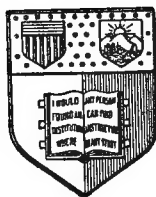


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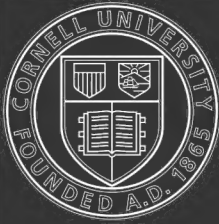
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SURVEYS OF FOREST RESERVES.

LETTER

FROM

THE SECRETARY OF THE INTERIOR,

TRANSMITTING,

IN RESPONSE TO RESOLUTION OF THE SENATE OF FEBRUARY 28, 1898, LETTER FROM THE DIRECTOR OF THE GEOLOGICAL SURVEY TRANSMITTING REPORT OF SURVEYS MADE UNDER HIS DIRECTION, AND ACCOMPANYING PAPERS IN RELATION TO THE FOREST RESERVES, SINCE JUNE 4, 1897.

MARCH 15, 1898.—Referred to the Committee on Public Lands and ordered to be printed.

DEPARTMENT OF THE INTERIOR.

Washington, March 15, 1898.

SIR: I have the honor to acknowledge the receipt of resolution of the Senate dated February 28, 1898, as follows:

Resolved, That the Secretary of the Interior be directed to furnish for the use of the Senate all information relating to the surveys of public lands since June 4, 1897, that have been designated as forest reserves under Executive proclamation, together with the amount of land surveyed in each of said reservations under authority of the act of Congress approved June 4, 1897, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1898, and for other purposes."

In response thereto I transmit herewith a letter from the Director of the Geological Survey, dated the 14th instant, transmitting a report of the surveys made under his direction; also a report made by Special Forestry Agent Gifford Pinchot, and a special report upon sheep grazing in the Cascade forest reserve of Oregon, prepared by Mr. F. V. Coville, botanist of the Department of Agriculture. These reports contain a summary of all the information that has been obtained in relation to the forest reserves since June 4, 1897.

Very respectfully,

C. N. BLISS, *Secretary.*

The PRESIDENT OF THE SENATE.

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REPORT ON THE SURVEY AND EXAMINATION OF FOREST RESERVES (MARCH), 1898.

The Senate resolution adopted February 28, 1898, calling on the Secretary of the Interior for a report on the survey of the forest reserves by the Geological Survey, is as follows:

Resolved, That the Secretary of the Interior be directed to furnish for the use of the Senate all information relating to the surveys of public lands since June 4, 1897, that have been designated as forest reserves under Executive proclamation, together with the amount of land surveyed in each of said reservations under authority of the act of Congress approved June 4, 1897, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1898, and for other purposes."

In response to a similar resolution of date December 15, 1897, a report was made to the Senate on December 22, 1897. This report was, with slight exception, as full and complete as it is possible to make a report at present, so far as regards surveys and subdivision. The present report is, therefore, in these respects, largely a copy of the former report. As to the examinations of the forests and matters relating thereto, a digest of the reports of the special forestry agents is furnished. Since the former report was submitted, some surveying has been done upon the reserves in southern California, a statement of which has been added.

The act making provision for the survey of the forest reserves, approved June 4, 1897, is in the following words, to wit:

For the survey of the public lands that have been or may hereafter be designated as forest reserves by Executive proclamation, under section twenty-four of the act of Congress approved March third, eighteen hundred and ninety-one, entitled "An act to repeal timber-culture laws, and for other purposes," and including public lands adjacent thereto, which may be designated for survey by the Secretary of the Interior, one hundred and fifty thousand dollars, to be immediately available: *Provided*, That to remove any doubt which may exist pertaining to the authority of the President thereunto, the President of the United States is hereby authorized and empowered to revoke, modify, or suspend any and all such Executive orders and proclamations, or any part thereof, from time to time as he shall deem best for the public interests: *Provided*, That the Executive orders and proclamations dated February twenty-second, eighteen hundred and ninety-seven, setting apart and reserving certain lands in the States of Wyoming, Utah, Montana, Washington, Idaho, and South Dakota as forest reservations, be, and they are hereby, suspended, and the lands embraced therein restored to the public domain the same as though said orders and proclamations had not been issued: *Provided further*, That lands embraced in such reservations not otherwise disposed of before March first, eighteen hundred and ninety-eight, shall again become subject to the operations of said orders and proclamations as now existing or hereafter modified by the President.

The surveys herein provided for shall be made under the supervision of the Director of the Geological Survey, by such person or persons as may be employed by or under him for that purpose, and shall be executed under instructions issued by the Secretary of the Interior, and if subdivision surveys shall be found to be necessary, they shall be executed under the rectangular system, as now provided by law. The plats and field notes prepared shall be approved and certified to by the Director of the Geological Survey, and two copies of the field notes shall be returned, one for the files in the United States surveyor-general's office of the State in which the reserve

is situated, the other in the General Land Office; and twenty ¹⁸⁹⁷ photolithographic copies of the plats shall be returned, one copy for the files in the United States surveyor-general's office of the State in which the reserve is situated; the original plat and the other copies shall be filed in the General Land Office, and shall have the facsimile signature of the Director of the Survey attached.

Such surveys, field notes, and plats thus returned shall have the same legal force and effect as heretofore given the surveys, field notes, and plats returned through the surveyors-general; and such surveys, which include subdivision surveys under the rectangular system, shall be approved by the Commissioner of the General Land Office as in other cases, and properly certified copies thereof shall be filed in the respective land offices of the districts in which such lands are situated, as in other cases. All laws inconsistent with the provisions hereof are hereby declared inoperative as respects such survey: *Provided, however,* That a copy of every topographic map and other maps showing the distributions of the forests, together with such field notes as may be taken relating thereto, shall be certified thereto by the Director of the Survey and filed in the General Land Office. (30 Stat. L., p. 34.)

In conformity with the terms of the statute, a plan of operations was submitted to the Secretary of the Interior on June 7, 1897, and received his approval on June 8. (See Appendix A of this report.)

ORGANIZATION OF THE SURVEY.

The surveying parties were at once organized and placed in charge of the chiefs of the Rocky Mountain and Pacific sections of topography, Mr. E. M. Douglas and Mr. R. U. Goode, both of whom have had many years' experience in the rugged and heavily timbered regions of the West and Northwest. To each were assigned certain reserves. The examination of the distribution and character of the forests and woodlands, the amount of damage inflicted on them by forest fires, the amount of dead timber, the extent of timber already cut, and the effects of pasturage upon the forests, was placed in charge of Mr. Henry Gannett, whose long experience, first with the Hayden Survey of the Territories, and since 1879 with the Geological Survey, in the forest-covered area of the West, particularly qualified him for this important work. A copy of his instructions is submitted herewith as Appendix B, and a copy of the instructions to topographers in regard to the mapping of the wooded areas as Appendix C.

CHARACTER OF THE LANDS UNDER SURVEY.

Outside of the Black Hills and Big Horn reserves comparatively little was known of the physical characteristics of the areas included within the several forest reserves. In considering the problem of the best method to secure such information, it became at once apparent that a reliable map was essential, in order to supply a proper base upon which to delimit the distribution of the forested lands and also to indicate the possibilities of utilizing the water supply.

The forest reserves which it was proposed to survey are, with the exception of the Black Hills reserve, situated in high, mountainous regions, the altitudes ranging from 5,000 to 13,000 feet. They are all at a considerable distance from railroads and in most cases are without many settlers. Roads and trails are very few, and in many localities entirely absent. The rugged character of the mountains and the density of the timber make travel off the lines of the roads and trails often impossible, except on foot. Because of the high altitude and the northern latitude, storms are frequent and snows fall in nearly every locality under survey early in September, thus delaying the work or causing its entire stoppage after a very short field season. The surveys were prosecuted with the utmost difficulty. In many

cution was greatly impeded. These obstacles have retarded the work in the forest reserves very materially and have made it more costly than was anticipated. The relative cost of the work done thus far is further increased by the expense attending the purchase of new instruments and field material, this item alone amounting to nearly one-fifth of the total expenditure.

The surveys were placed in the immediate charge of men who were thoroughly familiar with the duties required of them, and I am of opinion that the best possible results have been obtained that could be secured under existing conditions. The parties began operations in the field at various dates between the 1st of July and 1st of November, and remained at work in the northwest as long as weather conditions permitted.

EXAMINATION OF THE FORESTS ON THE RESERVES.

Of the appropriation of \$150,000 for the survey and examination of forest reserves, the sum of \$16,000 was allotted for examining into the condition and distribution of the forests upon the reserves and adjacent timber lands and other economic matters connected therewith. Of this amount the sum of \$11,256 had been expended up to March 1.

The examination of the forests has been made by men specially qualified in work of this character. They were selected solely on the score of their ability in this kind of work, without the slightest regard for political affiliations or local representation, it being understood that the desire of Congress was solely to gain full, exact, and reliable information regarding the timber resources of these reserves.

The information which these men, known as special field assistants, were instructed to obtain may be summarized as follows: The amount, species, age, size, and distribution of the timber, these facts being represented as largely as possible upon maps; the extent of timber cutting; the prevalence, extent, and amount of damage by fire; the extent and character of the undergrowth; the character of the soil and the humus; the amount and character of settlement within the reserve; the extent and location of arable land within its limits; the extent and value of mineral lands; the demand for timber; the means and facilities for logging operations, and the effect upon the forests of the pasturage of sheep and cattle within them, particularly the former.

PROGRESS AND RESULTS OF SURVEYS AND EXAMINATIONS.

Following is a particularized report of the progress of the surveys and examinations and the results that have been accomplished thus far in the field, the reserves being taken up separately in their order from east to west.

BLACK HILLS FOREST RESERVE.

The following are the limits, as described in the Executive order, establishing the reserve:

Beginning at the northwest corner of township one (1) south, range seven (7) east, Black Hills meridian, South Dakota; thence westerly along the Black Hills

base line to the southwest corner of township one (1) north, range six (6) east; thence northerly along the range line between ranges five (5) and six (6) east to the northwest corner of township two (2) north, range six (6) east; thence westerly along the unsurveyed township line between townships two (2) and three (3) north to the point of intersection with the boundary line between the States of South Dakota and Wyoming; thence southerly along said State boundary line to the point of intersection by the township line between townships six (6) and seven (7) south, Black Hills base line; thence easterly along said township line to the southwest corner of township six (6) south, range four (4) east; thence northerly along the range line to the northwest corner of said township; thence easterly along the township line between townships five (5) and six (6) south to the southwest corner of township five (5) south, range six (6) east; thence northerly along the range line to the northwest corner of said township; thence easterly along the first (1st) standard parallel south to the southwest corner of township four (4) south, range seven (7) east; thence northerly along the range line between ranges six (6) and seven (7) east to the northwest corner of township one (1) south, range seven (7) east, the place of beginning.

Survey.—It was known in advance that considerable section-subdivision work would be necessary in this area, and that there were some township lines to run, but the exact localities of the work could not be known until a field examination had been made.

A leveling party, consisting of four men, was organized and commenced work on the 18th of June, and disbanded December 11; and a second leveling party, consisting of three men, commenced work on the 12th of July and disbanded on December 4. A topographic party, consisting of eight men, commenced work on July 14 and disbanded December 5. Owing to the fact that the necessary instruments for land-surveying work could not be obtained until August, although ordered in June, sectionizing parties could not be started as early as desired. One sectionizing party, consisting of nine men, was organized August 10, a second of nine men commenced work on the 30th of August, and a third of nine men on October 17. The total number of miles of standard and township lines run to December 4, the close of the season's work, by the three parties, is 109 miles of township, 405 miles of subdivision lines, and 21 miles of retracements of old surveys, being portions of 14 townships. There remain to be subdivided portions of 16 townships.

Judging by statements made by parties living in the Black Hills and from Mr. Douglas's own experience while working in that locality late in November, the latter had good reason to suppose that field work could be prosecuted to advantage until late in December. He therefore planned to increase the Black Hills parties in October and November by adding to them such parties as would be forced to discontinue work in other reserves on account of storms and snow. This plan of increasing the parties was carried out, and in October one triangulation party of four men and two topographic parties of three men each were added. Another topographic party of three men was added in November. Satisfactory progress was made until the latter part of November, when frequent and severe storms and cold weather intervened to greatly delay the work. The expense being so great and the results so small in comparison, it was decided early in December to order the field work stopped. The outline of the timber areas was obtained and depicted by sketches on the old maps of that section of the country.

Up to the close of the work an entirely new and accurate survey was being carried forward, including the running of level lines, the placing of bench marks, as required by law, the accurate sketching of the topography, and the careful outlining on the map of all timber areas, distinguishing between burned or dead and living timber, the work being executed by a total force of 57 men.

The total amount of topography mapped comprises an area of 1,164 square miles, being about two-thirds of the entire area. This required the survey of 1,311 miles of roads. The triangulation of the whole area is completed. Twelve new stations have been located. There have been run 484 miles of spirit-level lines, and 141 bench marks have been established, being about four-fifths of the whole number required.

