factor to be considered in forest management. In many cases the mature trees may be cut out for lumber and the saplings left will be a sufficient stock, partly grown, for a new harvest of logs. By carefully marking the trees to be cut and by using care to preserve this young stock, the continuity of the forest may be unbroken by logging operations.

In this old forest the young growth is apt to have a large proportion of spruce and a small proportion of lodgepole pine, as the shade of the old trees is favorable to the starting of spruce, but unfavorable to the pine. Next in proportion to spruce, red fir is common, and in the more open places balsam follows next in order, while larch and lodgepole pine choose the spots that are most free from underbrush and grasses. Yellow pine seems to come in only on lands that have bare earth.

The areas having old mixed forests with a fair stock of young growth are very few on the eastern slope, except in some of the smaller valleys near the Continental Divide. Such areas occur on the headwaters of the Middle Fork and on the western tributaries of the North Fork of Sun River; also on the Middle Fork and on the lower half of the South Fork of Flathead River. The lower portion of the Swan River Valley, although considerably scarred by fires, has much of such forest still remaining, especially in the tributary gulches. The upper portions of these valleys have been overrun by moderate fires that have thinned the forest, and while most of the land is restocked, the seedlings are seldom over 10 feet high.

UNDERBRUSH.

The principal species of brush are alder, willow, dogwood, buckbrush, waxbush, yew, squawberry, service berry, brittlebrush, and juniper. Beside these shrubs, some of the trees often grow in such a manner as to practically form an underbrush in the forest, especially after a light fire that has not seriously thinned the forest, yet has permitted seedlings to start.

In general, the underbrush is not dense. With the exception of some of the damper ravines where yew abounds, the brush would offer no serious difficulty to taking horses anywhere, unless through the aspen thickets on the eastern slope (see Pl. XI, *B*).

Brush is most abundant, perhaps, in the valley of the Middle Fork and in the lower portion of the valley of the South Fork of Flathead River and in the lower portion of the Swan River Valley.

In the higher altitudes, especially where exposed, balsam and spruce, and east of the Continental Divide limber pine, are frequently matted

close to the ground, forming dense but small impenetrable thickets, although they are tree species.

Except where kept in subjection by light fires brush is usually abundant enough to be a serious hindrance to logging operations and to prevent the ready starting of seedlings.

CUTTING.

There are three small sawmills within the reserve, one on the South Fork of Depuyer Creek, another on the South Fork of Teton Creek, and a third on Smith Creek, southwest of Haystack Butte (Pl. XII, *A*). The logs for these mills are taken from the mountain sides or the basins above them.

For the mill first mentioned the logs are twitched down the mountain side to the stream, then floated with great difficulty about 2 miles through the canyon to the mill at its mouth. Some 300,000 feet B. M. have been cut in the valley of the South Fork of Depuyer Creek. This timber was spruce, red fir, and lodgepole pine.

The second mill is near the head of the South Fork of Teton Creek, about 6 miles from the plains. The logs are being taken from the mountain side near the mill and are almost entirely spruce and lodgepole pine. On the forks of Teton Creek are several old mill sites, and, roughly estimated, a million feet B. M. have been cut on the South Fork and 600,000 feet on the North Fork.

The mill on Smith Creek, but a short distance within the reserve line, is cutting logs from the high mountain side south of the headwaters of the stream. The logs are dragged with much difficulty and some danger about 2 miles down the steep slope. The timber used is lodgepole pine and spruce. There is little red fir in the basin. About a million feet B. M. of all kinds have been cut in this valley.

Besides the log timber cut east of the divide, some 300,000 railroad ties have been cut and floated down to the Helena branch of the Great Northern Railway. Some 200,000 of these were cut on the North Fork of Sun River and approximately 100,000 on Dearborn Creek.

All along the eastern front of the mountains the people from the treeless plains get fuel, house logs, and poles for fences and corrals. Almost every little valley that is wooded and that is reasonably accessible has a well-used wagon road leading into the timber. The people come and cut the timber as they need it, loading it immediately upon their wagons without leaving any amount cut and lying upon the ground, even over night. Ranchmen, as a rule, bring their own teams, but for village supplies there are half-breeds living among the foothills who make a business of taking out the wood and selling it. A colony of these woodcutters was found on the South Fork of Teton Creek (see Pl. XVIII, *B*), another on Smith Creek, and another on Dearborn, near the mouth of Falls Creek. Altogether about 62,000

4. CUTTING AND SKIDDING ON PLACID CREEK

7. BURN OF 1889, UPPER DEARBORN RIVER, 3 MILES EAST OF
PTARM GAIL PEAK

cords of fuel, house logs, and fencing have been cut on the eastern slope of the mountains.

Along the Great Northern Railway there has been a great deal of cutting for bridge timber and ties, and besides some material has been taken for fuel, cribbing, tunnel timber, wagon bridges, and corduroys. The construction camps also have taken a large amount.

On account of lack of time no attempt has been made to estimate the amount of this material. It is said that all or nearly all the bridge and tie timber used in the construction of the railway through the mountains from Columbia Falls to Midvale was taken from the woods along the line.

Elsewhere on the reserve the only cutting has been for the cabins of prospectors, hunters, and trappers, and the few squatters in the Swan-Clearwater Valley, and for trails or camp use.

The logging operations of the Blackfoot Milling Company, on the Clearwater drainage, have worked up to but have not cut over the south line of the reserve. The logs are floated down Blackfoot River (see Pls. XIII, A, and XV, A).

FIRES.

Extent.—Only the areas recently burned, or those overrun by fire within the last forty years, have been shown on the map. The older ones have lost the characteristics and the features of burns that make them noticeable in the distant view necessary in mapping them. They have either become barrens or have been restocked with trees. A considerable but undeterminable portion of the mountain ridges shown on the map (Pl. III) as bare or destitute of forest has been made so by fires that have exterminated the stunted forests which were just able to exist under the severity of climate without the fire.

Many of the eastern foothills now grassed prove upon close examination to have been once wooded; for here and there upon them old charred roots and stumps are found. The fire lines on the map can be drawn only approximately, for the effects of fire often fade out with an impreceptible border.

Roughly estimated, the recently and severely burned areas within the reserve are as follows:

Areas recently burned in Lewis and Clarke Forest Reserve, Montana.

	Square miles.
East of the Continental Divide	600
Middle Fork of Flathead River	95
South Fork of Flathead River and the Blackfoot drainage	485
Swan-Clearwater Valley	240
Total	1,420

In addition there are, as shown on the map (Pl. III), outside the reserve the following burned areas:

Areas recently burned adjacent to Lewis and Clarke Forest Reserve, Montana.

	Square miles.
Along the Great Northern Railway.....	134
East of the reserve line	40
South of the reserve line.....	206
Total	380

This, added to the 1,400 square miles within the reserve, makes a total of 1,800 square miles of recently burned forest shown on the map.

Causes of fire.—While some of these fires have no doubt been caused by lightning, nearly all have been due to carelessness on the part of men. The causes of fire may be grouped into four classes: First, those originating directly or indirectly from the railroad; second, those running in from the prairie; third, those escaping from settlers on the borders of the forest; fourth, those caused by Indians, hunters, and prospectors.

The greater area, probably some 1,200 square miles, was burned during 1889. That year is said to have been exceptionally dry, and the smoke from the forest fires almost unendurable. At that time the Great Northern Railway was being built across the mountains, and the great number of men employed in its construction, and the many prospectors and claim hunters attracted by the opening of the country, made a combination of circumstances very favorable to the starting of fires.

About forty years ago, also, many fires occurred. Most of the burns of that time have been reburned since. Where not repeated, they have either been covered again by forest or they have become mountain barrens.

Intensity of fires.—On most of the burns mapped the fires have been severe enough to kill all, or nearly all, the trees and to consume the humus (see Pls. XIII, *B*, and XV, *B*). The borders of the burns are generally sharp and well marked. But many light fires have also occurred; these have crept over extensive areas, killing brush and the smaller and tenderer trees.

The fires have varied through all degrees of intensity. The severest have rushed through the tree tops consuming the needles and smaller twigs and igniting the humus lying upon the surface, which, even when burning slowly, has made fire enough to consume the smaller roots that were in the humus. The fires of 1889 were generally of this sort. Many other fires have occurred, doing much less damage to the forest. Creeping slowly along, they have killed much of the vegetation and even some large trees, but the lightest of them have merely thinned the forest, injuring many trees, but still leaving many seed trees and a favorable surface for seeds to start.

LEWIS AND CLARK FOREST RESERVE
MONTANA

Showing distribution of cedar, hemlock, white pine and silver fir
Prepared under the direction of Henry Gannett, Geographer in charge
BY H. B. AYRES

J. S. D. B. C. 11

Damage by fires.—The damage done by fires might by some be estimated as nothing because the timber had no market value at the time, but by the community and the State it should be viewed as an injury to a great natural resource. While the timber trees, the saplings, and the seedlings killed had no immediate market value where they stood, they had a future value which has been destroyed. In addition, the fires have postponed the possibility of again having such a forest on much of this land within one hundred years, and on some of it a very much longer time, for the fires have consumed the product of centuries in humus, shade, shelter, and other necessities for the germination and growth of seedlings. These higher regions are now frequently found barren, or lightly covered with grass or mountain plants, with a few roots and stubs remaining as proof that a forest was once there.

Deadwood.—The amount of material standing dead is roughly estimated as follows:

<i>Deadwood standing in Lewis and Clarke Forest Reserve, Montana.</i>	
	Cords.
Missouri River drainage	200,000
Middle Fork of Flathead River, within the reserve.....	100,000
Middle Fork of Flathead River, outside the reserve	150,000
South Fork of Flathead River	600,000
Swan-Clearwater Valley, within the reserve.....	128,000
Total	1,178,000

No effort was made to estimate the material that is down. It is not marketable and never can be until made accessible immediately after falling, as where logging and woodcutting are being carried on.

Reproduction.—The burned areas east of the Continental Divide and those of the valley of the Middle Fork of Flathead River are very scantily restocked, having little else than small lodgepole pine in strips and groups, usually near the unburned forest.

In the valley of Willow Creek (South Fork drainage) there is a dense stock of lodgepole pine coming up through the network of fallen trees.

The same condition prevails in the region about Spotted Bear, while on Hungry Horse the old burn has a very scant stock.

In the valley of Swan River the "Big burn," about 6 miles below Holland's ranch, has enough lodgepole pine to cover it in about twenty years.