Cost of topography, including leveling and triangulation, to close of season. \$11,756. There has been a total of 535 miles of section and township lines run, which includes 21 miles of retracements of old surveys, at a cost of \$5,350, the total cost of the work being \$17,106. The land-survey work cost, approximately, \$10 per linear mile, which includes the cost of new instruments and outfits, thus making the rate slightly less than would have been allowed under land-office regulations.

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

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

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

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

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

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

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

The only tree in the Black Hills of commercial importance is the yellow pine. The other species are so small, occur in such limited numbers, or have so few uses that they are of little or no economic importance. By far the greater portion of the hills is covered with a pure forest of yellow pine.

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

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

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

Although the plains surrounding the Black Hills are within the arid region, having a rainfall of less than 20 inches annually, the Black Hills, by virtue of their greater altitude and broken character, enjoy a greater rainfall, giving them a subhumid climate. In some years there is sufficient rainfall for the maturing of crops, and in others there is drought, consequently the practice in regard to irrigation is by no means uniform. Some farmers prefer to irrigate, and thus insure their crops, while others take the chances on the rainfall. In some localities the soil is more moist than in others and irrigation is unnecessary in the majority of seasons, while in other and drier localities the reverse is the case. Hence it is difficult to say whether the criterion of agri-

cultural land should be the ability to irrigate it. It therefore seems best to point out the areas of open valley country within the reserve. These open valleys are scattered all over the reserve, intersecting bodies of timber in narrow strips, but nowhere appearing in large bodies except in the southern part of the reserve, where there is an area, comprising several townships of open country, containing but little timber, and that in small groves and patches.

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

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

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

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

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

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

BIG HORN FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Beginning at the southeast corner of township forty-eight (48) north, range eighty-four (84) west, sixth (6th) principal meridian, Wyoming; thence northerly along the range line to the northeast corner of said township; thence westerly along the twelfth (12th) standard parallel north, to the southeast corner of township forty-nine (49) north, range eighty-four (84) west; thence northerly along the range line to the northeast corner of section thirteen (13), township fifty (50) north, range eighty-four (84) west; thence westerly along the section line to the northeast corner of section seventeen (17), said township; thence northerly along the section line to the southeast corner of section twenty-nine (29), township fifty-one (51) north, range eighty-four (84) west; thence easterly along the section line to the southeast corner of section twenty-six (26), said township; thence northerly along the section line to the northeast corner of section two (2), township fifty-two (52) north, range eighty-four (84) west; thence westerly along the thirteenth (13th) standard parallel north to the southeast corner of section thirty-five (35), township fifty-three (53) north, range eighty-four (84) west; thence northerly along the section line to the northeast corner of section fourteen (14), said township; thence westerly along the section line to the northeast corner of section fourteen (14), township fifty-three (53) north, range eighty-five (85) west; thence northerly along the section line to the northeast corner of section (2), said township; thence westerly along the township line to the northeast corner of section two (2), township fifty-three (53) north, range eighty-six (86) west; thence northerly along the section line to the northeast corner of section two (2), township fifty-four (54) north, range eighty-six (86) west; thence westerly along the township line to the southeast corner of township fifty-five (55) north, range eighty-seven (87) west; thence northerly along the range line to the northeast corner of said township; thence westerly along the township line to the northwest corner of said township; thence southerly along the range line to the southwest corner of said township; thence westerly along the township line to the northwest corner of township fifty-four (54) north, range eighty-eight (88) west; thence northerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west to the northwest corner of township fifty-six (56) north, range eighty-eight (88) west; thence westerly along the fourteenth (14th) standard parallel north to the southwest corner of township fifty-seven (57) north, range eighty-eight (88) west; thence northerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west to the point of intersection with the boundary line between the States of Wyoming and Montana; thence westerly along said State boundary line to the point for the unsurveyed range line between ranges ninety-two (92) and ninety-three (93) west; thence southerly along said unsurveyed range line to the fourteenth (14th) standard parallel north; thence easterly along said standard parallel to the northeast corner of township fifty-six (56) north, range ninety-three (93) west; thence southerly along the range line between ranges ninety-two (92) and ninety-three (93) west to the northwest corner of township fifty-four (54) north, range ninety-two (92) west; thence easterly along the township line to the northeast corner of said township; thence southerly along the range line to the southeast corner of said township; thence easterly along the township line to the northeast corner of township fifty-three (53) north, range ninety-one (91) west; thence southerly along the range line to the southeast corner of said township; thence easterly along the thirteenth (13th) standard parallel north to the northwest corner of township fifty-two (52) north, range eighty-eight (88) west; thence southerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west to the southwest corner of township fifty-one (51) north, range eighty-eight (88) west; thence easterly along the township line to the southeast corner of said township; thence southerly along the range line between ranges eighty-seven (87) and eighty-eight (88) west to the southwest corner of township fifty-nine (49) north, range eighty-seven (87) west; thence easterly along the twelfth (12th) standard parallel north to the northwest corner of township forty-eight (48) north, range eighty-seven (87) west; thence southerly along the range line to the southwest corner of said township; thence easterly along the township line between townships forty-seven (47) and forty-eight (48) north to the southeast corner of township forty-eight (48) north, range eighty-four (84) west, the place of beginning.

Survey.—Two topographic parties of four men each, two leveling parties of three men each, and one triangulation party of four men were outfitted for work in this reserve. To the triangulation party was also assigned the duty of connecting the triangulation with that to be executed for the Teton Reserve, both depending on a base line and astro-nomic position previously measured near Sheridan, Wyo.

The triangulation party commenced field work July 5, and first secured control for topographic work over that part of the reserve in the vicinity of Cloud Peak. This necessitated the selection and occupation of ten stations. Positions of these were computed at once and furnished to the topographic party to which had been assigned the duty of mapping the area. The further work of the triangulation party in the vicinity of the Yellowstone and the Teton timber and forest reserves consisted in the selection and location of twelve stations. The field work of this party ended on November 10.

One leveling party was outfitted and commenced work at Sheridan, Wyo., on June 26, and terminated field work on November 6. A second leveling party commenced work early in July, and was disbanded on the same date as the other party. The total length of level lines for these two parties is 330 miles. Their work also included the establishment of 80 permanent bench marks.

One topographic party commenced a survey of the Cloud Peak area on the 12th of August and continued in the field until November 2. During this period an area of 400 miles was surveyed, including a careful location of the outlines of all timber areas. The second party commenced field work on July 8 and was disbanded on September 5, on account of illness in the immediate family of the chief of party. During this period of activity an area of 245 square miles was mapped and the outlines of timber were carefully sketched.

The total cost of the work in the Bighorn area, including that of the triangulation party, which also did work for the Teton Reserve, is \$8,952.

Examination of forests.—Mr. F. E. Town was employed as special field assistant for the examination of this area. He commenced work about the middle of July and ended at the close of September.

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

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

While the entire area of the Bighorn Mountains, with the exception of a small region above timber line, is, judging from its climate and other indications, capable of producing forests, still the general aspect of the reserve is that of a lightly timbered region. It contains no large or valuable timber. It is only in a very few localities that any timber

suitable for the sawmill is to be found, and a large proportional area, probably quite one-half, consists of open parks. Nearly all of the timbered region has been burned over, and much of it has been repeatedly subjected to devastation from fires. In the park areas it is evident that the timber has been driven out completely by fire. Of the timbered region a large part is covered with young growth, ranging from ten to fifty years of age, while the ground is strewn with dead trees, the victims of fires, and these dead trees also are young and small. Fires have prevailed so frequently and universally over this region that it is only in limited localities that mature forests exist.

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

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

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

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

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

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

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

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

There has been some prospecting for minerals in these mountains for several years, but few discoveries have been made which have shown sufficient promise to induce regular work. Some mining has been done upon Bald Mountain, near Cloud Peak, near Black Mountain, on Tongue

River, and on Wolf Creek. On the whole, however, the mining industry in the Bighorn Mountains is at present a trifling matter.

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

TETON FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Beginning at the southeast corner of township forty-three (43) north, range one hundred and ten (110) west, sixth (6th) principal meridian, Wyoming; thence northerly along the surveyed and unsurveyed range line between ranges one hundred and nine (109) and one hundred and ten (110) west, to the point of intersection with the south boundary of the Yellowstone National Park Timber Land Reserve as established by proclamation of September tenth, eighteen hundred and ninety-one; thence westerly along said boundary to its intersection with the boundary line between the States of Wyoming and Idaho; thence southerly along said State boundary line to the point for the unsurveyed township line between townships forty-two (42) and forty-three (43) north; thence easterly along the unsurveyed and surveyed township line between townships forty-two (42) and forty-three (43) north, to the southeast corner of township forty-three (43) north, range one hundred and ten (110) west, the place of beginning.

Survey.—As a portion of the area included in this reserve was known to be settled, and as initial geodetic positions and level elevations were available, the work planned was to secure additional triangulation control, to commence the leveling, and to begin the preliminary work for mapping the eastern part of the reserve. The necessary outfit for two parties of five men each was procured at Idaho Falls, Idaho, this being the nearest available outfitting point. Field work was commenced July 18, and stopped on October 18.

The total sum expended to date is \$4,867.

The practical results accomplished are the location of eight triangulation stations within the reserve, the running of 154 miles of accurate spirit level lines, the establishment of 13 level bench marks, the survey of 173 miles of road, and the careful location of 60 land survey corners. The work is now in such condition that topographic surveys can be commenced, when the weather permits, without any additional office or field work.

Examination of forests.—This work was assigned to Dr. T. S. Brantledge, who was employed as special field assistant for this purpose. He commenced work about the 1st of July and concluded about the end of September.

Topography.—The principal relief features are simple. Traversing the reserve from north to south, near its western boundary, is the Teton Range. This has an average breadth of 12 to 15 miles, and is extremely rugged, rising in the highest summit, the Grand Teton, to an altitude of 13,870 feet, while the average altitude of the range is probably not far from 12,000 feet. On the west the mountains descend quite steeply to Teton Basin, across the eastern upper edge of which runs the west boundary of the reserve at an altitude of 6,500 to 7,000 feet. On the east the Teton Range descends by cliffs and extremely steep slopes to the valley known as Jackson Hole. This is a broad expanse, extending from the north boundary of the reserve in a direction a little west

of south to the southern boundary. Its breadth ranges from 10 to 12 miles, and its altitude within the reserve from 6,500 to 7,000 feet. It is drained by Snake River, which traverses it from north to south, receiving the waters of several large branches from the east, including Buffalo and Grosventre rivers. There are several lakes in the valley, the largest of which is Jackson Lake, near the north boundary of the reserve, through which flows Snake River. The surface of the valley is, in the main, a gravelly bench land, quite level, and producing a scanty growth of sagebrush interspersed with grass. The bottom land of the river is broad and inclosed between low bluffs. It is covered with a dense growth of cottonwoods, willows, and other brush.

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

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

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

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

Jackson Hole comprises a large amount of agricultural land. It lies easy for irrigation, and the supply of water is ample for the entire area. The altitude, however, is great, and the consequent severity of the climate will prevent the production of anything except the hardiest

vegetables and grains. Its value as agricultural land is not, therefore, great. The area included in this valley is as follows:

In range 113 west, the three western tiers of sections of township 46 north, and the south half of township 45 north.

In range 114 west, the north half of townships 46, 45, and 44.

In range 115 west, the west half of townships 46, 45, 44, and 43.

In range 116 west, the two eastern tiers of sections of township 44, and the east half of township 43.

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

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

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

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

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

LEWIS AND CLARK FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

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 (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 surveyed 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.

FLATHEAD FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Beginning at the southwest corner of township thirty-three (33) north, range twenty-five (25) west, principal meridian, Montana; thence easterly along the surveyed and unsurveyed eighth (8th) standard parallel north, to the northeast corner of township thirty-two (32) north, range twenty-two (22) west; thence southerly along the range line between ranges twenty-one (21) and twenty-two (22) west, to the southeast corner of section thirteen (13) of said township thirty-two (32) north, range twenty-two (22) west; thence easterly along the unsurveyed section line to the point for the southeast corner of section thirteen (13), township thirty-two (32) north, range eighteen (18) west; thence southerly along the unsurveyed range line between ranges seventeen (17) and eighteen (18) west, to the northwest corner of township thirty-one (31) north, range seventeen (17) west; thence easterly along the township line between townships thirty-one (31) and thirty-two (32) north, to the northwest corner of section two (2), township thirty-one (31) north, range seventeen (17) west; thence along the section lines southerly to the southwest corner of section twenty-three (23), and easterly to the northeast corner of section twenty-five (25), said township; thence southerly along the range line between ranges sixteen (16) and seventeen (17) west, to the southeast corner of said township thirty-one (31) north, range seventeen (17) west; thence easterly along the unsurveyed township line between townships thirty (30) and thirty-one (31) north, to the point for the southeast corner of township thirty-one (31) north, range sixteen (16) west; thence southerly along the unsurveyed range line between ranges fifteen (15) and sixteen (16) west, to the point for the southwest corner of township thirty (30) north, range fifteen (15) west; thence easterly along the unsurveyed township line between townships twenty-nine (29) and thirty (30) north, to the point for the southeast corner of said township thirty (30) north; thence northerly along the unsurveyed range line between ranges fourteen (14) and fifteen (15) west, to the point for the southeast

corner of section thirteen (13), said township thirty (30) north, range fifteen (15) west; thence along the unsurveyed section lines, easterly to the point for the southeast corner of section sixteen (16), and northerly to the point for the northeast corner of section four (4), township thirty (30) north, range fourteen (14) west; thence easterly along the unsurveyed township line between townships thirty (30) and thirty-one (31) north, to the point for the southeast corner of township thirty-one (31), range fourteen (14) west; thence northerly along the unsurveyed range line between ranges thirteen (13) and fourteen (14) west, to the point where it will intersect the west boundary of the Blackfeet Indian Reservation, as said boundary is defined and described in the act of Congress approved June tenth, eighteen hundred and ninety-six, entitled, "An act making appropriations for current and contingent expenses of the Indian Department and fulfilling treaty stipulations with various Indian tribes for the fiscal year ending June thirtieth, eighteen hundred and ninety-seven, and for other purposes;" thence northwesterly along the boundary of said Indian reservation to its point of intersection with the international boundary line between the State of Montana and the British possessions; thence westerly along said international boundary line to the point for the unsurveyed range line between ranges twenty-five (25) and twenty-six (26) west; thence southerly along the unsurveyed range line between ranges twenty-five (25) and twenty-six (26) west to the ninth (9th) standard parallel north; thence easterly along said parallel to the northeast corner of township thirty-six (36) north, range twenty-six (26) west; thence southerly along the range line between ranges twenty-five (25) and twenty-six (26) west, to the southwest corner of township thirty-three (33) north, range twenty-five (25) west, the place of beginning.

Surveys.—Both of these reserves embrace a practically unsettled country, where there are very few roads or trails, and of which no accurate maps have ever been made. Therefore the first work planned was the carrying forward of triangulation to cover the whole area, to serve as a basis for topographic maps and for tie points for land surveys to be carried on another season. Two parties of four men each were outfitted for work to commence at a base line to be measured near Helena, and to use the Coast and Geodetic Survey astronomic station at Helena, this being the nearest astronomic station. Field work was actually commenced on the 10th of July, and was continued by the Flathead party until September 28, when, because of numerous storms and deep snow, it was decided that further work for the season was impracticable. The Lewis and Clark party remained in the field until November 10. During this time eight triangulation stations were selected and marked, and signals erected outside of the forest reserve. In addition to these eight stations within the reserve were selected and occupied, and five additional points for stations selected. Five other prominent points for control of topographic mapping were also located within the reserve. When the office computations for this work are completed ample control will be furnished for commencing topographic and other surveys. The Flathead party was engaged the greater part of the season in assisting the Lewis and Clark party, for until the positions in the latter reserve were carried northward no base would be furnished for the Flathead Reserve. The only practical results accomplished in the Flathead Reserve are the reconnoissance for triangulation and the selecting and monumenting of four stations.

The total amount expended for these two reserves to date is \$4,685.

Enough is now known of these two reserves to plan future work intelligently and to at once commence topographic and land surveys.

Examination of forests.—No examinations of the forest conditions of the Lewis and Clark and Flathead reserves were made, owing mainly to the fact that no adequate maps of the areas were available for the representation of such data.

UINTA FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Beginning at the northwest corner of township one (1) south, range seven (7) east, Salt Lake meridian, Utah; thence easterly along the base line to the southeast corner of township one (1) north, range eight (8) east; thence northerly along the range line to the northeast corner of said township; thence easterly along the township line between townships one (1) and two (2) north to the southeast corner of township two (2) north, range thirteen (13) east; thence northerly along the range line to the northeast corner of said township; thence easterly along the surveyed and unsurveyed township line between townships two (2) and three north to its point of intersection with the Green River; thence in a southeasterly direction along the middle of the channel of said river to the point for the unsurveyed range line between ranges twenty-two (22) and twenty-three (23) east; thence southerly along the unsurveyed and surveyed range line between said ranges to the point for the southeast corner of township two (2) south, range twenty-two (22) east; thence westerly along the unsurveyed and surveyed township line between townships two (2) and three (3) south to the northwest corner of township three (3) south, range nineteen (19) east; thence southerly along the west boundary of said township to its intersection with the east boundary of the Uinta Indian Reservation; thence northwesterly along said Indian reservation boundary to the northeast corner of said reservation; thence southwesterly along the north boundary of said Indian reservation to the intersection therewith by the range line between ranges six (6) and seven (7) east; thence northerly along said range line, surveyed and unsurveyed, to the northwest corner of township one (1) south, range seven (7) east, the place of beginning.

Surveys.—It was planned to carry triangulation for this reserve from the Coast and Geodetic Survey transcontinental stations in the vicinity of Salt Lake, and to run level lines from Evanston, Wyo., into the reserve, and to commence at an early date the subdividing of townships where found needful. After a preliminary examination of the country it was deemed impracticable and, for the present, unnecessary to commence subdivisional surveys.

One triangulation party of four men and one leveling party of three men were outfitted at Salt Lake and Evanston. The triangulation party found it necessary to occupy nine stations outside of the reserve in order to secure positions and distances. The stations actually located within the reserve are two in number. Only 57 miles of spirit level lines were run, the greater part of which were outside of the reserve. The weather in this locality was even worse than that encountered in the other reserves.

The total amount expended for this reserve to December 1 is \$3,506.

Examination of forests.—The examination of the forest conditions of the Uinta Reserve was included in the plans at the outset of the season, with the intention that Dr. T. S. Brandegee should make such examination upon the completion of his work in the Teton Reserve. At the time this latter was finished, however, the season was so far advanced that it was decided to be unwise to begin the work, since the region consists of high mountains, ranging in altitude from 10,000 to 13,000 feet. This work was, therefore, postponed until the spring of 1898.

BITTERROOT FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Beginning at the northeast corner of township thirty-six (36) north, range five (5) east, Boise meridian, Idaho; thence southerly along the surveyed and unsurveyed range line between ranges five (5) and six (6) east, to the point of intersection with

the Salmon River; thence in an easterly direction along the middle of the channel of said river to the point of intersection for the unsurveyed range line between ranges eighteen (18) and nineteen (19) east; thence northerly along said unsurveyed range line to the point of intersection with the boundary line between the States of Idaho and Montana; thence in an easterly direction along said State boundary line to the point for the unsurveyed range line between ranges nineteen (19) and twenty (20) west, principal meridian, Montana; thence northerly along said range line to the base line; thence westerly along said base line to the southeast corner of township one (1) north, range twenty (20) west; thence northerly along the range line to the northeast corner of said township; thence westerly along the surveyed and unsurveyed township line between townships one (1) and (2) north, to the point for the southeast corner of township two (2) north, range twenty-two (22) west; thence northerly along the unsurveyed range line between ranges twenty-one (21) and twenty-two (22) west, allowing for the proper offsets on the first (1st) and second (2nd) standard parallels north, to the point for the northeast corner of township ten (10) north, range twenty-two (22) west; thence westerly along the unsurveyed township line between townships ten (10) and eleven (11) north, to the point of intersection with the boundary line between the States of Montana and Idaho; thence along said State boundary line to the point for the unsurveyed township line between townships thirty-eight (38) and thirty-nine (39) north, Idaho; thence westerly along said township line to the point for the northwest corner of township thirty-eight (38) north, range ten (10) east; thence southerly along the unsurveyed range line between ranges nine (9) and ten (10) east, to the point for the southwest corner of township thirty-seven (37) north, range ten (10) east; thence westerly along the unsurveyed seventh (7th) standard parallel north, to the northeast corner of township thirty-six (36) north, range five (5) east, the place of beginning.

Surveys.—Probably there is no other portion of the country, exclusive of Alaska, about which there is so little known as of the territory included in the Bitterroot Forest Reserve. It was therefore necessary to commence ab initio, as nothing whatever was available from a topographic standpoint. The first step was to determine an astronomic position, measure a base line, and expand a system of triangulation which would serve to furnish starting points for the topographic mapping. A location for the astronomic station was selected in the town of Hamilton, Mont., and the latitude and longitude of a masonry pier built at this point were determined. The latitude was obtained by observations on 60 pairs of stars, and the longitude by time observations and telegraphic exchange of clock signals with Washington University, at St. Louis, Mo., on five nights. A permanent meridian mark was also set one-half mile south of the astronomic pier. A base line was twice measured with a 300-foot tape under a constant tension of 20 pounds, several hundred thermometric readings of the temperature of the tape being obtained during the process of measurement. The total length of this line was 5.7 miles, and the difference between the two measurements, after all corrections had been applied, was about 1 inch. Triangulation was expanded from the base line over an area of about 6,500 square miles, 1,000 miles being covered so that no further work is necessary, and the remaining 5,500 being covered in a manner sufficient to provide a basis for a reconnaissance map, including the whole area of the Bitterroot Forest Reserve.

Topographic work was prosecuted by two separate parties, one being engaged in preparing a detailed map of the territory included in and adjacent to the Bitterroot Valley, and the other party being detailed to secure data for the reconnaissance map above referred to. About 600 square miles were included in the detailed survey, and the remaining portion of the reserve was mapped by the reconnaissance survey. On the maps resulting from each of these surveys will be shown, with considerable detail, the extent and variety of the forest areas, and also those areas that have been denuded by forest fires, as well as those which are naturally bare of timber. There was also obtained informa-

tion for defining the mineral areas and the areas that are suitable for agricultural purposes.

The boundaries of this reserve are defined in part by the lines of the public-land system, none of which have been surveyed. For the purpose of locating these boundaries, and also for establishing a basis from which other township and section lines could be projected, a special party was organized. The Montana base line was extended westward for a distance of 12 miles, and from this were projected northward and southward lines aggregating about 50 miles. This work was prosecuted with the greatest difficulty, owing to the rugged and precipitous nature of the territory traversed. The line crossed, at right angles, the spurs making down from the summit of the Bitterroot Range, which are 3,000 or 4,000 feet above the beds of the intervening streams.

In addition, numerous level lines were run throughout the Bitterroot Valley and as far up the tributary drainage as it was practicable to carry lines of spirit levels, and in other localities careful elevations were obtained by vertical angulation.

In the prosecution of the surveys in the Bitterroot reserve there were five parties engaged, employing a varying force of about 35 men, and the sum of \$12,606 was expended. This expenditure included the purchase of 9 horses and mules, 3 wagons, and other camp material, such as tents, cooking utensils, etc.

It is believed that the information obtained in this reserve is sufficient to answer satisfactorily any question that may arise.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PRIEST RIVER FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Bounded on the east by the summit of the ridges dividing the waters tributary to the Kootenai River and Priest Lake and River; on the west by the summit of the ridges dividing the waters tributary to the Pend d'Oreille River or Clarkes Fork of the Columbia River and Priest Lake and River; on the north by the international boundary line between the States of Idaho and Washington and the British possessions, connecting the east and west boundaries above described; on the south by the township line between townships fifty six (56) and fifty-seven (57) north of the base line, Idaho, projected to connect the east and west boundaries above described.

Surveys.—No surveys of any kind, except a small amount of land subdivision, had been made in this area. It was therefore decided to extend the township lines, to establish lines of level, and to arrange for triangulation, so that detailed mapping could follow during the next field season.

The thirteenth standard parallel north of the Boise meridian was extended westward from the existing termination, which was 3 miles west of the Boise meridian, to the State line between Idaho and Washington, a distance of about 27 miles, and a connection was made with one of the mileposts of the latter line. From this standard parallel a guide meridian was projected northward from a point 24 miles west of the Boise meridian to the location of the international boundary, as well as could be determined, there being no surface mark to indicate the exact location. In addition, information was secured to prepare a reconnaissance map of the entire reserve, and level lines were carried from Priest River station to Priest Lake, and from the northern end of Priest Lake to the Upper Lake, the connection between the stages of water at the lower and upper extremity of Priest Lake being determined by a series of synchronous observations. Priest Lake was care-

fully triangulated and meander lines were run along the shore line of the lake connecting the triangulation stations, so that data were obtained sufficient to prepare a map of the lake. The triangulation points here, as elsewhere, were permanently marked by copper bolts set in the solid rock, so that they will remain recoverable for an indefinite length of time.

A varying force of about twenty-five men was employed in this locality, and the sum of \$6,992 was expended. This expenditure included the purchase of seventeen mules and a camp outfit of tents and other articles.