The burn on Crow Creek Pass is principally occupied by brush, but has a sprinkling of spruce, lodgepole pine, and balsam.

The large burn on the mountain west of Swan Lake has a scanty stock of spruce, balsam, and lodgepole pine.

The upper portion of Swan River Valley has a dense stock of lodgepole pine and larch under the larger larch that has survived several incursions of moderate fires.

The burns on other mountain ridges, so far as stocked at all, have a mere sprinkling of nut pine, Engelmann spruce, and balsam.

The stock on lightly burned regions, as a rule, is not only mixed as to species, but also as to size. There are some areas on old burns which are occupied by lodgepole pine only, but these are the exception and are not large.

Liability to fire.—Until the appointment of forest rangers there had been no steps to prevent the starting or the spread of fires except the carefulness of those likely to cause them. During the season of 1899, however, no fires were found burning, though several had been extinguished by the forest rangers, who patrolled the trails and kept themselves posted as to the movements of persons within the reserve. Along the railroad the greatest danger of fires is from locomotive sparks, though they are liable also to be started by trackmen burning rubbish. East of the mountains the danger is from fires sweeping in over the prairie or from the lunch fires and smudges of the woodcutters who come from the plains. In all the mountain area the camp fires of prospectors, trappers, tourists, and sportsmen are a constant menace.

Effect of fire on composition of forest.—The severe fires below 6,000 feet have been followed by lodgepole pine where restocked at all (see Pl. XVI, A), but the moderate fires in the lower altitudes and all those in the higher altitudes have usually been followed by a mixed growth in which spruce predominates. Many of the severe old burns that have been restocked have first been covered with lodgepole pine, under which spruce, white pine, larch, balsam, and other shade-enduring trees have sometimes started. A very dense stand of the original stock, however, does not readily admit other species, and lodgepole pine in such cases is apt to remain until the trees begin to die of old age (see Pl. XVII, A).

Moderate fires may thin out the species most sensitive to fire and leave those protected by thick bark. A notable instance of this was found in the upper portion of the Swan River Valley, where a mixed stock of larch and lodgepole pine had been run through by light fires, which killed the thin-barked lodgepole pine, but left the thick-barked larch but slightly injured. On looking over this valley from the mountain side in October, when the leaves were colored, the upper half of the valley seemed almost entirely wooded with larch.

RATE OF GROWTH.

The rate of growth varies greatly not only according to soil and moisture, but also according to exposure and the influences of surrounding vegetation. The average increase on the stump in the lowland was found to be about an inch in ten years, accompanied by a proportionate growth in height.

.1. DAM ACROSS OUTLET OF PLACID LAKE.

B. NUT PINE (*PINUS ALBICAULIS*) KILLED BY FIRE, SOUTH END OF WHITE RIDGE, NEAR MIDDLE FORK OF SUN RIVER

A. LODGEPOLE PINE FOLLOWING LARCH AND YELLOW PINE,
KILLED BY FIRE.

B. GROUP OF RED FIR (*PSEUDOTSUGA TAXIFOLIA*) PROBABLY
KILLED BY DROUGHT.

Ascending the mountains, the rate diminishes until, near the line of perpetual snow, the annual rings are sometimes so thin as to be invisible to the naked eye. Height growth is especially slow in exposed situations, where even the hardiest species, as spruce and balsam, are compelled to lie matted on the ground without being able to form an upright trunk. The rate of accretion on the stump of open-grown trees in the lowland is sometimes one-fourth of an inch in one year, while densely crowded trees, especially those overtopped, may have only one-hundredth of an inch in one year.

The rate varies with the species also, larch being one of the most rapid-growing trees and lodgepole pine one of the slowest. The average rate seems less than in the forests of the Lake States. Here a crop of timber trees can hardly be expected in less than one hundred years, even on the most favorable portion of the lowlands.

ACCESSIBILITY.

Along the eastern slope of the mountains there are few streams that are practically drivable for log timber, possibly only Sun River and Dearborn Creek, but Birch and Badger creeks may prove drivable with some expense. The timber on most of the streams must be hauled out when cut. The question of transportation, however, will probably be how to reach the local market, as the treeless plains immediately east of the mountains could consume all the timber this slope would produce, with the exception of the Sun River Valley. This stream being easily drivable would afford fair transportation to the more distant or general market.

The valley of the Middle Fork of Flathead River has its only outlet by the way of Java, on the Great Northern Railway, and the river would afford the most feasible means of transportation, as it would be drivable at moderate expense. Should a permanent system of lumbering be established in this valley an electric railroad would perhaps be desirable to take supplies up the river, and possibly even to haul up empty cars on which logs could be taken down, perhaps in successful competition to river driving.

The valley of the South Fork of Flathead has also an outlet to the north, and the river may possibly be made drivable, although there is some doubt on this point, owing to the crookedness of several box canyons. It would be somewhat difficult to construct a railroad in this valley, because of many deep ravines cutting through the bench land.

The valley of the headwaters of the North Fork of Blackfoot River, continuous with this valley and separated from it by an almost imperceptible divide, has so little timber that the question of transportation need not be considered immediately. The valley of Willow Creek and the headwaters of the North Fork of the Blackfoot have a very smooth bottom and railroad grading would be very easy.

The tributary valleys of the South Fork of the Flathead are more

difficult of access, and it seems probable that chutes and flumes may be the best means of getting the material out to the main valley.

The Swan-Clearwater Valley, at least between Clearwater Lake and Goat Creek, can probably be worked best by a logging railroad, as the streams have many gravel bars and many places where logs would float out into the brush during high water. Logs put into Swan Lake could be easily driven to Flathead Lake, a favorable point for manufacturing.

The divide between the Swan and the Clearwater valleys is a low one, and offers no serious obstruction to a railroad if it should be found desirable to take logs over from Swan River to the Blackfoot.

Throughout the reserve are large areas on the mountain sides that can be logged only by means of chutes.

MARKETS.

At the small mills east of the mountains rough sawed lumber brings \$16 per thousand feet, and the deadwood is worth 25 cents a cord on the stump at Midvale, and would, doubtless, command that price all along the range southward. Log timber east of the range should be worth \$1 per thousand feet on the stump in the more accessible regions, but quite a large proportion of it, possibly 50 per cent, has no value because of difficulty of access.

West of the Continental Divide probably nothing within the reserve has a market value to-day, owing to the difficulty of transportation. Improvements to make the timber accessible would doubtless be profitable at once in the Swan River Valley, and capitalists able to make these improvements could probably afford to pay a moderate stumpage value on the standing timber.

Outside of the reserve, along the Great Northern Railway, the mountain slopes, though steep and rocky, are fairly accessible, and the material on them should have a slight stumpage value under a thorough system of cutting and marketing.

SUGGESTIONS FOR MANAGEMENT.

Considering the configuration of the land, the isolation of the valleys, the liability of fire, the difficulty of two or more operators working in the same valley, the benefit to the operator of having control of a definite area and also of the means of transportation leading to it, and the advantage of having one person responsible for fires or depredations in a single district, it seems advisable that the right to cut in each valley be leased entirely to one person, and that the lease be made for a long time. This person could then improve the stream, make flumes or roads, establish a permanent mill plant, and carry on his business in conformity with a system of forestry that should, of course, be decided upon before the lease is made. Under such a system of leases there would be an opportunity both for small and large operators.

1. EFFECT OF REPEATED FIRES.

2. EAST SHORE OF SWAN LAKE, NEAR BOND'S.

The small valleys east of the Continental Divide would be suited to those only who run small mills and who would sell their sawed lumber at the mill to people from the plains, and who would handle fuel and fence poles as well as log timber.

The timber west of the divide must seek a more distant market, as there is not now, and probably never will be, any great local demand. The management of these lands should conform to the necessity of such operators as could manage them.

REGULATIONS SUGGESTED FOR CUTTING.

A mere restriction or limitation to certain sizes, such as permitting only trees over 12 inches in diameter to be cut, while perhaps a convenient rule for loggers to work by, would be very injurious to the forest. In fact, a forest could hardly be in worse condition than this rule would bring about. The forest needs thinning, but this regulation would not accomplish that object. As the forest stands now there are patches of large trees and patches of small. Under this rule the tracts of large trees might be cut clean, while the patches of small would be left untouched, however much they might be in need of thinning. This is found to be the effect under the present system, and such a rule would not make any material change in the custom. The thing to be done is to provide a market for both large and small material and have the trees to be cut marked, so that while getting out marketable material the condition of the forest may also be improved, and after logging is over be left in as good or even better growing condition than it was before.

MINING.

No ore is being shipped from the reserve at present. A few copper and silver claims are held on Smith Creek, and a few on the lower portion of the South Fork of Flathead River. At the "coal banks," about 25 miles above the mouth of the river, a tunnel has been driven in the bank of the river along a bed of lignite coal.

CLIMATE.

There are very great differences of climate between the bleak and frosty alpine summits and the sheltered canyons above 5,000 feet. The dwarfed trees on the mountain ridges show the effect of cold weather, frequent storms, and lingering snow, although in sheltered canyons or gulches a short distance away they may be growing luxuriantly at the same altitude.

There is also a marked difference in the climate east and west of the mountains. During the severe storm or blizzard, with deep snow fall, that raged on the plains about the middle of October, there was in the Swan River Valley only a moderate amount of wind and only about 6

inches of snow. While a temperature of about 20° below zero was reported from the plains, in the Swan River Valley it was little below freezing.

A corresponding difference was found in the vegetation. Certain species which love moisture and are unable to endure much exposure are found in the western valleys, but do not appear east of the Continental Divide. Among these are larch, white pine, cedar, hemlock, and yew. Some of the higher ridges east of the Continental Divide seem to have been wooded with a stunted growth of alpine trees. Now a few pieces of pitchy roots are found on the rocks above the present timber limits. Such places were noticed on Birch and Deep creeks, and on the ridges about the headwaters of Ford Creek. This suggests that the climate may be growing drier. The great number of red fir found dead on the eastern slope in places most subject to drought indicates the same thing. On the South Fork of Depuyer Creek, where some cutting has been done in a mixed forest of red fir, Engelmann spruce, and lodgepole pine, the mountain side was patched with areas of dead, or half-dead trees (see Pl. XVI, *B*). One of these areas was found along a skidding trail, worn to a depth of 2 feet below the surface. Walking along this trail it was noticed that among the dead trees the bottom of the trough was dry and hard, while among the adjoining live trees it was moist. The dead trees were not older than the living, and no other cause could be found for their dying than the fact that the ground where they stood was drier than that on which the living trees stood.