Examination of forests.—For the examination of this reserve and a portion of the Bitterroot Reserve, Mr. John B. Leiberg was transferred temporarily from the Department of Agriculture, in which he has for several years been employed in similar work. Mr. Leiberg commenced work upon the Priest River Reserve July 1, and finished the examination of that reserve in August.

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

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

Forests.—The Priest River Reserve is essentially a forest-covered region. There are but few tracts within its boundaries that do not now, or did not a few years ago, support a dense, magnificent forest. The only areas destitute of forests from natural causes are marshes and the rocky crests and slides in the mountains. These, together with the water surface of the lakes and streams, are estimated to aggregate about 30,000 acres, which is only 8 per cent of the entire area.

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

The white-pine zone is the predominant one. It is found mainly between altitudes of 2,400 to 4,800 feet above sea level, altitudes which

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

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

The amount of merchantable timber at present contained in the reserve is estimated at 4,833,600,000 feet B. M., including that suitable for saw timber, railway ties, and telegraph poles. The amount available for each of these several purposes is estimated as follows:

Saw timber	1,903,600,000
Railroad ties	2,720,000,000
Telegraph poles	210,000,000

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

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

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

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

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

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

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

WASHINGTON FOREST RESERVE.

The following are the limits, as described in the Executive order establishing the reserve:

Beginning at the point for the southwest corner of township twenty-nine (29) north, range eight (8) east, Willamette meridian, Washington; thence northerly along the unsurveyed range line between ranges seven (7) and eight (8) east, to the point for the northwest corner of township thirty-two (32) north, range eight (8) east; thence easterly along the unsurveyed eighth (8th) standard parallel north to the point for the southwest corner of township thirty-three (33) north, range twelve (12) east; thence northerly along the unsurveyed range line between ranges eleven (11) and twelve (12) east to the point for the northwest corner of township thirty-six (36) north, range twelve (12) east; thence westerly along the unsurveyed ninth (9th) standard parallel north to the point for the southwest corner of township thirty-seven (37) north, range seven (7) east; thence northerly along the unsurveyed range line between ranges six (6) and seven (7) east to its point of intersection with the international boundary line between the State of Washington and the British Possessions; thence easterly along said international boundary line to the point for the unsurveyed range line between ranges twenty-two (22) and twenty-three (23) east; thence southerly along said unsurveyed range line, subject to the proper easterly or westerly offsets on the ninth (9th) and eighth (8th) standard parallels north, to the point for the southeast corner of township twenty-nine (29) north, range twenty-two (22) east; thence westerly along the unsurveyed and surveyed seventh (7th) standard parallel north to the point for the southwest corner of township twenty-nine (29) north, range eight (8) east, the place of beginning.

Surveys.—Three separate and independent parties were organized in this reserve—one in the eastern portion of the reserve, in the vicinity of Lake Chelan; the second in the territory west of the summit of the Cascade Range, operating from Monte Cristo, and a third at Ellensburg, for the purpose of extending reconnaissance triangulation over the entire reserve. As in the other reserves mentioned, few or no data were available from which to start surveys.

In the section east of the summit of the Cascade Range it was therefore necessary to measure a base line in the vicinity of Lake Chelan and to expand therefrom a system of triangulation, which system was ultimately connected with the Ellensburg base by the observations of the party referred to above as the triangulation party. Depending on this triangulation, detailed mapping was commenced in the basin of Lake Chelan and about 400 square miles were mapped, including a careful survey of the shore line of the greater portion of the lake and the topography of the adjoining mountains. Level lines were carried from a bench mark previously established by the Army Engineer Corps at Chelan Falls, on the Columbia River, to the lower end of Lake Chelan. A connection between the lower and the upper end of the lake was established by synchronous water height observations, and from the head of the lake the levels were continued to the summit of the Cascade Mountains at Cascade Pass. Connections were obtained with the existing land surveys, so that land lines may be projected in their proper location over any portion of the territory surveyed. Careful observations for defining the extent and variety of the timbered areas were made and the necessary data were secured for the segregation of such lands as proved to be more valuable for agricultural than for timber purposes.

No triangulation existed in the area west of the summit of the Cas-

cade Mountains on which topographic work could be based; therefore the triangulation party was directed to extend as quickly as possible the triangulation resting on the Ellensburg base, so as to reach the area proposed for topographic survey. Operations in the vicinity of Monte Cristo were prosecuted under the greatest difficulties on account of the alternation of smoke and stormy weather, and it was found necessary to discontinue work entirely about the 1st of November, as the snow in the mountains made work practically impossible. During the season topographic surveys were extended over an area of about 500 square miles, and level lines were run over the existing roads and practicable trails. In addition, various other elevations were determined by vertical angles and permanently marked, so as to meet the requirements of the law providing that at least one bench mark shall be established in each township. Information was also secured relative to the segregation of mineral lands.

The triangulation party succeeded in extending a reconnoissance survey from the Ellensburg base northward, so as to cover the territory surveyed by the two parties above mentioned. These observations were not finally completed, as the party was forced to discontinue work early in November on account of the unusually heavy snows, which absolutely prohibited the party from making the ascent of the mountain summits used as triangulation stations.

An average force of about 30 men was employed at various times in this reserve, and the sum of \$13,465 was expended, including the purchase of about 20 animals and various articles of camp equipment.

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

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

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

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

Forests.—Almost the entire area of the reserve is naturally a forested region, with the exception of a few small tracts, which are above tim-

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

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

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

Douglas fir, *Pseudotsuga taxifolia*, is found in the bench lands of the valleys and the lower mountain slopes.

Cedar, *Thuja plicata*, which is found, mixed with Douglas fir and hemlock, in the bottom lands and on mountain slopes.

Mountain cedar, *Cupressus nootkatensis*, which is found on mountain slopes above 2,000 feet.

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

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

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

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

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

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

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

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

Alpine larch, *Larix lyallii*, is not uncommon along the summit of Cascade Range from Cascade Pass northward.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Settlements.—Upon the west side the mining towns of Monte Cristo and Silverton have already been mentioned. Besides these there is some little settlement in the valley of the St. Ilaguamish below Silverton. Upon the Sauk, within the reserve, there are a few ranches. Upon

Cascade River are three or four ranches, and there is some settlement in the Ruby Creek district depending upon the mines. Upon the east side there are a number of ranches in the Methow valley, including the little town of Winthrop and the mining village of Camp Gilbert. Upon Lake Chelan there are a few ranches and the hotel at the head of the lake. A few miners are located upon Railroad and Company creeks, west of the upper portion of the lake.

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

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

FOREST RESERVES IN SOUTHERN CALIFORNIA.

Surveys.—After the parties engaged in the Northwest were forced to discontinue work they were transferred to southern California and work was begun in the San Gabriel Timber Land Reserve and in the San Jacinto Reserve.

In the former the survey will prove especially important, as the city of Los Angeles is now considering the question of water supply, which will largely depend upon the preservation of the forested areas in the mountains over which the reservation extends. The area to be surveyed includes the entire drainage basin of the Los Angeles River, and will afford valuable and indispensable information to the engineers engaged in the solution of the question of the water supply for Los Angeles. In order to provide control for this work the existing triangulation in the Los Angeles valley was extended northward. One hundred square miles of detailed topography have been completed.

Work has been commenced in the San Jacinto Reserve and will be prosecuted throughout the spring months by topographic, triangulation, and level parties. There are a number of artesian wells in this locality, and the water supply of a large section of the country devoted to fruit raising, for the success of which constant irrigation is essential, is directly dependent upon the preservation of the trees and shrubbery in the mountains included in the reserve.

About \$9,000 have been so far expended in this locality, and there is at present a force of twenty men engaged.

On the 1st of January a party commenced work in the San Bernardino forest reserve, and up to March 1 had succeeded in covering an area of about 200 square miles.

Examination of forests.—About the middle of February Mr. J. B. Leiberg was ordered to this region for the purpose of making an examination of the San Jacinto, San Bernardino, and San Gabriel reserves, upon which work he is at present engaged.

Summary.—In the accompanying tabular statistical summary are given the figures relating to the surveys thus far executed in the forest reserves.

Of the results of the examination of the forests it may be briefly stated that in the area examined, which is approximately 15,000 square miles, the statistics of the several species of standing timber and the amounts of each, with the areal distribution, have been collected.

MISCELLANEOUS DATA CONCERNING FORESTS ON RESERVES.

Mr. Leiberg, after completing his reports upon the Priest River and Bitterroot reserves, prepared a report upon the timber lands of northern Idaho, a region of which he has made a prolonged study and with which he is familiar.

There is in existence, scattered about in the hands of many persons, but uncollected and unpublished, a vast amount of information concerning our forests. Nearly all the subdivided forest lands of the West have been examined. All the lands comprised in the heavy timber belt of the Northwest (Washington, Oregon, and California), except those which have not yet been subdivided by the General Land Office, have been examined with reference to their timber, and much of them repeatedly, by timber cruisers in the employ of the States (for making selections), railroads, and lumber companies. These cruising have never, so far as learned, been compiled. These statistics are being collected. Altogether there have thus far been ascertained the timber supply and its distribution over some 6,000,000 acres, and similar statistics concerning some 10,000,000 or 12,000,000 acres more are now being compiled. These statistics will furnish, for the first time, clear, definite information concerning the amount, character, and distribution of the merchantable timber of the West, and will enable public and private holders of timber land to manage their holdings with economy and profit.

Survey of forest reserves, statistical summary.

	Black Hills.	Big Horn.	Uinta.	Teton.	Lewis and Clark.	Flat-head.
Base lines measured					1	
Triangulation stations located	12	22	11	8	23	4
Triangulation	2,500	5,000	3,500	2,000	4,500	1,200
Detailed topography, including sketching of timber lines						
Level lines	1,164	735				
Permanent bench marks	484	330	57	154		
Traverse lines	141	80	25	13		
Land surveys:	1,311	203		173		
Standard	6					
Township	103					
Section	405					
Average number of men employed	40	18	7	10	4	4
Total cost to Dec. 1	\$17,106	\$8,952	\$3,506	\$4,867	\$3,272	\$1,413

	Bitter-root.	Priest River.	Washington.	San Gabriel.	San Jacinto.	San Bernardino.	Total.
Astronomic stations determined	1						1
Base lines measured	1						2
Triangulation stations located	19		28	7	7		141
Triangulation	6,500		7,000	500	1,000		33,700
Detailed topography, including sketching of timber lines, square miles	600		845	492	390	125	4,351
Reconnaissance topography, square miles	6,500	1,000					7,500
Level lines	157	37	104	121	97		1,601
Permanent bench marks	22	8	30	58	24		401
Traverse lines	608		231	350	403	250	3,529
Land surveys:							
Standard	21	66					93
Township	38						141
Section							405
Meander	6	63					69
Streams gauged	11						11
Average number of men employed	85	25	30	10	10		193
Total cost to Mar. 1	\$12,606	\$6,992	\$13,465	\$5,241	\$3,035	\$664	\$81,219

Amount allotted

\$126,000

Amount expended to March 1

81,219

Balance available for office work in completing field notes and for continuing surveys in the spring

44,781

APPENDIX A.

PLAN FOR THE SURVEY OF THE FOREST RESERVES.

All surveys to be confined to the forest reserves that are suspended by Congressional action until March 1, 1898, with the exception of surveys during the winter months on the San Jacinto or San Bernardino reserves, California.

The surveys of the reserves may be divided into: First, topographic and subdivisional surveys; second, forestry surveys.

Method of making the topographic and subdivisional surveys.—The topographic surveys will be made in the same manner as the other topographic surveys of the United States Geological Survey. The base for the topographic work will be triangulation and spirit-level lines, except in the higher and more rugged mountain portions, where there are no roads or trails. In such areas the best practicable methods are to be employed to secure elevations and distances. The subdivisional surveys to be made in the same manner as in the survey of the Indian Territory. The land subdivision surveys are not to be extended over the higher and more rugged mountains, the classification of areas there to depend upon the natural features, as shown by the topographic map.

The purposes of these surveys are: (a) The preparing of topographic maps upon the scale of 2 miles to the inch, with contour intervals of 100 feet, to serve as base maps for the representation of forestry details, agricultural and mineral lands, etc.; (b) the establishment of bench marks indicating elevation above sea level; (c) the subdivision of the reserves by running township lines (unless this has heretofore been done by the General Land Office), for the purpose of designating tracts of land; (d) the demarcation, by means of section lines, of tracts which are more valuable for agriculture and minerals than for their timber, it being understood that the land subdivision surveys shall be limited to township exteriors, except in cases where more than the area of one-fourth of a township is taken up by agricultural or mineral lands or by settlements, in which latter event the townships shall be subdivided into sections over such portions as include agricultural or mineral lands or settlements. While the ultimate decision regarding the status of such lands rests with the Secretary of the Interior, tentative decisions, for the purpose of deciding whether or not such tracts should be surveyed, shall be made by the chief of party; (e) the mapping by the topographer in charge of each party of the outline of all wooded and forest areas.