OCCUPANCY.

Most of the land occupied by squatters east of the Continental Divide is on the plains, in the angle south of Birch Creek. These squatter claims were not all located in passing. There are probably 6 or 8 in this angle (see Pl. XVIII, *A*). If the reserve line were drawn close to the foot of the mountain these would be excluded.

On Ford Creek a ranch and a herder's cabin were seen. The ranch is not far within the reserve line. About the ranch are some 30 acres under cultivation, and the owner of this ranch, in company with others, had some 500 cattle and about as many sheep grazing on the hills about the headwaters of the stream.

On Sun River, the ranches of Wagner and Hannon are well within the reserve. Wagner has a log house, barn, and pasture fence. Hannon, on Storehouse Creek, has some 20 or 30 acres in meadow, with house and outbuildings and several fences across the lower portion of the valley. He has some stock. Thirty of his horses were found grazing on the North Fork of Sun River.

On Teton Creek, McGurk's mill, and on Smith Creek, White's mill lie within the reserve, and about them are clustered several houses occupied by the employees.

A. HOUSE OF A SQUATTER ON THE RESERVE

B. COLONY OF HALF-BREED WOODCUTTERS ON SOUTH FORK OF TETON CREEK.

.1. HOLLAND'S RANCH, UPPER SWAN RIVER VALLEY.

R CUTTING LODGEPOLE PINE

On Dearborn Creek, near the mouth of Falls Creek, and on the South Fork of Teton Creek are groups of cabins occupied by half breeds, who cut wood on the reserve and haul it out to market on the plains (see Pl. XVIII, *B*).

A lime kiln is being operated by Mr. C. V. Clemens near the mouth of Falls Creek.

On the South Fork of Depuyer Creek, Alex. Yule has a sawmill at the mouth of the canyon, and above the canyon has several houses occupied by his loggers.

On Willow Creek, or the east branch of the South Fork of Flathead River, Mr. James Donahue has a stock ranch and about 100 head of cattle and horses. A few cabins, built by trappers or prospectors, were seen here and there in passing down the valley.

At the coal banks, Batti's cabin was found occupied, and a few miles above this, on a branch of the main valley, there are prospectors' cabins occupied at times.

In Swan River Valley are several squatters about the head of Swan Lake, but they have few improvements except their houses. Between this and Hollands there are about 10 log houses, all of them unoccupied.

Holland's ranch, at the mouth of Holland Creek, comprises several log houses and stables. Mr. Holland has several hundred acres fenced in, which he is using as pasture for cattle and horses (see Pl. XIX, *A*).

At the foot of Elbow Lake is a trapper's cabin, occupied at present.

On the Clearwater, Mr. Seeley, a forest ranger, has occupied a ranch at the head of the lake for several years. He has recently built a larger house, near the foot of the lake, and within about one-fourth of a mile of the reserve line.

FISH AND GAME.

All the waters of this region are remarkably full of trout, of which there seems to be several species. The most abundant are about a foot long and weigh from one to two pounds. Salmon trout were seen on the South Fork of Flathead River, the largest being 36 inches long.

East of the mountains large game has been hunted until a track is seldom found.

In the center of the reserve, however, are elk, moose, goats, sheep, black- and white-tailed deer, and the several species and varieties of bear common in the Rocky Mountains. Blue grouse are abundant, especially eastward. The common ruffed grouse are rare eastward, but abundant in the Swan River Valley. The fool hen is common everywhere in medium altitudes.

SCENERY.

This region, though not as alpine as the Flathead Reserve, has many high mountains and rugged hills.

There are a few glaciers, a small one at the head of Gordon Creek,

one near McDonald Peak, and the Stanton Glacier, west of Essex, one of the largest in the range.

The peaks about the Stanton Glacier, Scapegoat Mountain, Turret Mountain, Silvertip, and Pentagon on the main range, three or four points on the Kalispell Range, and McDonald Peak on the Mission Range, are 8,000 to 10,000 feet high and afford excellent views, while the valleys, though much marred by fires, contain many attractive places. The opening of the trails by the forest rangers is rapidly making the region accessible by saddle and pack horses.

EXPLANATION OF MAPS.

It should be said, in explanation of the maps, that sharp lines on the maps for distribution of species and the limits of burned areas do not represent the actual condition in the forest. A blending of adjacent colors and a fading out toward the prairies and toward burns would, in most cases, represent the actual condition far better, but as it would be impossible to print such a map the lines are drawn sharp, and are thus only approximately correct. The borders of light burns may actually be several miles from the lines shown on the map, because, creeping lightly over the surface, some of them do so little damage that the effect is not noticeable from a distance, and the line could only be mapped by the slow process of tracing its course with compass, and pacing through all its meanderings. A few of the borders of burns are found sharp and definite in the forest, but where they are not found well defined in the woods the line is drawn on the map as near as possible where half of the forest has been killed.

There was difficulty, also, in determining the lines on old burns that have been more or less restocked, and there may be many inaccuracies on this account. Where the dead trees of a burn are still standing the distant view of such a tract gives the impression that the line should be drawn at the border of the deadwood. This is approximately correct, because usually the deadwood falls before any young stock that follows could become large enough to be called a forest. Where young stock, 15 feet or more high, was found on old burns it was marked as forest.

In marking the distribution or habitat of species one never feels certain that he has found the extreme limit of distribution, but thinks more of the same kind may possibly be found beyond. In mapping, the outmost known points were joined by lines that seemed, according to known habits of the tree, the most probable in consideration of the climate and topography.

It should be said that red fir, lodgepole pine, alpine balsam, and Engelmann spruce have a general distribution over the reserve, with the exception that red fir and lodgepole pine are not found above 7,000 feet. For this reason the distribution of these trees has not been specially indicated on the map.

A. CONTINENTAL DIVIDE, FROM HEAD OF LITTLE BADGER CREEK

B. DÉBRIS FROM BURNT MOUNTAIN VALLEY TRIBUTARY TO DEARBORN RIVER.

From southwest slope of Mount Dearborn, 5 miles west of reserve line.

MISSOURI RIVER DRAINAGE OR EASTERN SLOPE OF CONTINENTAL DIVIDE.

Topography.—This tract, lying between the Great Plains on the east and the Continental Divide on the west, and between the Great Northern Railway on the north and Lewis and Clarke Pass on the south, is 12 to 30 miles wide and about 65 miles long, with an area of about 1,600 square miles. A small portion of this strip is level, undulating or rolling prairie, with general eastward slope. The foothills are mountainous, often precipitous toward the east, the tilted rock beds dipping southwestward, with their upturned edges exposed in cliffs fronting the plains, especially along the parallel ridges north of Haystack Butte. The numerous canyons formed by the streams cutting across the tilted strata are usually sharp and deep. The altitudes range between 5,000 and 9,000 feet (see Pl. XX, *A*).

Rock.—The peaks, ridges, and canyon walls of this region are composed of gray limestone. Very little other rock was found except on Birch Creek and the Teton creeks, where schists underlie the limestone unconformably, and on Smith Creek, where injected metamorphic rocks appear. The rock of the plains and some of the lower foothills resembles the Cretaceous beds common farther east. Among the limestones are some beds of slates and quartzites, but probably over 90 per cent of the rock on this strip is limestone. It is gray to buff in color and contains many fossil corals and brachiopods.

Soil.—The soil seems fertile and productive when moist enough. Probably 20 per cent of the area is without soil, the surface being bare rock, especially on the summits and steeper slopes. About the eastern foothills some alkaline spots are found, but such areas are small. In mechanical composition there is endless variety. Some clays are found along the eastern foothills and, rarely, in parts of the valleys among the mountains. Gravels prevail along the lower portions of streams or wherever alluvial deposits have been formed. Loam is found among the rocks on the slopes and, usually, near the hills along the creek bottoms.

Subsoil.—Clay subsoils are rare, although they are found east of the mountains, where there are many lakelets and ponds in the foothills. Clay is also found in the valleys of the mountain streams above dams caused by slides and mountain torrents or by the action of the now extinct glaciers. The greater portion of this tract has its scant soil resting directly upon the rock, but gravels and bowlder clays are to be found on perhaps 30 per cent of the area, especially in the valleys of Sun River and Dearborn Creek.

As a rule, humus is very light, owing to the dry climate, the frequency of fires, and the steepness of the slopes. On about half of the surface there is practically no humus, and on the remainder the soil is seldom colored to a depth of more than 3 or 4 inches. Where

the foothills are so well watered as to prevent fires burning the humus, as about the mouths of the ravines and around springy places, there is often a foot of black soil. Without careful observation one may be led to believe the humus much more abundant than it really is, by seeing several feet of dark earth in the banks of some streams. Such deposits are small and are only in places where wash from the mountains or hillsides has accumulated. In forest which has been unburned for fifty years or more, as in the damp basins, sometimes 6 inches of black earth are found, but such areas are neither numerous nor large.

Litter.—Deadwood *débris* is not abundant. Although a large proportion of the trees are dead, the fires that killed them have as a rule been so recent that the deadwood has not fallen, while most of the *débris* from the older fires has been consumed by the later fires. In the remaining area of unburned forest, fallen leaves have accumulated to a depth of several inches.

Trees and timber.—The areas of forest that have escaped the general burn of 1889 and the other and lesser fires, both prior and later, are few and excepting along Badger Creek, Birch Creek, the South Fork of Depuyer Creek, the North Fork of Teton Creek, the South Fork of Deep Creek, and portions of the valleys of Smith Creek and Dearborn Creek the areas are so small and so remote and inaccessible as to make the timber on them of no commercial value. The amount of timber, regardless of accessibility, is roughly estimated on the basis of present usage in the northern middle States as follows:

Estimate of timber in Missouri River drainage in Lewis and Clarke Forest Reserve, Montana.

Areas.	Log timber.	Green small wood.
	<i>Meq. B. M.</i>	<i>Cords.</i>
Badger Creek	10,000	300,000
Birch Creek	1,200	26,000
North Fork of Depuyer Creek		3,000
South Fork of Depuyer Creek	2,000	24,000
North Fork of Teton Creek	2,000	70,000
South Fork of Teton Creek	500	5,000
South Fork of Deep Creek	3,000	20,000
North Fork of Sun River	20,000	550,000
Middle Fork of Sun River	20,000	430,000
North Fork of Ford Creek	300	6,000
Smith Creek	2,000	25,000
Dearborn Creek	2,000	120,000
Additional small areas		660,000
Total	63,000	2,239,000

1. MILL ON SOUTH FORK OF TETON CREEK.

2. LOOKING UP VALLEY OF NORTH FORK OF SUN RIVER

The additional small areas mentioned are scattered along the eastern front of the mountains. They are small tracts that have escaped fire. The wood on them is short and knotty—fit only for fuel. There are also on these slopes and on the foothills, fairly accessible from the plains, some 200,000 cords of deadwood of inferior quality, most of it killed by the fire of 1889.

The species composing this material are in order of predominance: Lodgepole pine, Engelmann spruce, Douglas spruce, and limber pine.

Engelmann spruce is the favorite log timber among the sawmill men. The wood of this species is white and tough. Though knotty, there are few black knots. In size some of the largest trees are 30 inches in diameter, and sometimes contain 500 feet of lumber.

Douglas spruce or red fir is usually small and very defective. Trees appearing sound on the outside often open with soft red, rotten spots in the heart or near the branches. The largest are about 30 inches in diameter.

Lodgepole pine is most generally distributed, and is mostly sound. While it is ignored and even considered a nuisance by some, its value will before long be appreciated. Farther west, where there is a moister climate and where larger and more sought timber can thrive, there may be some valid objections to its habit of densely occupying the ground immediately after a fire. Here it only occupies land on which other species do not thrive and produces lumber where no other species would. It reaches a diameter of 24 inches and a height of 70 to 80 feet, and is more frequently clear than any other timber. Logs as small as 5 inches at the top are sawed, and the lumber is sold (rough) for \$15 per thousand, the same price as spruce and red fir, but it is sold under the name of "white pine."

Limber pine (*Pinus flexilis*) is usually so crooked and knotty as to be worthless for log timber and for the same reason is of little value for fuel.

Nut pine (*Pinus albicaulis*), while common in the higher altitudes of this region, is of no commercial value at present because of its inaccessibility. It is frequently found growing tall and straight, 8 to 10 inches in diameter and 60 feet high. It is easily distinguished from other white pines by its purple cones.

Cottonwood is found all along the lower streams, but seldom as log timber.

Aspen is usually associated with lodgepole pine and often succeeds limber pine on the burns.

Balsam is common only at high altitudes and is commercially unimportant for timber.

All species vary greatly according to exposure and moisture. Those that venture on the higher summits, which are both dry and exposed, form only mats upon the ground, while the same species in well-watered localities sheltered from the wind make large trees.

On the slopes a graduated difference is noticeable, according to the soil, moisture, and exposure. On the south side of Depuyer Creek where timber was being cut at an altitude of about 7,000 feet, Engelmann spruce, lodgepole pine, and Douglas spruce, on moist soil, average 150 to 500 feet per tree, but on the drier ground very few trees were large enough for log timber, and many of these were defective. In looking over the mountain side in this basin many small, brown areas of deadwood appeared in the green forest. These were first supposed to be the effect of fire, but examination proved them unburned, but on dry ground where no moist earth could be found near the surface.

Young growth.—Throughout the portion of this region facing the plains, an area of 600 square miles, tracts of young growth in good condition are rare. Where fires have run they have been so severe that over large areas no seed trees and no seeds have been left. In fact, on most of these burns the humus has been consumed. The few burns that have been restocked are about the basins at medium elevations where fires have been less severe, owing to greater moisture. Such restocking is best near the unburned tracts. In moving southward from the Great Northern Railway, a scant restocking was found on the Two Medicine drainage covering probably 4,000 acres south of the railway. South of that area the following small tracts of a few acres were seen: On Little Badger Creek (south of the stream), about 1,500 acres; about the head of Big Badger, some 5,000 acres; on the South Fork of Depuyer Creek, 500 acres; on Storehouse Creek, some 2,000 acres; on Beaver Creek, probably 3,200 acres; on Ford Creek, some 500 acres; on Elk Creek, 1,200 acres; on Dearborn Creek, 3,000 acres; on Falls Creek, 2,000 acres; a total, roughly approximated, of 37,000 acres.

Underbrush.—Underbrush is scant throughout this region. Only on the dampest ground is there enough to cause serious resistance to travel. The prevailing species on the northern slopes are brittlebrush and huckleberry, while along the streams are clumps and narrow strips of dogwood and willow. In the higher altitudes much of the brush consists of species that under favorable conditions form trees. Such are balsam, limber pine, and Engelmann spruce. In the higher ravines near the Continental Divide, especially under Engelmann spruce, brush is often found so thick as to be a serious hindrance to travel, but unless accompanied by fallen timber it does not form an impassable barrier.

Fires.—Outside of the reserve about 45 square miles along the Great Northern Railway and 95 square miles in the foothills bordering the plains have been very seriously burned.

Of the 1,600 square miles within the reserve nearly 600 have been seriously burned within the past 40 years. Besides this severely burned area there are many lightly burned areas that now have some

A. VALLEY OF NORTH FORK OF SUN RIVER, LOOKING SOUTHWARD TOWARD JUNCTION OF NORTH AND MIDDLE FORKS.

B. HEAD OF MIDDLE FORK OF FLATHEAD RIVER.

dead trees killed by fire, but are principally wooded. There are also many areas of old burns that have been restocked. The areas shown as burned have been severely burned. The fire of 1889, which seems to have run over most of this area, occurred during a very dry time, and most of the ground over which it ran has only dead trees and a very small amount of humus left. Within this area this fire covered about 530 square miles, most of which is now bristling with dead trees, except in places previously burned. On such places nearly all the material has been consumed. A previous fire covered an undetermined area, the signs of it being on much of the ground, obliterated by later fires. On some 50 square miles, principally along the Continental Divide, plain evidence of the fires of this period remain. The dead trees and stubs left by these fires are better preserved in the high altitudes than in the valleys, as, being more isolated, they have partially escaped the later fires, which, on the foothills bordering the plains, have obliterated nearly all traces of the forest they have destroyed. Only occasional stubs and roots remain in the grass or brush. The dates given on the maps are those of the later fires.

Reproduction.—The area restocked is about 6 per cent of the area burned over. Almost invariably the restocking has been with the same species that occupied the ground before. There is, however, a noticeable increase in the proportion of lodgepole pine, doubtless owing to the more abundant seeding of this species and the favorable condition for its growth after fires. . Where spruce and balsam lands have been burned over the new stock is invariably sparse. That this is the usual habit of these species in restocking is inferred from the condition of all of the old forests composed of them. Such forests do not have trees of uniform age, but always have young trees coming in among the sparse old stock. Reasons for this condition are found both in the scant seeding of these species in the higher altitudes where they grow and in their preference for shade in which to germinate and grow while young. Old forests of lodgepole pine frequently have young spruce and balsam as an undergrowth. The extensive, almost continuous burns on the foothills once partially covered with limber pine (*Pinus flexilis*) have not been restocked and so far as covered with vegetation have only weeds and brush if recent, or bear grass and scant forage plants if old. The principal bushes are willow and aspen. Young trees of limber pine are found on the half barren knolls that reach out into the plains and on the recently and severely burned lands. The condition of the burned land is most desolate. Only about 6 per cent of it is restocked and the remainder bristling with deadwood, standing or fallen, sometimes has no plants growing upon it, especially if high in altitude or dry. Most of the area, during the years that have passed since the fires, has grown only a scanty stock of weeds, grasses, or brush. The best pasture grasses are seldom found on the burns. Pine

grass and "bear grass" (never eaten by stock) are more prevalent on such lands than the bunch grasses, but some grazing land is now found on the once wooded portions of the foothills. Although some ten years have passed since the principal fire, only about half the burned area is now covered with vegetation, and that is of very much less economic value than the original stock.

Effect of burns on water flow.—In the valleys or basins most thoroughly burned over the widening of the streams and the increased washing down of bowlders is quite noticeable. The valleys of Dearborn River, Ford Creek, and the forks of Teton Creek are much washed, the wide gravel and bowlder beds of the water courses being a prominent feature of the landscape (see Pl. XX, B).

Deadwood.—Wherever severe fires have recently run through the forests deadwood is standing. Even some of that killed by fire forty years ago remains standing, but only on the higher and drier portions where the climate is more favorable to the preservation of deadwood. Very little of such old material is suitable even for fuel and under the estimates only that killed within the past ten years which is standing and is suitable for fuel, fencing, or house logs is considered. None of the old deadwood is marketable as log timber. The estimate of the amount more recently killed is necessarily very rough and only approximate as follows:

Estimate of deadwood in valleys east of Continental Divide, Lewis and Clarke Forest Reserve, Montana.

	Cords.		Cords.
Two Medicine Creek.....	100,000	Other valleys, southward to	
Little Badger Creek.....	500	Beaver Creek	8,000
Badger Creek.	500	Beaver Creek.....	5,000
Birch Creek.....	30,000	Ford Creek.....	2,000
North Fork of Depuyer Creek .	10,000	Smith Creek	1,000
Black Leaf Creek.....	5,000	Elk Creek	1,000
Other valleys, southward.....	10,000	Dearborn Creek.....	80,000
North Fork of Teton Creek....	10,000	Falls Creek	20,000
South Fork of Teton Creek....	12,000	Sun River.....	200,000
Other valleys, southward	6,000		
Deep Creek.....	3,000	Total	504,000

Some 20 per cent of this may have a stumpage value of about 25 cents a cord. The remainder is probably worthless, because of difficulty of access.

Cutting.—All that portion of this region fairly accessible from the plains has been invaded by ranchmen and by others cutting for village use. Wagon roads were found leading from the plains up almost every stream, and over these wood and poles, when needed, are hauled in small loads. Often the material can be taken out only with great difficulty. It is often cut high on the mountain slopes and slid down to the roads. In some places it is hauled a long distance from the stump to the wagon, where it is loaded, frequently 40 miles from where

4. HOMESTEAD CABIN.

5. NATURAL THINNING AMONG LODGEPOLE PINE, UPPER SWAN RIVER VALLEY.

it is to be used. Several small sawmills have been operated, and three were found running. On the South Fork of Depuyer Creek up to July 17 some 1,600 trees, scaling about 300,000 feet, had been cut in the basins and floated through the canyon to its mouth, where they were sawed and sold rough for \$16 per thousand. On the South Fork of Teton Creek is a mill about 6 miles from the plains (see Pls. XIX, *B*, and XXI, *A*). In this valley about 1,000,000 feet of lumber and 6,000 cords of wood and poles have been cut. On Smith Creek a mill has been operated some years, and from this valley about 1,000,000 feet of lumber have been taken, most of it lodgepole pine and spruce (see Pl. XII, *A*). It is not far from the unsurveyed reserve line, but there is little doubt it lies within the boundaries. On Dearborn Creek something over 100,000 ties were cut and floated to the Helena branch of the Great Northern Railway when that line was being built. In the valley of Falls Creek, a branch of the Dearborn, large quantities of poles and fuel have been cut. August 2 a party of half-breed Indians was found cutting 10 to 20 loads a day and hauling them to market on the plains.