Out of the appropriation of \$150,000, made for the survey of the forest reserves, \$128,000 will be allotted to the topographic and subdivisional surveys, and the following work will be undertaken under the charge of Mr. E. M. Douglas, chief of the Rocky Mountain section of topography:

BLACK HILLS, SOUTH DAKOTA.

It is proposed to run such additional township lines as may be necessary to complete the township surveys over the whole area, and to subdivide such townships as may be found to include agricultural or mineral lands. Also to completely revise the maps of this timber reserve, to run such level lines, and set such corner posts as may be needed to comply with the existing law. Amount allotted, \$14,000.

BIG HORN RESERVE, WYOMING.

It is proposed to continue the township surveys of this area and to extend triangulation as needed for topographic surveys, to continue the topographic surveys of the whole area, and to run such level lines and set such corner posts as are required. Amount allotted, \$14,300.

TETON RESERVE, WYOMING.

This, like the Big Horn Reserve, is mainly an area of high mountains in which snow falls in October. It is proposed to extend triangulation from the vicinity of Hart Mountain (Sheridan Base) southwestward across the reserve east of the Park, and over the whole of the Teton Reserve. Also, to resurvey all valley areas and, if the existing maps of mountain areas are found to be defective, to correct or resurvey them; and to run level lines and add bench marks, as required by law. Amount allotted, \$10,000.

UINTA RESERVE, UTAH.

It is proposed to extend triangulation from the Coast Survey base over this whole area. It is also proposed to do such exterior work as can be done by one party during the season, which it is thought will include about two-thirds of this reserve.

Also, it is proposed to run level lines and set the bench marks needed for commencement of topographic surveys next season. Amount allotted, \$9,700.

LEWIS AND CLARK AND FLATHEAD RESERVES, MONTANA.

It is proposed to measure a base line at Helena, connecting with the astronomical station at that place, and to extend triangulation northwestward over the Lewis and Clark and Flathead reserves. Amount allotted, \$11,000.

For convenience of supervision, Mr. R. U. Goode, chief of the Pacific Section of Topography, will take charge of the survey of the following areas:

BITTERROOT RESERVE.

Practically no survey work has yet been done in this reserve. It is proposed to locate an initial point astronomically, measure a base line and extend triangulation into it. It is further proposed to commence topographic work, including leveling, and to run township lines and segregate agricultural areas, and to complete the survey of the eastern portion of the reserve this season. All these classes of work will be continued as far as the season will permit. Amount allotted, \$21,000.

PRIEST RIVER RESERVE.

As no surveys of any kind have been made in this area, it will be necessary to extend township lines over it and to accompany these lines with lines of level. It will not be possible the present season to extend triangulation over it or to commence topographic mapping. Amount allotted, \$12,000.

WASHINGTON RESERVE.

This is a very heavily forested area, the survey of which will be costly and slow. It is proposed to start with the known mineral and agricultural areas, and, as far as possible, provide a basis for the subsequent survey of other portions of the reserve. The work of running township lines within the reserve will be commenced and carried as far as the season will permit, and to carry triangulation forward from the Ellensburg base. Amount allotted, \$26,000.

SAN JACINTO OR SAN BERNARDINO RESERVE, CALIFORNIA.

It is proposed to have the surveyors who are driven from the northern reserves by cold weather and snow proceed to this reserve and survey as much of it as possible, owing to its great value to the irrigation interests of southern California. Amount allotted, \$10,000.

FORESTRY SURVEY.

This work will be in charge of Mr. Henry Gannett, geographer. For the examination of the forests a number of experts will be employed, and to each will be assigned an area consisting of a single reserve, or more than one in the case of small reserves. It will be the duty of these experts, with the aid of the topographic maps, to study the distribution of forests and woodland, the size and density of the timber, and the distribution of the leading economic species; in short, to obtain an estimate of the economic value of the forests. They should, moreover, examine and report upon the ravages of forest fires and the amount of damage inflicted by them, the amount of dead timber, the extent to which forests are pastured, and the effect of this upon the forests, and the extent of the timber already cut.

One such expert will be assigned to an examination of the forests of the Black Hills, a preliminary map of which has been prepared by the Geological Survey.

A second will be assigned to the Big Horn Reserve, a part of which has already been surveyed by the Geological Survey, while the survey of the remainder will probably be completed during the coming year.

A third will be assigned to the Teton, Wyoming, Reserve, and the Uinta, Utah, Reserve, maps of which, believed to be approximately adequate for a reconnaissance survey, have been prepared by the Hayden, Powell, and King surveys.

A fourth expert will be assigned to the Priest River Reserve and the eastern portion of the Bitter Root Reserve. By accompanying the surveyor engaged in running township lines, it is believed that he will be able to report upon these areas.

If the funds will allow, it is also proposed to employ one or two additional experts for the purpose of making a reconnaissance survey of the Washington Reserve.

The surveyors and forestry experts will not be limited in the scope of their work

by the present lines of the reserves, but will be instructed to extend their examinations to adjoining public lands.

Amount allotted for the forest survey, \$16,000. The balance of the appropriation of \$150,000 to be used to defray office expenses and serve as a contingent fund.

Résumé.

Topographic and subdivisional surveys.....	\$126, 000
Forestry survey.....	16, 000
Office and contingent.....	8, 000
	150, 000

DEPARTMENT OF THE INTERIOR, *June 8, 1897.*

The foregoing plan for the survey of the forest reserves for which provision is made in the sundry civil act approved June 4, 1897, is hereby approved.

C. N. BLISS, *Secretary.*

APPENDIX B.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 14, 1897.

SIR: You are hereby assigned to the charge of an examination of the forests and woodland of the forest reserves and adjacent wooded regions. The allotment for this work will be \$14,000.

You are authorized to employ assistants, who must be experts in the examination of forests, as hereafter set forth, at salaries not exceeding \$125 per month and expenses. As topographic surveys will be in progress in each of the reserves to be examined, such experts may make their headquarters in the camps of the surveying parties, but should be prepared to make short trips independently, in order to insure freedom in their work.

The topographers will outline all wooded areas upon the topographic maps. It will be the duty of the forestry experts to classify and map the areas occupied by timber suitable for the sawmill and for inferior uses, such as mining, railroad ties, and firewood. They will map also the distribution of the leading species of timber of economic value individually. They will make note, furthermore, of the size and density of the distribution of the valuable timber, and of the character and density of the undergrowth. They will map the area from which the timber has been destroyed, whether from burning, cutting, or other means, the extent to which the forests have been culled, and the species culled, the main purpose being to obtain an estimate of the value and character of the timber upon the reserves and adjacent regions. These experts should also make inquiries and be prepared to report upon the extent and character of the demand for timber, the means of getting it out, including the character of the streams, roads, railroads, etc.

Of the Black Hills, of South Dakota, a map has been prepared by the United States Geological Survey. For the examination of this area you will employ one such expert, and owing to the character of the country and the importance of the interests dependent upon it, great care should be exercised in his selection.

Of the Big Horn Reserve, in Wyoming, a small portion only has been mapped, but the remainder will be mapped during the coming year. For the examination of this reserve you will employ one expert, who will use this map and tracings of the plane-table sheets of the remaining area as fast as they are prepared.

The Teton Reserve has been mapped by the Hayden Survey, and the Uinta Reserve by the Powell and King Surveys. For the examination of these reserves you will employ one expert, who will use these maps for the purpose.

The Priest River Reserve has been in part subdivided into townships, and the remainder will be subdivided similarly during the current season. For the examination of this reserve you will employ one expert, who will use the plats of the township exteriors for the purpose, thus defining areas by townships.

Work will be commenced upon the Bitter Root Reserve upon its eastern side, extending westward into it. For the examination of this reserve you will employ one expert, who will accompany the surveying party, using tracings of their plane-table sheets for his examinations.

In the Washington Reserve work will be commenced upon the east and west sides. One expert will be employed and accompany the surveying party, working upon the east side, using copies of the plane-table sheets as prepared; a second expert will

be employed upon the west side of this reserve, and the same expert may make examinations in the Cascade Range to the southward, touching the question of the effect of sheep husbandry upon the forests.

You are authorized to make such journeys as may be necessary in carrying out these instructions, either by rail or by other mode of public or private conveyance, and to authorize the persons employed by you to make similar journeys.

I am, yours, with respect,

CHAS. D. WALCOTT, *Director.*

MR. HENRY GANNETT,

Geographer, United States Geological Survey.

APPENDIX C.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY, *June 15, 1897.*

INSTRUCTIONS RELATIVE TO MAPPING WOODED AREAS.

(1) Topographers will map on their field sheets the outlines of all wooded areas with as great detail and accuracy as they locate other topographic features.

(2) In the prosecution of plane-table triangulation angles of wooded areas, prominent trees and other features in the boundaries of woodland should be located, to aid in sketching. Traversemen should locate similar points.

(3) In topographic sketching the topographer should, with the aid of the control points furnished by his topographic base, as well as those above mentioned, sketch the outlines of all wooded areas, using a symbol which will not conflict with those employed in representing other features.

(4) The topographer must use his judgment in distinguishing the limits of wooded areas. It is impossible to give rules applicable to all cases, but it is not intended, on the one hand, to limit these areas to large merchantable timber, nor, on the other hand, to include brush or scattered trees.

(5) The topographer should make notes of the characteristics of these wooded areas—that is, whether they are composed mainly of conifers or of broad-leaved trees. He should distinguish between cedar, piñon, and quaking aspens on the one hand, and pine, spruce, and firs on the other, as well as between chaparral, mesquite, and large timber.

(6) Burned areas should be noted.

(7) In the office the topographer will draw, on a photograph of the topographic atlas sheet, the outlines of all wooded areas, noting in the body of the map or on the margin such distinctions in the character of the trees as have been above referred to.

REPORT ON EXAMINATION OF THE FOREST RESERVES.¹

BY GIFFORD PINCHOT.

I. BOUNDARIES.

AREA.

The forest reserves established under the act of March 3, 1891, consist almost entirely of mountainous lands valuable for the production of timber, but for the most part incapable of making any other contribution to the national wealth. Their capacity for the sustained production of wood is, however, vast, and of itself forms an imperative reason for their protection. Their estimated area is 38,944,640 acres, or 60,851 square miles, of which more than one-half has been suspended until March 1, 1898, so that the reserves at present fairly protected against loss by sale or entry embrace less than 19,000,000 acres. It will, however, be necessary in this report to deal with all the reserves as being equally subject to administration by the Government, without reference to the suspension of some of them.

The estimate of area given above is based upon the total number of acres included within the boundaries of the reserves. It disregards the acquired rights of settlers and miners, the grants of school lands, and the very considerable area covered by the land grants of various rail and wagon roads. A sufficiently reliable estimate of the loss to the reserves from settlement and mining claims is not available at this time; nor will it probably be reached in the near future, since, under the law, rights acquired to lands within the reserves may be exchanged for similar rights to unreserved lands without limit as to time. Sections 16 and 36 have been granted as school lands in every township throughout the reserves, but title does not pass until after the lands are surveyed. Where these lands are disposed of by the Government before survey lieu lands must be selected elsewhere to make their loss good. Where the lands have been surveyed it is believed that the right of exchange, mentioned above as applicable to individuals, should enable the States also to transfer their claims from lands within the reserves to lands without them. An approximation to the area of railroad lands within the boundaries prepared for this report by the General Land Office indicates that the loss from this source may be in the neighborhood of 4,000,000 acres. Accurate figures are out of reach on account of unde-

¹This report is divided into three parts, of which the first deals with boundaries and general policy, the second with administration, and the third with 18 of the forest reserves, in alphabetical order. The English names of trees have been made to conform, with some important exceptions, to the list contained in Bulletin 14 of the Division of Forestry, Department of Agriculture. The Latin names, a list of which will be found at the end, are taken from the same document without change.

cided litigation, and because the railroad grants do not give title to mineral lands within either primary or indemnity limits. The proportion of mineral lands in the odd-numbered sections within these limits is not yet known.

Among other cases, that of the Priest River Reserve may be cited in illustration. By far the larger part of it is covered by the land grant of the Northern Pacific Railroad, within which the ownership of the United States is restricted to even-numbered sections in every township and to the odd-numbered sections which may be found to be mineral. It will be distinctly to the advantage of the Government and will immensely simplify the task of administration if some equitable arrangement can be made by which, through exchange, the Government holdings can be consolidated. Odd-numbered sections within a reserve might in this way be exchanged for the same or a different area of even-numbered sections elsewhere not reserved, so as to give the Government full and undivided control of its holdings and prevent the mountain forests, so far as possible, from passing to other hands. In some cases it might be necessary to exchange lands already reserved for odd-numbered sections within reserve boundaries; but this course should be avoided whenever possible, even at very considerable cost. Partial ownership within the boundaries fixed by proclamation would thus be exchanged for full ownership within the same or smaller limits. The loss to some of the reserves will be very considerable unless the exchange of unreserved for reserved lands can be effected, and the definite adoption of this policy is strongly urged. It would serve the profit of the railroads as well as that of the Government, since by means of it they could secure solid blocks of land in grazing and agricultural regions, and thus greatly increase the sale and rental values of pasture and other lands within their grants. A little more or a little less than one-half of the reserves will be affected by the policy adopted according to the issue of suits now pending.