Owing to the desultory manner of such cutting, accurate estimates of the amount cut are impossible without much time and labor.

Approximately the following amounts of both green and dry material have been cut within the reserve:

Estimates of cutting east of Continental Divide, Lewis and Clarke Forest Reserve, Montana.

Locality.	Cords.	M feet B. M.	Ties.
North of Badger Creek	2,000	.....	.....
Badger Creek	2,000	.....	.....
Birch Creek	2,000	.....	.....
Birch to Teton Creek	5,000	.....	.....
South Fork of Depuyer Creek .....	.....	300	.....
North Fork of Teton Creek	6,000	1,000	.....
South Fork of Teton Creek	5,000	600	.....
Teton to Sun River	22,000	.....	.....
North Fork Sun River	25,000	.....	200,000
Sun River to Smith Creek	10,000	.....	.....
Smith Creek .....	.....	1,000	.....
Dearborn River .....	.....	.....	150,000
Falls Creek	3,000	.....	.....
Total	82,000	2,900	350,000

Transportation.—The point on this land nearest the railroad is about 5 miles distant and the farthest is about 80. The streams, with the exception of Sun River, are of little value for transportation, as they

are rapid and rough and the diversity of their directions and the small amount of timber to be marketed from each would hardly warrant their improvement for log driving, although the water could often be used to advantage in bringing material from the mountain basins to the mouths of the canyons on the border of the plains, the most favorable situation for mills.

Demand.—Demand at present is purely local and only from the plains eastward, whence ranchmen and villagers look to the mountains for all their wood material. Sawed lumber brings \$16 a thousand at the mill in the foothills and, according to accessibility, should bear a price of from \$1 to \$3 a thousand on the stump. Fuel and fence poles, though nothing has heretofore been paid for them, should be worth 25 cents a cord on the stump. The amount of material used on the adjacent plains will be greatly increased as irrigation is developed and the land capable of agriculture cultivated.

Agricultural land.—There are on this portion of the reserve approximately 150 square miles of land that have some agricultural value. Some of it is cultivated now and is very productive of crops not liable to injury by frosts. Timothy grows especially well. About 80 square miles of this land lies east of the foothills in that angle of the reserve reaching into the plains south of Birch Creek. This land should be opened to settlement. On the North Fork of Sun River, the tract next in size, are about 5 square miles of agricultural land (see Pls. XXI, *B*, and XXII, *A*). The remainder is in small isolated areas here and there, not adapted to farming, but of value for raising hay and vegetables for the use of men employed in the forests.

Irrigation.—The amount of water used in the reserve at present is insignificant. Perhaps altogether 100 acres are now under irrigation. These lands are some garden spots and hay land in the angle south of Birch Creek; Hannon's ranch, on Storehouse Creek (a branch of Sun River); and two ranches on Ford Creek. East of the reserve several large ditches are being used. The only one of these reaching the reserve is that tapping Dearborn River at the mouth of Falls Creek. The possibilities of irrigation on the plains eastward are great, as there is a large amount of rich, irrigable land. In view of the future demand for water, the destruction of the cover on the mountains is greatly to be regretted. Although the principal burns occurred only ten years ago, their effect upon the waterflow is plainly noticeable in the widening of the streams, the cutting of the banks, and the great deposits of gravel.

Occupancy.—While no great amount of the land is utilized, small tracts are used here and there. Most of these are on the plains, in the angle south of Birch Creek. These were not examined in detail. On Sun River are two ranches, Hannon's and Wagner's (see Pl. VI, *B*). Hannon has about 100 acres under cultivation and in pasture, while

1. ENGELMANN SPRUCE ON MOUNTAIN SIDE, SOUTH OF UPPER MONTOUR CREEK.

2. STUMP LAND UNBURNT ADJOINING RESERVE ON SOUTH

Wagner has 200 acres fenced in in pasture, and Hannon has about 30 horses on the North Fork of Sun River. On Ford Creek two ranches were found; one, recently established, has no land under cultivation; the other, on the main stream, has about 100 acres in grain and hay. At the head of Ford Creek about 500 cattle and as many sheep were found grazing July 27. This stock is owned by several different persons, the Fords, having ranches on the lower creek, being the principal owners. About the mouth of Falls Creek are several cabins occupied by half breeds who cut and saw wood from the reserve. About 5,000 sheep, said to be owned by J. C. Fay, of Hogan, Montana, were grazing in the valley of Falls Creek August 1.

Water power.—The numerous streams (averaging about 6 miles apart) furnish many water powers along the eastern border of the reserve. Sun River, the largest, was about 300 feet wide and 3 feet deep, with rapid current July 24. Dearborn River, next in size, was 100 feet wide, 2 feet deep, and moderately rapid. Ford, Deep, Depuyer, Birch, and Badger creeks in July were each 25 feet or more wide and 2 feet deep, with strong current.

Mining.—Some prospecting for gold and copper is being done on Smith Creek. Otherwise no mining operations were noticed. The principal rock is limestone.

VALLEY OF MIDDLE FORK OF FLATHEAD RIVER.

Topography.—This valley lies partly within and partly without the reserve. About 576 square miles, in a fairly compact body, are included within the boundaries. The portion of the valley outside the reserve is a strip, seldom more than 4 miles wide, along the Great Northern Railway. The portion within the reserve, while not reaching into the highest altitudes of the range, is still very rough and mountainous, excepting along the bottoms of the main valley and the two principal branches. With this exception there is very little level land. The principal areas are occupied by irregular mountain ridges and peaks, the highest of which hold snow in drifts throughout the year. The portion outside the reserve is simply a mountain side along Summit Creek and the Middle Fork of Flathead River below the mouth of Summit Creek.

Rock.—Limestone is the principal rock occupying the summits of all the higher ridges, but shales and schists are found in the banks of the river where it cuts across the range. Some beds of quartzite outcrop in the mountain sides, but these are much thinner than those in the mountains north of the railroad.

Soil.—As the soil is derived principally from limestone, it may be expected to be rich in plant food; and, in fact, wherever there is moist earth, unencumbered by snow, vegetation is luxuriant. A large part of the mountain summits is bare rock. Much of this area was once

wooded, but fires have so thoroughly consumed the mosses and humus covering the surface that trees could not grow there now.

Litter.—The amount of litter in this valley is greater than in any of the others. On the burned areas the trees killed by fire form a network over the ground, except where fires have been repeated and severe. On the unburned areas, covering nearly all of the two main forks of the valley, the old trees and others killed by overcrowding have fallen and such an amount of material has accumulated that it is difficult to take horses through the woods.

Humus.—Corresponding with litter, humus is very light or wanting on the burns and heavy where the forest is uninjured by the fire. Both the west branch and the east are covered by a dense growth of trees, and excepting a small area near the forks have escaped fire many years. This freedom from fire has permitted humus to accumulate to a depth of 2 or 3 inches over most of the valley. There are occasionally willow bottoms where black muck has a depth of a foot or more, but these have no large area.

Trees and timber.—Of this tract about 124 square miles are timbered. Besides this, 110 square miles are fairly covered with wood, about 180 are naturally bare, being on the high summits, and 162 square miles have been severely burned. Outside of the reserve some 35 square miles are scantily wooded with spruce and balsam, with some lodgepole pine, larch, and red fir on the lower slopes—perhaps 20 million feet B. M. of log timber and 200,000 cords of other material. The remaining 115 square miles are either burned or naturally barren. The species here do not differ from those in the South Fork Valley. Engelmann spruce is the principal timber tree. Larch, red fir, and lodgepole pine follow in importance. Balsam abounds on the higher mountain slopes, but is of little or no commercial importance. White pine may occur, but it was not noticed.

Estimates.—The amount of log timber in the portion of the valley within the reserve is roughly estimated at 154 million feet B. M. Besides this log timber, there are about 1,500,000 cords of material unfit for the saw. The log timber is about 30 per cent spruce, 25 per cent larch, 20 per cent lodgepole pine, 20 per cent red fir, and 5 per cent other species. As to size and quality, there is great variety. In the ravines are tall and straight spruce of rapid growth and usually sound, while on exposed ridges are dwarfed and knotty trees often defective.

Young growth.—Except on the burn on the main fork of the stream, there is no great amount of young growth. On the larger burns restocking has been scant and the trees are yet small. Among the older trees some young ones have started as the mature trees have fallen and made openings. These are of various sizes and are promising for timber. But there are not in all cases enough to form a new stock of desirable kinds if the old trees were cut. The abundance of brush is a serious hindrance to the starting of seedlings.

A. SWAN LAKE, LOOKING SOUTHWARD FROM POINT 3 MILES ABOVE OUTLET.

B. LOOKING TOWARD McDONALD PEAK FROM SWAN-CLEARWATER PASS.

Underbrush.—Underbrush is more abundant than in any other portion of the reserve. The litter and brush make the trail through this valley almost impassable. Most of the hills east of the river, however, have been burned until they are almost free from brush. West of the river burns are older and brush has had time to reappear.

Fires.—About 95 square miles within the reserve and 60 outside of it have been severely burned within the past twelve years. The hills east of the river are almost barren as a result of fire. The origin of most of these fires seems to have been along the railway, and they probably started either during the grading operations, or from sparks, cinders, or camp fires along the line since. It is said that at the time of the grading of the road there were two dry seasons, and fires were burning everywhere through the mountains. These statements are confirmed by the conditions in which we now find the forest. The fires at this dry time were almost invariably severe, killing all the forest through which they ran. Very few trees, indeed, are left living; only a few clumps in damper places, often several miles apart. Owing to the severity of these burns, reproduction has been scant. Most of the new stock is lodgepole pine, and most of this is near the border of unburned forests. Probably not over 20 per cent of the burns are restocked with seedlings of any species. The view over the mountains south of Bear Creek reveals a very few small unburned tracts in the most sheltered places, but the surface is nearly all bare, with the exception of a few dead trees, either standing or fallen.

Deadwood.—Perhaps 100,000 cords of deadwood are standing within this portion of the reserve and 150,000 cords outside of the reserve line along the railroad.

Cutting.—Within the lines of the reserve there has been no cutting except for camps and trails, but on the adjoining strip a great deal was cut during the construction of the railway for ties, bridge timber, and fuel. No attempt was made to estimate the amount of this material, as there was not time.

Transportation.—The only outlet for this valley is down the stream. The stream is drivable at moderate expense, and at Java touches the Great Northern Railway. The material outside the reserve, in the narrow strip along the railway, is, compared with the rest of the region, very accessible, as it is only necessary to chute the timber down the mountain side to load it on the cars.

Demand.—Probably none of the material on this tract could be sold to-day at any price on the stump. East of this point, as at Midvale, and even near Summit, there is a growing demand for deadwood to be used on the plains eastward, but as this tract is on the western slope and below some of the heavier grades it could probably not compete at present with material from the eastern slope of the mountains, which now commands a price of only 25 cents a cord on the stump.

Agricultural land.—There is no prospect for agriculture in the valley except, perhaps, that on a few spots the vegetables or hay needed by lumbermen or miners working in the valley could be grown.

Water power.—Water power is abundant, the rapid fall of the stream furnishing many mill sites.

Occupancy.—There is no one living within the reserve, but along the railroad below are some three or four resident squatters. Essex is quite a little village, supported by railroad work, this place being used as a coaling station and for keeping engines used in helping up the mountain grade. At the other stations—Bear Creek, Java, Paola, and Nyack—are nothing but section houses.

Mining.—Along Summit Creek, not far above Java, are some mining prospects, staked during the season of 1898. Aside from these no claims were noticed in the reserve.

VALLEY OF SOUTH FORK OF FLATHEAD RIVER.

Topography.—The area of this tract is about 1,860 square miles. Excepting about 240 square miles draining into the Blackfoot, of which the surface is irregularly mountainous, with very narrow stream bottoms, this area comprises the whole drainage basin of the South Fork of the Flathead River. This basin is about 92 miles long and from 10 to 30 miles wide. It is bounded on the west by the high and sharp Kalispell Range, on the east by the Sheep Horn or Stanton Range, which southeastward joins the Continental Divide and with it forms an irregular boundary. This range has very rough topography on its western slope.

For some 40 miles above the mouth of the South Fork the valley is narrow and, excepting some recesses in the mountains eastward, fairly uniform, but above or southward the parallel ridges forming the foothills of the Continental Divide are sharply cut across by streams, and a very rugged topography is the result.

The west branch of the South Fork has a fan-shaped drainage, the western tributaries of which head in the mountains about Pend Oreille Pass and flow through sharp canyons until they reach the main stream.

Willow Creek, which joins the West Fork to form the South Fork of the Flathead, has a much broader valley bottom than the West Fork. Above the first canyon there is an area of gravelly land with a maximum width of about 3 miles. About 8 miles above the first canyon is a short canyon through a ridge which cuts the valley in two near its middle. Above this canyon is a willow bottom about 7 miles long and from half a mile to a mile wide. This glaciated U-shaped valley continues southward beyond the headwaters of Willow Creek to those of the North Fork of the Blackfoot. The divide between the two streams is so low that the headwaters of Willow Creek could easily be turned into those of the North Fork of the Blackfoot.

4. MIXED FOREST OF YELLOW PINE, LODGEPOLE PINE, AND LARCH.

B. YELLOW PINE AND LARCH, UPPER SWAN RIVER VALLEY.

Rock.—Limestone forms the principal crests on each side of the valley, and in the limestone are some beds of quartzite, the quartzite being most abundant southward, where a transverse uplift, which reaches across the whole Rocky Mountain Range, forms the divide at the head of the South Fork of the Flathead River. Along both the Sheep Horn and the Kalispell ranges green schistose rocks are found in occasional outcrops. The lower portion of the valley of the South Fork is occupied by Cretaceous or allied rocks, in which are some beds of lignite coal.

Soil.—Derived almost entirely from limestone rocks, the soil is productive wherever loam is abundant and well moistened, but large areas are gravelly and too thoroughly drained. Near the mouth of the tributaries, however, there are usually some areas of very fertile soil. The mountain ridges are usually bare and rocky. The slopes below produce a vigorous growth of such vegetation as can endure the peculiar variations of excessive moisture and drought to which these mountain sides are subjected. Throughout the valley are many isolated small areas of wet land, commonly called sloughs, which now have a growth of wire grass, flat grass, or blue joint. These have a deep accumulation of muck, which usually proves fertile after draining and weathering. The depth of the soil is usually very slight, seldom more than 2 or 3 inches on the bench lands, although it may reach 6 inches, or even a foot, about the mouths of ravines.

Subsoil.—The subsoil is greatly variable. In general, the banks and benches along the river are gravel; yet, in many places, clay banks are exposed in river bluffs and miry tracts of clay can hardly be avoided by the trails. For several miles below the mouth of White-water River much clay was noticed, both in the bluffs and on the river bottom. Some of these clay deposits are saline, especially near the tops of the bluffs, which are often 200 feet above the river. The beds are stratified and probably settled in post-Glacial time from water held back by a natural dam, a short distance below the mouth of Bear Creek. Such dams must have been common as the glaciers were receding, for along the main valley many terraces are seen and at several different levels. As a rule, the gravels do not extend far up the mountain side, and above them the subsoil is practically formed from the local rock and consists largely of clay mingled with rock fragments. The general color of the subsoil is a reddish buff or brown.

Humus.—Humus is fairly abundant, except on burns and gravel ridges, where it is slight in proportion to the intensity of the burn or the dryness and exposure of the ridge. This soil has been formed since the recession of the glaciers and is but slightly colored by humus. The color seldom exceeds a depth of 2 or 3 inches. In the unburned forest, well-decomposed material is commonly found 2 or 3

inches deep. But where burned, all such material is consumed, except in the damper spots, or where the fire has been exceptionally light.

Litter.—There is only a moderate amount of litter, even on the burns. Most of the fires that have occurred have been severe and have cleaned up the smaller litter quite thoroughly. That falling since the fire of 1889 is coarse and principally the trunks of trees killed by that fire. In the unburned woods the trees killed by overcrowding and the branches that are overshadowed and drop off accumulate to a moderate amount, but are seldom so abundant as to obstruct the passage of horses through the woods.

Trees and timber.—Larch, red fir, spruce, yellow pine, white pine, and lodgepole pine are the principal timber trees. In addition to these, balsam, nut pine, cedar, hemlock, and cottonwood occur, the first two abundantly on upper mountain slopes and sometimes reaching to the valley bottom. Silver fir and cottonwood occur sparingly (see Pl. XXIV, A).

Roughly estimated, according to the custom in the Lake States, the amount of log timber and other material above 3 inches in diameter is as follows:

Amount of log timber above 3 inches in diameter in valley of South Fork of Flathead River, Montana.

Species.	Feet B. M.	Cords.
Larch	176, 944, 000	1, 000, 000
Yellow pine	35, 388, 800	.....
Red fir	110, 590, 000	876, 000
Spruce	88, 472, 000	1, 096, 000
White pine	8, 847, 200	300, 000
Lodgepole pine	22, 118, 000	1, 008, 000
Balsam .....	.....	800, 000
Cedar, hemlock, and others .....	.....	50, 000
Total.....	442, 360, 000	5, 130, 000

The maximum sizes of the timber are approximately as follows:

Size of timber in valley of South Fork of Flathead River, Montana.

Yellow pine	40 inches by 90 feet
Red fir	36 inches by 80 feet
Larch	40 inches by 150 feet
Spruce	30 inches by 100 feet
White pine.....	30 inches by 125 feet
Balsam.....	20 inches by 70 feet
Nut pine	20 inches by 70 feet
Lodgepole pine	24 inches by 90 feet

LEWIS AND CLARK FOREST RESERVE MONTANA

Showing distribution of yellow pine, white-bark pine, and limber pine
Prepared under the direction of Henry Gannett, Geographer in charge

BY H. B. AYRES

Scale
0 5 10 15 20 25 30 Miles

Sketch contours
1899

LEGEND

- YELLOW PINE (*Pinus ponderosa*)
- WHITE-BARK PINE (*Pinus albicaulis*)
- LIMBER PINE (*Pinus flexilis*)

In quality there is a great variety, according to the situation where grown. In general, the timber has grown in dense forests and is fairly free from large knots.

The yellow pine, as usual, borders the prairies and other openings, and is limby above the first 25 or 30 feet from the ground. It is often fire scarred in the butt.

Red fir, while less defective here than on the eastern slope, is often found full of dry rot.

Lodgepole pine is usually sound and fairly clear, though small.

White pine is frequently defective; in fact, it is seldom sound. Much of it is dying, and in dying the sapwood turns blue. Besides this defect, it is common to find dry rot in the trunks, and the many defective logs greatly increase the cost of logging.

Some cedar 34 inches in diameter and 75 feet high was seen, but this size is exceptional. There are no large areas of this species. It is limited to ravines and other damp places.

Nut pine is greatly variable in quality, seldom being suitable for log timber, and where suitable it is so inaccessible as to be of no commercial value.

Young growth.—With few exceptions, there is a fair stock of young trees throughout the forest. The tracts not burned have young trees coming in where the old have fallen. Most of the burns in the low country are being fairly restocked, but the burns of 1889 were so severe that reproduction on them, as found on Hungry Horse, Upper Gordon Creek, and the eastern slope of the Kalispell Range, has been scant. Willow Creek, however, is fairly well stocked, but all the young growth there is small, usually from 2 to 10 feet high. But little of the unburned forest lacks sufficient young growth to constitute a new stock were the mature trees cut. On the burned land, however, the trees being small and usually all of one kind, the problem of thinning and securing a valuable stock would be a more difficult one, for the severe burns have little else than lodgepole pine.

Underbrush.—The species most abundant here are alder, maple, spiraea, dogwood, willow, brittlebrush, yew, juniper, redroot, and squawberry. These are often dense enough to form a serious obstruction to logging operations, especially on or near the bottom, where dogwood and yew are dense under the spruce. These species follow up the water courses into the gulches on the mountain sides, leaving ridges, especially the moraines, fairly free from brush. The northern mountain slopes, especially in high altitudes, have brittle brush and huckleberry in some abundance. The medium altitudes, both on the slopes and flats, especially if moist, have maple and yew often so dense as to be difficult to pass through; but the southern slopes and gravelly benches have some clumps of alder, service berry, squawberry, and redroot, but, as a rule, not enough brush to obstruct travel through them.