FIRE.

By far the greater part of the reserves is covered with growing trees; but they contain also considerable areas which have been more or less completely stripped of live timber by older or more recent fires. In many regions now covered with trees the forest itself affords unmistakable evidence that the land was once cleared by fire; and, in general, it is more than probable that most of the forests throughout the United States have been burned and have grown again repeatedly during the course of geologic time. There is no cause to doubt, but on the contrary conclusive reason to believe, that this process of rehabilitation will be repeated once more on the forest lands which are at present devastated. Indeed, some of the successive steps in the return of burned areas to fertility may be observed wherever the fires have cleared lands once covered with the growth of trees. Such lands will resume their former character as productive forests as soon as the increasing fires can be checked. They are essentially forest lands, and as such belong with entire propriety to the reserves.

With the progress of settlement and the extension of surveys the useless waste of timber by fire has steadily grown. At present it is the one paramount danger, both to the growing forests, whose existence it threatens, and to the burned forest lands, whose return to value it may indefinitely postpone. In comparison with the damage from fire, the loss to the national timber lands from the ax is almost insig-

nificant. Except for the fact that under the present system cutting is followed by fire with almost mathematical certainty, the injury from this source would have been far less important than it is. Nor should the fact be overlooked that a very large part of the timber cut has been used in the development of the country, while the loss from forest fires is wholly without compensation. The fires have done no one any good.

The time required for the rehabilitation of burned lands may be long when computed from the standpoint of the individual, but it can not be fairly measured in that way. The life of the nation is here concerned, and it must furnish the point of view from which alone the periods of time involved in forestry can be justly estimated. Like the growth of a nation, the growth of its forests is continuously productive, but it can not be adequately governed with an eye single to the immediate present.

THE FLOW OF STREAMS.

In addition to the clear necessity for protecting the reserves for the sake of their present and future productive value, great interests, dependent upon the flow of streams, demand the conservation of their mountain forests. Such forests have a double function with relation to water supply. They tend, on the one hand, to maintain the flow of water in the streams during the period when it is most needed for irrigation and most apt to fail. On the other hand, no other agency is so powerful for the prevention of destructive floods in regions liable to the enormous damage which they often cause. This function of the mountain forests in the northern portion of the Pacific slope has hitherto been overlooked, and criticisms of certain of the reserves have been based on the statement that there is already too much water in the streams whose head waters they embrace. No better reason for the existence of these reserves could have been adduced.

MINERAL LANDS.

Beside lands valuable for forest purposes alone, certain of the reserves contain considerable areas more or less rich in valuable minerals. Under the present law and the regulations framed to give it effect, mining within the reserves is at no disadvantage as compared with mining on unreserved public lands. Prospecting is unrestricted, and the development of mineral resources is on the same basis within and without the reserves. Not only is this true, but there is in addition strong evidence to show that mining interests are more fully protected in the reserves than outside, and that the recognition of this fact has made rapid progress among those most deeply interested. In those cases, however, where restricted areas support a comparatively dense population occupied in mining, it would be wisest, from the point of view of practical administration, to exclude them from the reserves, although it does not appear that such communities would suffer in any way did they remain within the boundaries.

AGRICULTURAL LANDS.

The lines of some of the reserves, as originally laid down, embrace considerable areas of agricultural land. Although the total extent of these areas will be very much reduced by the rectification of boundaries now in preparation, no general readjustment of the lines will suffice to

exclude all agricultural land from the reserves. Instances are not uncommon in which land of this character is so intermingled with the forest that to attempt to exclude every parcel by name would involve very great expense for surveys and a most unwieldy multiplicity of detail. The great danger to the reserves which must result from long delay in establishing their status pending the surveys forms a still more serious objection to this plan. It is estimated that five years will be required to complete these surveys at the present rate of expenditure. Fortunately it appears to be as unnecessary to attempt to survey out every 40-acre tract which might eventually be used for agricultural purposes as it would be slow, dangerous, and costly. It is true that the contribution of agricultural lands to the national wealth is greater than that of equal areas of forest, and the conclusion follows that it would be unwise to hinder the development of any such lands which may lie within the reserves. The presence of settlers in a reserve is not undesirable, provided suitable regulations are made and enforced, nor will the reserve work any hardship to the settler. Protection against fire requires men, who can not be had without long delay unless there are settlements near at hand. No other forest is so safe as that which lies near a community interested in its preservation. Two courses seem open, each of which offers a solution of this question. The first is to offer to settlers the possession of small bodies of agricultural land under license for a term of years in consideration of assistance to be rendered in the protection of the reserves. Such licenses should be forfeited upon proof of the commission of offenses against forest laws or regulations, and renewal should be refused to license holders who have not fulfilled their obligations toward the forest. This plan has the great advantage of controlling, to some extent, the settlers within the reserves, and of securing their cooperation. On the other hand it makes the settler's tenure of his land and improvements dependent, to some extent, upon the arbitrary judgment of the forest officers, and it engages the Government in business as a landlord. The other plan, although intrinsically less effective, seems more feasible at the moment. It involves a general provision like that outlined below. When a proclamation of the President is issued assigning new boundaries to any reserve, it may be made to include a paragraph exempting from its provisions any lands which are more valuable for agriculture than for forest purposes, and which shall be shown to be such to the satisfaction of the Secretary of the Interior. A definition by the Secretary may then establish the meaning of the term "agricultural lands," and filings for homestead entry may be required to include both a special affidavit to the non-forest character of the lands, and a certificate from the resident forest officer to the effect that the lands in question fall within the Secretary's definition. A more explicit reference to this matter will be found on page 47, where its relation to existing laws is briefly noted.

PASTURAGE.

The character of the forest in certain portions of the reserves fits it to furnish pasturage to large numbers of domestic animals during certain periods of its growth. Injury from grazing will be slight, or altogether wanting, provided horses, cattle, and sheep are excluded from those portions in which the immediate reproduction of the forest is desired. Grazing does little harm to old trees. To young growth it is usually fatal. Sheep, in particular, are so dangerous that their exclusion is a prime condition of the successful reproduction of the forest.

Treading down the young seedlings where they do not browse upon them, they reduce what might have been a vigorous young forest to the condition of scattered clumps of young trees, many of them crooked and unhealthy from wounds received in early youth from the sharp hoofs. Cattle and horses are dangerous to young growth chiefly because they browse upon it. In forest regions they rarely gather into bands large enough to trample out the young trees over any considerable areas, whereas the densely packed bands of sheep, whose feet pulverize the soil and uncover the roots of the seedlings over which they pass, necessarily inflict the most serious damage. Nevertheless, it is the regulation of pasturage within the reserves, not its prohibition, that is required if all their resources are to be rightly developed (see page 48). That such regulation is easy, and the complete exclusion of domestic animals unnecessary, is abundantly proved by the case of British India, where upward of 3,000,000 head of domestic animals, chiefly sheep and goats, are annually pastured with entire safety in the Government forests.

CONDITIONS OF SUCCESSFUL MANAGEMENT.

The success of the procedure here proposed with reference to agricultural and grazing lands, as well as that of the whole plan of administration recommended in this report, depends altogether upon the character and efficiency of the service which may be organized for the management of the Government forests. Such provisions as those just described are necessarily open to the possibility of many abuses. They could be applied with safety only under the direction of a permanent force selected with rigid care on the basis of fitness alone. From the very nature of the task before it, the attempt to organize a forest service on any other basis must, in the judgment of the writer, inevitably result in mismanagement, failure, and very serious harm both to the cause of forestry and to the forests themselves. This matter will be touched upon more at length under the head of Administration.

PUBLIC OPINION.

Perhaps the most striking fact developed during my investigations in the field season just closed is the profound change now taking place in public opinion with regard to forest preservation in general and to the reserves in particular. The outburst of public protest which followed the establishment of thirteen reserves by President Cleveland has spent its force, and a widespread recognition of the value of the reserves to the communities about them is taking its place. The largest factor in this change has been the diffusion of knowledge regarding the rules and regulations issued by the Department for the government of the reserves. These rules, framed to bring about the use of the reserves, and liberal to a marked degree, are gradually becoming known. During four months in the Northwest I have met but one man to whom a knowledge of their provisions did not furnish sufficient reason for hearty approval of the reservation policy. But great numbers of those most interested are as yet incompletely informed, and a wider publication of the forest policy of the Government, perhaps through the post-offices situated in or near the reserves, would go very far to establish the good opinion gradually forming in the public mind, and to secure the national forests against future attacks from any source.

THE PUBLIC FOREST LANDS.

The National Irrigation Congress held at Lincoln, Nebr., September 30, 1897, passed unanimously a resolution advocating the withdrawal from sale or entry of all lands now in possession of the Government which are of more value for their timber than for agriculture or for minerals. This representative body of Western men has expressed a conclusion in which I fully concur. No good reason can be given for the maintenance of the present reserves which does not also demand the withdrawal and protection of all similar lands now held by the Government. The present regulations, with the addition of the provision regarding agricultural lands already mentioned, would have the effect to open all the resources of these lands to the fullest development, and no good reason remains why the reservation policy should not be extended to them also.

The conclusion embodied in the resolution of the irrigation congress was emphatically reiterated on December 8, 1897, by the American Forestry Association. It was strongly expressed by a committee of the National Academy of Sciences; and it appears to be supported with significant unanimity by the men most familiar with the Western forests, and most interested in their preservation. The progress of settlement has left in the ownership of the Government little Western forest land that is not mountain land as well. The welfare of the great agricultural and mineral regions in the West are known to be indissolubly connected with the safety of these forests. The protection of the mountain forests from fire is of the first and most immediate importance. Already certain mining sections are beginning to suffer from lack of timber as the direct result of forest fires, and the development of new mining centers will be seriously hampered, or even, in the case of low grade ores, be rendered impossible by the lack of accessible timber. The Big Horn Mountains of Wyoming, although partly included in a reserve, will furnish a typical illustration. This region is believed by residents to contain mineral deposits of great value. These deposits must be developed by the aid of local timber, or not at all, on account of the steepness and isolation of the range and the difficulties of transportation. During the past summer fires burned over about 70,000 acres, an area capable of yielding at one time, with entire safety to the forest, an amount of timber sufficient to meet local needs, at the present rate of consumption, for more than seventy years.

A powerful reason for assimilating all the Western public forests to the reserves is found in the fact that no adequate provision exists by which their timber can be made available for local needs. Means to this end have been provided for the reserves, and it is believed that the extension of these means to the unreserved forest lands would be welcomed throughout the West. Whether the withdrawal of the unreserved forest lands could best be achieved by Congressional action, or through proclamation by the President, is an open question. In the latter case it might be necessary to reach the end in view by the constitution of a number of new reserves, with boundaries subject to subsequent revision, and any inclosed agricultural land open to entry as heretofore described. Action in either direction should be preceded and accompanied by the widest possible diffusion of the regulations governing the reserves.

PRINCIPLES WHICH SHOULD GOVERN THE CHOICE OF BOUNDARIES.

1. All forest lands belonging to the United States, more valuable for forest purposes than for agriculture, should be reserved and protected from fire, and all their resources should be opened to development under the regulations of the Department.

2. With suitable modifications, the reserves now existing should be maintained.

3. Mining and forest protection are not incompatible, but under proper management mutually helpful, and except in the case of densely populated mining districts, mineral lands should not be excluded from the reserves.

4. Forest lands denuded by fire or otherwise may be as suitably included in a forest reserve as though covered with trees.

5. Considerable bodies of agricultural land should be excluded from the reserves. Small areas within the boundaries should be subject to location and entry for a definitely restricted number of years.

6. Railroad lands should be excluded from the reserves by exchange.

7. Open forests valuable for grazing should be used for that purpose, under suitable regulations, without exclusion from the reserves.

II. ADMINISTRATION.

The administration of forest lands differs from Government work in other departments in several very important respects. In dealing with the forest it has to do with a peculiarly delicate subject, of long life and late maturity, and of peculiar susceptibility to injury or destruction from accidents and injudicious handling. Forests are subject to wide-spreading calamities, such as forest fires, difficult to prevent, and, when once under way, often passing wholly beyond the reach of human intervention. The work of management in the field must be performed at a distance from centers of Government activity, and under circumstances which render control and inspection both matters of considerable labor and difficulty. The importance of individual initiative and devotion is therefore particularly marked. Finally, the duties which forest management entail require for their performance a kind of knowledge not widely distributed, and in general but moderately in demand for other than Government work. These and other similar facts lead naturally to the statement of the following three conditions, which are essential to successful Government forest administration, and which have been recognized as such in the organization of every Government forest service with which I am acquainted. They are:

1. PERMANENCE OF TENURE OF FOREST LANDS.

The reforestation of burned areas; public acceptance and support of Government ownership; the establishment of permanent boundaries; and the possibility of successfully carrying out plans whose final completion often can not take place for more than a hundred years; all these considerations demand that the lands in question should belong to the Government permanently and without the possibility of dispute.