Fires and reproduction.—On the Blackfoot drainage about 175 square miles, and on the South Fork of Flathead inside of the reserve about 310 square miles, and outside of the reserve 10 square miles, have been burned over severely. Most of this area was burned, some of it for the second time, in 1889. All the burns indicated on the map (Pl. III) have been severe, and very few live trees are left on these areas. They frequently have a network of fallen trees, among which some dead trees remain standing. Most of the humus has been burned off, and the earth is left bare. Along the borders of surviving forests conditions seem to be favorable for reproduction. In such places the forest has furnished seed, which has found a good place to germinate in the bare surface left by the fire. Away from the green woods, however, and in the high altitudes, where seeding is less abundant and where the less productive balsam and spruce prevail, the young stock is far less abundant. In the valley of Willow Creek reproduction is especially good, and 40,000 young lodgepole pine to the acre are frequently found. Some of the damper areas have a stock of Engelmann spruce and red fir or larch. The areas subjected to repeated fires have very little new growth, and this is almost invariably lodgepole pine.

There is no doubt that some of the fires, especially on the higher ranges, are due to lightning, but most of those in the valley seem to have been set by Indian and other hunting parties or by prospectors. The trails most frequented by Indians, as the Jocko and Pend Oreille, are noticeably burned, especially about the camping places. The lower portion of the valley shows the effect of railroad fires, started either during the construction of the road, or by campers along the track, or by sparks from locomotives.

Effect of fires.—These fires have greatly reduced the area of wood lands; in fact, the forest here is some 450 square miles less on account of them. The humus and fine litter consumed has probably averaged 2 inches in depth, aggregating, approximately, 86 million cubic yards.

The effect of the fires upon the composition of the forest has been to increase the proportion of lodgepole pine. Probably 90 per cent of the stock coming in is of this species. The effect of fires upon the policy of forest management must be serious. The new stock of trees will not be large enough for any commercial use for nearly fifty years, and in composition these burned tracts are reduced to less desirable species. On old burns some inclination to return to the original species was found, notably on the head of the North Fork of Blackfoot River, where spruce was found coming in under lodgepole pine. Larch, red fir, and white pine, too, sometimes reappear under lodgepole pine on old burns, but this reappearance is always slow, and marketable log timber can hardly be expected from these species naturally reseeded on burns in less than one hundred years.

1. LARGE YELLOW PINE, 2 MILES NORTH OF HOLLAND'S RANCH,
UPPER SWAN RIVER VALLEY.

2. LINE OF BURN OF LODGEPOLE PINE.

Deadwood.—The amount of deadwood standing is only about 600,000 cords, and this has no market value where it stands. Probably all will be fallen before it becomes accessible or marketable.

Cutting.—There has been no cutting on this tract except for cabins and camp use, unless it be in the extreme northwest corner of the reserve, which could not be located exactly, as the boundary lines there have not been surveyed. Many ties were made in that vicinity and put into the track during the construction of the road.

Transportation.—The only way to get timber out of this region is northwestward, or down the stream. Were it not for several bad canyons, the river would be drivable for at least 80 miles above its mouth. It is possible these canyons can be improved so as to permit log driving, but the expense would be great. Elsewhere on the river driving would often be difficult because of the wide bed of the river and the frequent gravel bars. A railroad along the river could be built with easy grade, but the expense would be considerable, owing to frequent cut banks and ravines, and it is questionable whether the timber interests alone would warrant the construction of such a road.

Demand.—At present, excepting possibly in the extreme northwestern part of the reserve, timber has no market value where it stands. Prices at the nearest mill, Columbia Falls, are \$3 per M, and fuel, at present, hardly commands any stumpage.

Agricultural land.—While some vegetables and hay would doubtless grow in favorable spots throughout the valley, the liability of destructive frosts at any time during the season precludes the possibility of commercial agriculture. Perhaps 80 square miles are level enough to be arable, but much of this is gravelly and unsuitable for agriculture except for garden spots, to supply lumber or mining camps, in case of special need.

Irrigation.—Very little water, indeed, will ever be used for irrigation in this valley, but it is possible that it may be used in the Flathead Valley outside of the mountains, where agriculture, though carried on at present without irrigation, would be improved by it.

Occupancy.—There are about half a dozen cabins in the valley, but these are not occupied all the year. They belong to prospectors, who use them only while doing their assessment work.

Water power. Water power is abundant along the main stream and three of the tributaries. Spotted Bear and two streams from the west are large enough to furnish power for sawmills. There are several very favorable sites for dams, and large amounts of water could be held above the canyons.

Mining.—No ore has been shipped from the valley, but several claims are held in the lower portion for coal, gold, silver, and copper.

SWAN-CLEARWATER VALLEY.

Topography.—This tract, having an area of about 728 square miles, is about 59 miles long and varies from 8 to 16 miles wide. The Mission Range on the west and the Kalispell Range on the east are high and sharp, and the low lands, increasing in width above the lakes, are undulating to rolling, and remarkably uniform in general topographic features.

Rock.—While outcroppings of limestone and quartzite, underlain by green schists, are almost continuous along the bordering mountain ranges, no outcrops were found in the bottom of the valley. There are certainly very few there. The bowlders of the valley are in general of the same material as found in place on the mountain sides, whence they have been brought by glacial action.

Soil.—About the head of Swan Lake clays are prevalent and reach continuously some distance up the valley, as far as Soup Creek. Above this point, both up Swan River and its lateral tributaries, the soil is greatly varied, though in general a glacial till, with beds or banks of bowlder clay, and morainic ridges reaching out of the mountain gorges. The material left by the glaciers has been considerably modified by the later action of the water, especially near the river. A short distance above Lion Creek, or about 16 miles in a direct line above Swan Lake, sand and gravel become more prevalent over the general surface, and instead of large bowlders and finer sediments, as found to the northward, there are south of this point ridges and mounds of sandy and gravelly material with intervening meadows, often without surface drainage. Occasionally clay tracts are found in this portion of the valley, but this clay does not seem more productive than the sand. It is, in fact, sometimes found nearly barren. The "big burn," having an area of about 5 square miles, about 28 miles above the lake, has a clayey soil, and is only about half covered with vegetation (lodgepole pine).¹

In proceeding southward above the "big burn," little other than sandy or gravelly land was seen, except in the bluffs along water courses. As regards productiveness, the lower portion of the valley, or that within 16 miles of Swan Lake, which is more clayey, has with few exceptions a heavy covering of vegetation. This is in contrast with the lands of the upper valley, where the rather scant covering of larch and lodgepole pine at first gives the impression of a very poor soil, but upon close examination it is found that the sparseness of tree growth is largely due to frequently occurring fires which have thinned the forest. The soil of the upper portion of the valley is really better than one would consider it is in passing hastily through it.

¹ The condition of this land is very much like the tract noted in the year 1898, on the North Fork of Flathead River, and the cause of such barrenness invites study.

4. EFFECT OF MODERATE FIRES, SURVIVING LARCH WITH UNDER-GROWTH OF LODGEPOLE PINE, RED FIR, AND LARCH.

B. LARGE YELLOW PINE, SUBORDINATE LODGEPOLE, JOCKO TRAIL, NEAR PLACID LAKE

1. STUMP LAND IN T. 26 N., R. 19 W., RESTOCKED DENSELY WITH RED FIR.

2. LARCH AND LODGEPOLE PINE ON BURN OF

Subsoil.—Boulder clay and gravels, as usual in these once glaciated mountain valleys, constitute the greater portion of the subsoil. For about 16 miles above Swan Lake, however, a depressed, narrow strip in the central portion of the valley, which seems to have been occupied by the lake, has silts and fine alluvium, varied according to accidents in the work of streams that brought such material into the lake. Outside of this depression, however, both between it and the mountains, and in the valley above, or south of it, the recent deposits of fine material are not abundant, and boulder clays, gravels, sands, and silts are almost the only subsoils.

Very deep beds of very porous gravel, which cause prairie openings common in many of the mountain valleys, because of too thorough subdrainage for trees, are not common, although the greater portion of the upper valley is so dry as to be adapted only to such dry-land trees as larch and lodgepole pine.

Humus.—Humus is light except in the lower portion of the valley, where it has been less burned and where it seems damper than above, or south of the old lake basin, which extends about 16 miles south of the present head of Swan Lake. Below the benches along the small streams there is frequently quite a depth of black earth, but in the morainic region nearer the mountains and southward across the main valley there is but little humus outside of the depressions that are so damp as to never burn deeply.

Litter.—Litter is correspondingly light where burns have been at all recent and abundant where the area is too damp to burn (see Pls. XXIII, *B*, and XXVI, *A*). Leaves and fine débris, however, have seldom accumulated to a depth of more than 3 or 4 inches. Probably three-fourths of the whole area of the valley has less than 2 inches of such litter, the scantiness of litter being due principally to fire.

Trees and timber.—The principal timber trees of the valley are larch, red fir, and yellow pine. Others that will yield a considerable amount are spruce, white pine, and lodgepole pine. Besides these are balsam, cedar, nut pine, hemlock, aspen, and cottonwood, of little commercial value, but possibly of use for some purpose.

In distribution the first three are confined to the valley bottom, the benches, and the lower foothills, and the nut pine and balsam are usually limited to the mountain ranges. The hemlock, cedar, and white pine are found only in sheltered, damp places, as in the ravines or on the lower mountain sides, and the cottonwood is confined to the banks of streams; otherwise the species are fairly well mixed, with perhaps the exception of spruce, which seeks constant moisture and avoids dry subsoil (see Pls. XXVI, *B*, and XXVIII, *A*).

In size the trees in this valley are hardly as large as in some other localities. The yellow pine, for instance, on the flat between Holt and Columbia Falls, reaches a diameter of 6 feet, even 7 feet on the stump,

and a height of 150 feet, while above Swan Lake the largest trees noticed were about 4 feet in diameter and 100 feet high. Lodgepole pine was rarely seen over 14 inches in diameter and 70 feet high, while spruce is seldom found over 30 inches in diameter and 90 feet high (see Pl. XXVIII, *B*). Although constituting the greater portion of the growth on the higher mountain sides, it has a size suitable for log timber only in gulches or on other damp, fertile land. The amount of log timber in the valley, roughly estimated to 8-inch top, is as follows:

Log timber in Swan-Clearwater Valley, Montana.