2. CONTINUITY AND STABILITY OF PLAN.

In the management of the forest, the long life of the trees which compose it must be recognized in the treatment to which it is subjected. Mistakes are peculiarly dangerous from the number of decades which

recovery from them may require. If irregularities are allowed to creep into the management of Government forest lands they will inevitably be followed by serious injury from overcutting. The temptation to commit this fault is always great, and it can only be restrained by the stability and high character of the management. Constant changes in the treatment to which forest lands are subjected can not but result in injury to the forests, laxity in the forest service, and a very serious loss of prestige, and hence of support, in the public mind.

3. THE PERMANENT EMPLOYMENT OF TECHNICALLY TRAINED FOREST OFFICERS.

Stability in the management of forests is to be secured only by permanence in the personnel which has it in charge. Technical training, indispensable to forest management, can be obtained only in men who make forestry their profession. The demand for such knowledge in this country outside of Government employment is at present so small that young men of adequate character and ability can not be expected to undergo the necessary training without a reasonable expectation of permanent work. This is but to say, in another form, that the necessary grade of skill and quality of work can only be had from men who expect to spend their lives in forestry. The peculiar responsibilities involved, the residence of forest officers far from centers of population, and the high standard of fidelity, honesty, and ability required for this work, demand as the essential of Government forest management, in this country as in all others, the selection of technically trained men on the basis of fitness alone, and their permanent employment during efficiency and good behavior. The difficulty of getting rid of inefficient men is not the least of the embarrassments which their presence may involve, as has been abundantly shown in the experience of other governments. The temptation to over-cutting, already referred to, may be used as an illustration. To cut freely may be safe or it may involve the ultimate impoverishment or destruction of the forest. In either case it may add greatly to the popularity of a forest officer, and perhaps to his professional reputation as well, by affording supplies of timber and results in money not otherwise to be obtained. Even thorough inspection may fail to discover the danger during the early stages of a forest administration, when exact data regarding the forest are scarce or lacking altogether. The only sufficient safeguard against this danger, and many others, is to be found in the creation of a professional esprit de corps, and this is impossible without a professional training. The important measures proposed in this report depend in every case for their success in operation upon the establishment of a forest force on the lines just described; and these measures are recommended with the proviso that they can be expected to succeed only on this condition.

The question may be raised whether, during the earlier stages of forest administration, when the refinements of forest management are both undesirable and out of reach, the necessity for the employment of technically trained men is as great as it is here made to appear. The answer is to be found in the crucial importance of beginning right. The traditions of any service necessarily determine its character to a very large extent, and its future complexion must necessarily be tinged by its beginnings. The confidence and good will of local populations are an essential part of the working capital of a forest service, and at no time can they be won or lost so easily as when the first impressions are made. Further, the danger of mistakes that will seriously affect

the future value of government forests is most serious at the outset, because accurate information upon which to base the working plans can not be had. For these reasons, as well as for more general considerations, it is of the first importance to start right.

FOREST SERVICE.

In accordance with my instructions, I have to recommend the following organization for a forest service to have charge of the reserves. It is based upon an annual expenditure of \$70,000, of which the salary list is expected to consume somewhat more than one-half. The task before such an organization will be altogether lacking in precedents in this country, and the number of Americans sufficiently trained to occupy the more responsible positions is small. It seems wise, therefore, to begin on a comparatively restricted scale. I have to recommend that the officers referred to in the following paragraphs be assigned to a small number of reserves, as hereinafter specified (p. 46), since the distribution of an inefficient force over large areas must necessarily result in small profit to these areas, while forfeiting the valuable example which a few reserves well managed may afford:

ADMINISTRATIVE FORCE.

One chief forester.

Duties.—General direction and supervision of the reserves. Since it is not easy to foresee all contingencies, nor desirable to attempt to provide for them in advance, the chief forester should have very full powers. He should be charged specifically with the direction and control of the reserves under the law and the general instructions of his superior. He should review and approve all working plans (specific schemes under which forests are managed); he should approve all permits for timber for more than \$50 in value; he should make frequent tours of inspection, and prepare an annual report; his headquarters should be in Washington; and he should hold office during efficiency and good behavior.

Three clerks in the office of the chief forester.

Duties.—The usual ones of an office force.

One inspector of forests.

Duties.—To act as assistant to the chief forester as required, to replace him at Washington during his tours of inspection, and to make frequent inspections himself in the forest reserves.

EXECUTIVE FORCE.

Seven forest rangers.

Duties.—To take executive charge of the work in the field. They should reside in or near the reserves, at points designated by the chief forester, and should be responsible for the proper conduct of work in the field. They should make frequent inspections of their charges; keep the necessary sets of books; oversee the disbursements of all moneys for bridges and other improvements, and account for the same; issue permits for the use of timber up to the value of \$50 stumpage to one man in one year; report to the chief forester; and assist him otherwise, as he may direct.

Three clerks, one in the office of each of three of the seven forest rangers.

Duties.—The usual clerical ones extended to include scaling and taking tallies.

PROTECTIVE FORCE.

Twenty forest guards.

Duties.—To act as protective officers and patrols within the reserves. They should reside in or near the forest reserves, at points designated by the chief forester in consultation with the forest rangers: should see to it that the rules and regulations governing the reserves are strictly observed; guard against injury from forest fires, and perform such other duties as may be assigned to them.

One hundred and sixty fire watchers.

Duties.—On condition of the yearly payment of \$25 in the Black Hills and \$50 in the other reserves specified below (p. 46), these men should bind themselves, under penalty of forfeiture of payment at the end of the year, to repair with all practicable speed to every fire which may occur within the limits assigned to them; to do their best to extinguish it, and, if necessary, to send immediate word to the forest guard; to report to the forest guard without delay all infractions of the forest rules and regulations which may come to their notice; and to appear as witnesses for the Government without further cost to the forest service except for traveling expenses.

A word of explanation may be required regarding the fire watchers here proposed. This plan will create a body of men pledged to fight all fires which may arise, but with the strongest incentive to prevent them from arising. The fewer fires the easier it will be for them to earn their pay. It will secure a considerable number of residents in or near each reserve who will become pecuniarily interested in its existence and safety. Depredations will be liable to discovery by a larger number of men than could otherwise be employed, each of whom will be directly interested in the protection of the forest. Although the amount of the pay in each case is small, ready money is so scarce among small ranchers in the West that the inducement to earn even this sum will be great, especially since the work involved may amount to very little in any year. Even so the object of the Government will be fully attained, for it is far better and cheaper to prevent the starting of fires than to put them out after they have begun. The safety of the reserves from fire and depredations must in the end depend largely upon the good disposition of the people who live in or near them, and the appointment of fire watchers such as are here described would, it is believed, be a considerable step in that direction.

Every forest officer, except the chief forester and the inspector, should be required to provide his own residence in or near a reserve at a point suitable and convenient for the discharge of his duties, and to keep at his own expense two horses constantly available for forest work. His own field equipment, with the exception of a uniform hat to be furnished by the Department, should also be provided at his own expense. No charge for food and lodging should be allowed when traveling. A subsistence allowance in addition to actual and necessary traveling expenses should be paid as follows:

	Per day.
Chief forester.....	\$3.00
Inspector.....	3.00
Forest ranger.....	2.00
Forest guard.....	1.00

A forest officer residing in a forest reserve should be allowed the use of not more than 160 acres of agricultural land, if such land, suitably placed, is available, together with free range for his own horses and

cattle to the number of 25 head in places where pasturage may safely be permitted. Every forest officer using public land in this way should be required to reside upon the land allotted to him.

In no case should a forest officer be allowed to be pecuniarily interested, in his own person or through another, in any matter connected with the reserves, or with any one of them.

COST.

Annual salary list.

1 chief forester	\$5,000
1 forest inspector	2,500
7 forester rangers, at \$1,800 each	12,600
20 forest guards, at \$720 each	14,400
100 fire watchers, at \$50 each	5,000
60 fire watchers, at \$25 each	1,500
1 clerk	1,200
1 clerk	1,000
4 clerks, at \$720 each	2,880
Total	\$44,080

Miscellaneous expenses.

Traveling expenses and allowances	\$10,000
Trails, bridges, and cabins	3,000
Fire fund	5,000
Contingent fund	7,920
Total	25,920
Grand total	70,000

COMMUNICATIONS AND FIRES.

The construction of trails, bridges, and cabins for shelter in different parts of the reserve should be one of the first duties assigned to the forest guards during the season when fires are not dangerous. No other expenditure can add so much to the safety of the reserves as that for means of rapid and easy communication. To gain an hour in reaching the scene of a fire may save hundreds or even thousands of dollars in damage done and labor expended. Cabins will be required, because to visit the large area under his charge will require days, or sometimes weeks, of travel on the part of each ranger or forest guard, and rough shelter should be provided at scattered points to make such trips as easy as possible. Every available means should be employed to encourage the forest officers to travel widely and constantly through their charges, and to provide shelters for the night is one of the best and least expensive steps to that end.

Forest fires, while they are to be dreaded only in certain months of any year, prevail to very different degrees in different years. It would be most advisable, therefore, for that portion of the appropriation devoted to the fire fund, and to the contingent fund as well, to be continuous, so that a season free from expensive fires may leave a balance at the disposal of the forest service for use in succeeding and less favorable years; and to this end the requisite clauses in the appropriation bill should be very carefully drawn. The fire fund itself is intended to permit the employment of men, not already members of the forest service, to meet emergencies caused by the prevalence of fires beyond the control of the regular force. To put out even a slow-burning fire in the dense

forests of many of the reserves may often be a matter of a week's work for several men, on account of the enormous mass of fallen and decaying wood on the ground. In view of the crucial importance of attacking threatening fires with sufficient force and without delay, the fire fund here recommended appears to be essential, and any surplus in the contingent fund should be made available for the same purpose. It should be noted, however, that great care will be required in the expenditure of this money, and that the rates fixed for labor should be reasonably small. Otherwise fires may be set for the purpose of creating a demand for men to extinguish them.

DISTRIBUTION OF FORCE.

As has been said, it appears inadvisable to scatter a force of the size recommended over the whole extent of the reserves, an area of more than 60,000 square miles. On the contrary, I have to recommend the concentration of the force upon those reserves where the danger from fire and illegal cutting is most serious and where the demand and opportunity for administration are largest. The reserves which these considerations indicate are the Black Hills, Bitterroot, Washington, Cascade, and the four reserves of southern California, the San Gabriel, San Bernardino, San Jacinto, and Trabuco Canyon, which, for administrative purposes, may conveniently be treated as one. Supervision should also be exercised by the officer in charge of the Bitterroot Reserve over portions of the Flathead and Lewis and Clark. The total area within the boundaries of these reserves is 12,250,000 acres, and the cost of the administration here proposed would amount to about 5.6 mills per acre per annum. It does not seem wise to reduce this amount still further by scattering the force over a larger area. The following table exhibits the disposition provisionally recommended, with the points of residence of the executive and protective officers. Fuller experience will undoubtedly indicate considerable variations from the detail here laid down. Much of the larger part of the time of each officer should be spent in the field. So far as possible those points are indicated from which various parts of the reserves are most easily accessible. The headquarters of the chief forester and the forest inspector would naturally be in Washington.

	Rangers.	Guards.	Fire watchers.
Black Hills	1 at Deadwood, 1 at Custer.	5 at or near Deadwood, Rockford, Custer, Sheridan, Bear Gulch.	60 at local points.
Bitterroot	1 at Missoula	4 at or near Hamilton, Darby, Ovando, Columbia Falls.	30 at local points.
Washington	1 at Hamilton	4 at or near Marblemount, Monte Cristo, Index, Stehelin.	25 at local points.
Cascade	1 at Oregon City, 1 at Roseburg.	5 at or near Summit Camp, Detroit, Sisters, Big Meadows, Fort Klamath.	30 at local points.
Southern California reserves.	1 at San Bernardino ..	2 at or near Pasadena, Hemet..	15 at local points.

It will be noticed that the force recommended for the Black Hills is much stronger in proportion to area than elsewhere. This is done because this reserve offers by far the best opportunity for successful forest management. There will be found more work to be done per acre than in the other reserves recommended for occupation, and suc-

cess or failure here will necessarily be conspicuous and important. In the Bitterroot Reserve only the eastern side of the mountains should be occupied at present, since only here is cutting going on. The oversight of the lumbering region in the southern part of the Lewis and Clark and a general supervision of the remainder of that reserve and of the Flathead should be included in this charge. In the Washington Reserve questions of protection are chiefly important at present. In the Cascade Reserve sheep and fire are important; cutting less so. In southern California, where the local population is thoroughly favorable to the reserves, fire must be the matter of chief concern.