	M. feet B. M.
Larch	1, 050, 000
Yellow pine.....	100, 000
White pine	10, 000
Red fir	500, 000
Spruce.....	175, 000
Lodgepole pine.....	30, 000
Total.....	1, 865, 000

This estimate is regardless of accessibility, of present custom of cutting, and present demand. It is simply intended to express a safe estimate of the amount of log timber. For the whole amount of wood material in the valley there should be added that too small for log timber, which has been very roughly estimated in cords, as follows:

Timber in Swan-Clearwater Valley too small for log timber.

	Cords.
Larch	1, 200, 000
Lodgepole pine.....	1, 000, 000
Yellow pine.....	100, 000
Spruce.....	900, 000
Balsam	500, 000
Red fir	400, 000
Other species	560, 000
Total.....	4, 660, 000

Young or sapling growth.—This is abundant, except where repeatedly burned, and its volume is fairly represented by the number of cords in the table above. The lower portion of the valley especially is well stocked with spruce, red fir, and larch subordinate to large trees on the same land (see Pl. XXIV, *B*). The upper portion of the valley is characterized by its young stock of lodgepole pine and larch, while the mountain slopes, especially the western slope of the Kalispell Range, are brushy with alder, willow, and maple and only a sprinkling of larch, lodgepole pine, balsam, red fir, and aspen. In fact, the condition and distribution of the young growth is much affected by fire (see Pl. XXIX, *A*). It is not only thinned by it, but the composition of the forest is made very irregular, and we find it patched by stock of various ages and by areas imperfectly occupied, or occupied by species

1. MODERATE BURN IN LODGEPOLE PINE AND LARCH, MOUNTAIN
RIDGE WEST OF NORTH END OF ELBOW LAKE.

2. YOUNG LARCH AND LODGEPOLE COMING IN AFTER FIRE UNDER
SURVIVING LARCH, NORTH OF HOLLAND LAKE, LOOKING EAST
TOWARD GORDON PASS

promising no value. As a rule the tendency in the valley is toward a stock of more valuable species. In the lower or northern portion spruce and red fir are coming in where the older trees subside, and in the higher or southern portion of the valley larch is becoming more abundant as the lodgepole pine is injured by fire. An exception to this general tendency is found on the more severely burned portions. These almost invariably have been preempted by lodgepole pine in varying degrees of density, often to be completely denuded by succeeding fire (see Pl. XXX, *B*). The yellow-pine lands, both about the headwaters of Swan River and in the Clearwater drainage, are, as usual, more free from young stock than the forests of other species, yet some of these tracts have a fair sprinkling of red fir, larch, and spruce coming in underneath the pine (see Pl. XXX, *A*). As a rule these species do not reach tree size, being killed while small by repeated fires, while the yellow pine standing over them, protected by its thick bark, remains and furnishes favorable conditions for a new lot of seedlings, such as those just destroyed, to start again (see Pl. XXIX, *B*).

So much for the lowlands. The mountain sides have different tendencies. On them balsam and spruce compete with the lodgepole pine and larch, and toward the summits, or above 6,000 feet, usually crowd them out, especially in the gulches, although the combs and drier portions of the mountain spurs are frequently found with very few trees following the fire. Many areas, in fact, have nothing but brush, though not burned over during the past thirty years. In general, the valley is well stocked with saplings to constitute a new stock when the mature timber may be cut.

Underbrush.—The common bushes of the valley are alder, willow, dogwood, maple, mountain alder, spiræa, yew, redroot, and juniper. The first three, usually limited to wet places, especially along streams, often occupy smaller areas exclusively, but do not thrive as an undergrowth. Yew seems to be the only underbrush that forms a serious obstruction to travel with horses through the woods, and as the distribution of this shrub is not general, but is limited to ravines and gulches in the lower valley, underbrush here will be of minor importance in logging operations. It will still have a serious effect upon the composition of the forest, as burned areas are often first reoccupied by brush, which prevents immediate restocking with trees. Over a very large portion of the valley young trees form the principal undergrowth, and while these might be considered as underbrush, they have been described as young growth.

Fires.—Probably 90 per cent of the valley has been burned over within the past one hundred years, but evidences of such burns are so hidden by the forest left growing over them or grown since that it has been found impracticable to map all such areas (see Pl. XXXI, *A*). Only those are indicated on the map which have been recently and

severely burned and on which evidence remains plain. After some forty years the trees killed by fire have usually fallen, the ground commonly has been reoccupied by forest and practically re-covered, and its character has changed from that of burn to woodland. Large areas, especially in the upper part of the valley, have been recently burned over without showing much effect of the fire, especially such effects as may be seen from a distance. While some 600 square miles of the valley have probably been burned over within the past one hundred years, only about 240 square miles, or approximately one-third of the whole area, are shown on the map as burned.

Reproduction.—The condition of these more prominent burns is varied. The mountains, especially on the western slope of the Kalispell Range, are either bare or scantily dotted with clumps of bushes or with strips of forest that have escaped fire because sheltered by rocks or water courses. About 6 miles below or north of Holland's ranch is a burn of about 6 square miles in area that has scarcely any other species than lodgepole pine following the fire. Reaching across the valley at this point, and occupying substantially all the land between the mountains above it, is a mixed forest of larch and lodgepole pine, the composition of which has been greatly modified by fire. The fires here have not, as a rule, been very severe. The greater portion of the larch has survived, and as most of the lodgepole pine has been killed the proportion of larch has greatly increased. Because of fires the great portion of the valley has now a network of fallen trees, either under a surviving portion of the original forest or under a new growth that has sprung up since the fire. Owing to the thickness of their bark the larger larch, red fir, and yellow pine trees endure fire better than other species and small trees. These are gradually gaining in proportion, while the lodgepole pine, except on the severest burns, is diminishing. On the yellow-pine lands the effect, while never harmless, is often hardly noticeable after the fire has passed. Such lands are seldom without small seedlings, and as a light fire is sufficient to kill and even consume them the evidence of damage done is difficult or impossible to find, even when, from the foresters' point of view, it is serious. The burns on the mountain sides, however, leave plain evidence to be seen for many years. The drought on these too thoroughly drained slopes is often so severe that all dead vegetable material burns readily, and even the smaller roots of living trees are consumed, leaving mountains almost entirely bare, to be restocked very slowly, indeed, if at all. The western slope of the Kalispell Range south of Swan Lake is now almost bare. The rarity of seeding years and of climatic conditions favorable to the germination of seeds in these high altitudes, especially on exposed slopes, has prevented restocking of trees, and even the reappearance of brush has been slow and imperfect. The western, or Mission Range, or the eastward slope

1. MIXED YELLOW PINE AND RED FIR IN T. 26 N. R. 19 W.

7. BURNT MOUNTAIN SIDE, SOUTH FORK OF BIRCH CREEK

of it, has a much less barren appearance and has been much less burned. The burn about Crow Creek Pass was visited, and in ascending the mountain was found to be less well stocked with trees among the rather dense growth of alder, maple, willow, and huckleberry brush. Ascending farther and reaching an altitude of about 6,000 feet, few seedlings were seen other than balsam and Engelmann spruce. The usual tardiness of restocking on these mountain slopes makes plain the importance of keeping them stocked, and this can be done only by preventing fire. The effect of burns in causing a change of species is very noticeable over a wide area of nearly 100 square miles in the upper portion of the Swan River Valley. Here, while severe fires have killed all the trees on some small areas, the greater areas have been only moderately burned, yet severely enough to kill the most sensitive trees. Prior to the fire the stock was principally lodgepole pine, with which larch was mingled in varying proportions, usually about half. The fires have killed most of the lodgepole pine and left most of the larch, and now from the mountain side the forest appears nearly all larch, but in passing through it a dense network of fallen lodgepole pine is found under the larch, and growing up through this fallen material are, as a rule, young larch, although lodgepole pine reappears on the least shaded spots (see Pl. XXXI, *B*). This is a remarkable exception to the usual effect of fires upon the composition of the forest, as they generally increase the proportion of lodgepole pine.

Deadwood.—There is no deadwood of commercial value, as the difficulty of access renders it worthless where it is found. There are, however, in the valleys probably about 128,000 cords of deadwood that could be used for fuel or fencing were it brought to market. The greater portion of this deadwood is high on the mountain sides, principally west of Swan Lake.

Cutting.—No cutting has been done except for cabins, fences, roads, trails, and bridges.

Transportation.—The streams after improvement promise feasible transportation for about half of the timber. The remainder must be first hauled on cars or flumed to driveable water. The abundance of water power and uniform down grade available promise most economy by use of electric railways. The material in the Clearwater drainage would naturally be floated down the Blackfoot River, although there is no serious obstacle to building a railway across the divide and bringing all dead material down the Swan River, at the mouth of which is an admirable location for a large and permanent mill plant.

Demand.—At present stumpage values in this tract, and even on more accessible land northward in the Flathead Valley, are nominal. Good timber there goes for 75 cents to \$1 per thousand feet on the stump. Within the reserve very little could be realized without extensive developments to make the timber more accessible.

Agricultural land.—Commercially, agriculture within the valley will never be important. Vegetables, small fruits, and hay, perhaps some grain, would grow, but only in a small way, and stimulated by the difficulty of bringing such material from outside. There are some 200 square miles in the valley that are smooth enough to be arable.

Grazing.—There are about a dozen small prairie openings in the valley, probably 500 acres of upland and the same area of slough. Snow evidently falls deep and lies long, but hay is plenty, and a few cattle may be kept with some care.

Occupancy.—There is no stock now in the valley except at Holland's, where there are about 30 horses and a dozen cattle. On Clearwater Lake Mr. Seeley has been living some time, and has recently erected a substantial house. About the head of Swan Lake are 4 resident squatters and on Flathead Lake are 11. Scattered through the valley are 15 cabins, none of which were found occupied, though 2 of them were locked and evidently used at times.

Water power.—Below Swan Lake are many fine water powers on the large and constant outlet of the lake. The smaller streams above the lake, excepting Holland Creek and the outlet of Long Lake, are of uncertain value, as they become quite low in autumn, although strong in spring. Holland Creek and the outlet of Long Lake having natural reservoirs, are much more steady and may be greatly improved for water power by building dams at the outlet of the lakes.

Mining.—There are no mining operations at present, and no prospects were found or heard of on which assessment work was being done.

LEWIS AND CLARK FOREST RESERVE

MONTANA

Showing classification of lands
Prepared under the direction of Henry Gantt, Geographer in charge
BY H. H. AYRES

LEGEND

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