AGRICULTURAL LAND.

The procedure recommended on page 38 for restoring small bodies of agricultural land to the public domain is based on the use of a paragraph similar in effect to that next below in each proclamation of the President defining the boundaries of a forest reserve:

Excepting from the force and effect of these provisions all lands within the boundaries hereinbefore described which are more valuable for agriculture than for forest purposes, and which, prior to January 1, 1905, shall be shown to be such to the satisfaction of the Secretary of the Interior, in accordance with rules and regulations to be established by him for that purpose.

The law specifies that such lands may be restored to the public domain after advertisement for sixty days. The advertisement of the provisions just described would, it is believed, comply with the law in this respect, and the lands excepted would be subject to the rules and regulations governing the public domain as soon as the Secretary had accepted and approved of their agricultural character. By such acceptance they would, in fact, be restored to the public domain in accordance with the law. The regulations mentioned in the last paragraph should provide:

1. Any 40-acre tract within a forest reserve, upon the application of an actual or intended settler in accordance with existing laws and regulations, accompanied by an affidavit of the entryman to the nonforest character of the land and by the affidavit of the resident forester that the tract so selected is more valuable for agriculture than for forest purposes, may, upon the approval of the Secretary of the Interior, and not until then, be entered in the usual way.

2. To be "more valuable for agriculture than for forest purposes" a 40-acre tract must be capable of yielding agricultural crops, either with or without irrigation, and it may have not to exceed one half of its surface covered in whole or in part with seedlings, young or old trees, stumps, or stubs of merchantable kinds of trees, either living or dead.

3. The affidavit of the forest officer must specify the number of acres of seedlings, young or old trees, stumps, or stubs, and whether living or dead, contained upon each 40-acre tract, and what crops, in his judgment, may be raised upon it. It must contain a full legal description of the tract, a statement of the watershed within which it is situated, the date of the examination, and, in the case of an actual settler, a list of improvements and a statement upon information and belief of the time of residence of the present occupant. Should it be deemed wise to put in force a system of licenses such as that briefly described on page 38 special regulations drawn with great care would be required.

The regulations just indicated are drawn with special reference to the Black Hills reserve, and should be modified to conform to the conditions of any other reserve to which they may be applied.

PASTURAGE.

The regulation of pasturage must be developed along lines which will vary considerably from one reserve to another, or even within smaller limits. As an example of a set of rules admirably adapted to the region for which it is intended, I wish to quote that proposed for the Cascade Range Reserve by Mr. Coville, Botanist of the Department of Agriculture, who spent the field season just ended in an investigation of sheep grazing in western Oregon. These regulations are here adduced in illustration of the general direction which should be followed, not as applicable to all the reserves. As Mr. Coville is careful to indicate, their success must depend on the character of the forest officers by whom they are applied. They are as follows:

1. Exclude sheep from specified areas about Mount Hood and Crater Lake.

2. Limit the sheep to be grazed in the reserve to a specified number, based on the number customarily grazed there.

3. Issue five-year permits allowing an owner to graze on a specified tract, limiting the number of sheep to be grazed on that tract, and give the owner the exclusive grazing right.

4. Require as a condition of each permit that the owner use every effort to prevent and to extinguish fires on his tract, and report in full the cause, extent, and other circumstances connected with each fire.

5. Reserve the right to terminate a permit immediately if convinced that the owner is not showing good faith in the protection of the forests.

6. In the allotment of tracts secure the cooperation of the Woolgrowers' Association of Crook, Sherman, and Wasco counties through a commission of three stockmen, who shall receive written applications for range, adjudicate them, and make recommendations, these recommendations to be received by the forest officer and finally passed upon by the Secretary of the Interior.

7. Ask the county associations to bear the expense of the commission.

8. Charge the cost of administration of the system to the owners in the form of fees for the permits.

9. If the woolgrowers decline to accept and to cooperate in the proposed system, exclude sheep absolutely from the reserve.

10. If after five years' trial of the system forest fires continue unchecked, exclude sheep thereafter from the reserve.

CUTTING.

The object of forest operations in any reserve should be to harvest the largest amount of timber consistent with steady improvement in the fertility and usefulness of the forest. The details of the work must vary to meet the requirements of each individual case, but the first step must always be the preparation of a careful plan to govern the distribution of the cutting and the selection of the trees to fall. Special regulations should then control the mechanical work of cutting and transportation within the forest, so that the reproduction of the more valuable kinds of trees may be secured. Each tree has habits and requirements of its own, and upon these depend the effects of cutting on the reproduction of the species. A working plan prepared with a knowledge of these peculiarities may insure the safety and prosperity of a forest while yielding more timber than would be obtained under another plan which would lead to its impoverishment and destruction,

because careless and unaware of sylvicultural results. An illustration may be drawn from the forests of the southern Alleghenies. Certain lumbering operations were undertaken there under the direction of a professional forester, and were carried out by small contractors with but slight differences from the usual way. The result has been a plentiful reproduction of the yellow poplar, or tulip tree, over the whole area of the cut. This is the first instance known to me in which this result has been either sought or obtained. The yellow poplar, one of the most valuable timber trees of the region, has been uniformly believed by lumbermen to be incapable of reproducing itself after cutting. Although the trees removed were yellow poplars almost without exception, the presence of a far larger proportion of this species in the future is assured.

To harvest its product while securing the perpetuity and improvement of the forest is the special work of the forester. The cost of his work, as compared with that of the ordinary destructive methods of lumbering, shows an increase usually so small as to be wholly out of proportion to the value of the results obtained.

Lumbering operations in the reserves should not be undertaken by the Government. The function of the forest officers in this regard should be restricted to the selection of the trees to be cut, their sale at public auction, and the enforcement of rules governing their felling and removal, and the disposition of the tops and other waste.

Since each part of each forest must be treated with special regard to its character, it is difficult to formulate general rules. It may be said, however, that all regulations and all work should aim at the following results:

1. Safety from fire.
2. The reproduction of the forest.
3. Its improvement in composition and yield.
4. The satisfaction of local demand for forest products.
5. A fair return in money to the Government.

The application of these general principles to the reserves will lead to widely different results in different forests. In some places great bodies of burnt land or young timber will require nothing but protection from fire for years to come. Elsewhere old trees, long past their prime, should be removed, while in very many localities the timber needed for local use can be taken, under the direction of trained men, with safety and advantage to the forest.

FOREST BRANDS.

In reserves where timber is sold it will be necessary to indicate unmistakably before the cutting what trees are to be cut, and afterwards to ascertain that these trees, and these only, have been taken. Similarly, trees to be cut under permit must be designated, and in many other cases an official timber mark is imperatively demanded. Provision should therefore be made for providing rangers and forest guards with branding hatchets, the brand made by each of which should show, by its general shape and particular figure, the executive charge and protective beat to which it belongs. Each brand should be registered in the State where it is used, and a special regulation of the Secretary should make the penal provisions of the act of June 4, 1897, applicable to the illegal manufacture, use, or possession of a Government branding hatchet. No other regulation will do more to facilitate the practical management of the forests in the reserves.

SECONDARY DUTIES OF FOREST SERVICE.

The duties of the forest service described above, in addition to those of protection and administration, should consist in opening lines of communication through the reserves, and in preparing careful maps and descriptions of the timber and of lines of transportation. A thorough knowledge of the local markets should also be acquired. Methods and tools for fighting fires have not yet been perfected, and as they must vary with the differences of the forest in each reserve they should early claim the attention of the forest officers.

THE WORK OF ORGANIZATION.

If effect is to be given to the recommendations contained in this report it is of great importance that the officer charged with their execution should be empowered to begin the work of organization without delay. The selection of suitable subordinate officers will be a matter of considerable time and difficulty, and they should have opportunity to become familiar with their routine duties before active field work begins. The system of pasturage proposed by Mr. Coville can not be applied during the coming summer unless steps to that end are taken this winter. Finally, specific administrative details, such as regulations for the use and protection of the reserves under this plan, and form for permits and reports, matters which can not properly find a place in this report, will require painstaking consideration. Such facts as these, taken together with the pressing necessity for the immediate protection of the reserves and the enforcement of the law and the regulations, make it plain that action can not long be delayed if noteworthy progress in the right treatment of the reserves is to be made during the coming year. The fact of such progress, or its absence, will weigh heavily with the Western people for or against the reservation policy. Timely and efficient action in Washington and in the field during the next year will strengthen and solidify popular feeling in favor of the reserves as powerfully as their absence will disappoint and reduce it.

III. THE FOREST RESERVES IN DETAIL.

BIG HORN FOREST RESERVE.

SUMMARY.

	Acres.
Situation: Northern Wyoming.	
Area within present lines	1, 127, 680
	Per cent of total area.
Adverse holdings not known.	
Area of forest land	(?) 95
Area marked by fire	(?) 90
Area badly burned	(?) 70

Revised lines can not be drawn without further study and a map.

Force recommended: One ranger, 4 forest guards, 25 fire watchers, after other more pressing reserves have been supplied with men.

Sources of information: Report of F. E. Towne, special field assistant, United States Geological Survey; statement by Henry Gannett, geographer, United States Geological Survey; no personal examination.

A broad high plateau, with a central granite crest, partly covered with forests of lodge-pole pine.

Fires have cleared about half of this reserve and are keeping it free from trees.

All the water flowing east is used for irrigation, and a considerable part of that which flows west.

Mining is expected to develop extensively.

Agriculture is not possible within the reserve.

About 450,000 sheep pasture within the reserve. Their grazing retards reproduction, and should be regulated.

Adjacent settlements should be supplied with necessary timber and fuel from the reserve.

The Big Horn Reserve is situated in northern Wyoming, and occupies about two-thirds of the Big Horn Mountain Range, which has a length from north to south of from 75 to 100 miles, and a breadth from east to west of from 30 to 50 miles. The boundaries of the reserve include an area of 1,127,680 acres, none of which is railroad land.

The Big Horn Range consists of a broad flat plateau rising abruptly from the plains to an elevation of from 8,000 to 9,000 feet. Along the center of the plateau is a granite crest which attains in Cloud Peak an altitude of 13,100 feet. The climate is dry, with little rain during the growing season. It is too severe for agriculture. Frosts occur during every month in the year, and snow lies from November to June.

The forests of the range furnish a small amount of lumber to the settlements east and west, and nearly two million railroad ties have been cut.

THE FOREST.

The forest is distributed chiefly along ridges parallel to the central backbone, and consists almost wholly of lodge pole pine, locally known under various names. On the whole, the region is lightly forested, while probably one-half of it bears at present no timber at all. About 84,000 acres are estimated to contain timber of merchantable size at present, and the total stand of this area is believed to be 210,000,000 feet B. M. In other words, less than 10 per cent of the total area of the reserve now contains merchantable timber. A half million acres, it is estimated, are covered with young growth capable of yielding, after from thirty to fifty years of protection from fire, a merchantable crop. By assuming the very moderate yield of 2,000 feet per acre, this young growth will produce, when mature, 1,000,000,000 feet of merchantable timber. In addition it may be made to furnish, under proper management, a regular annual product for an indefinite period. But for the fires this vast resource would be available now.

The lodge-pole pine is distributed from the plains to the timber line. Here, as elsewhere, on account of its vigorous reproductive power, its distribution is increased by the prevalence of fires. It reoccupies the ground from which forests of other trees have been removed by fire. It is capable of yielding an inferior quality of lumber, good fencing and building material, and great quantities of railroad ties. The average size of mature trees may be given roughly, as follows: Height, 70 feet; diameter, 1 foot; length of clear trunk, 25 feet.

The spruce, while not present in great numbers on the reserve, is widely distributed on both high and low elevations in moist places. It is larger, on the average, than the lodge-pole pine.

FIRE.

The larger part of the reserve south of Tongue River appears to have been burnt over about twenty-five years ago, as is indicated by the young growth which has sprung up since that time; and clear traces of other older fires may also be discerned. The open grassy parks, which are estimated to cover at least one-half of the reserve, are directly due to fire. Repeated burnings finally overcome the reproduc-

tive power of the lodge-pole pine, grass takes possession of the soil, and the subsequent return of the forest is very slow. Since the parks are due to fire, it is true that by far the largest part of the reserve has been burnt over. Probably the whole area, in the past, has been swept clear over and over again. During the past summer alone about 70,000 acres were devastated by fire. The stand of this area, if untouched by fire, can not reasonably be estimated at less than 2,000 feet per acre. It is interesting to note that the total product of all the mills drawing their timber from the reserve is less than 2,000,000 feet per annum, while the 70,000 acres burnt over last summer would have been capable of producing 140,000,000 feet, or seventy years' supply, if they had been permitted to grow uninjured by fire.

WATER.

The whole available flow of the streams which proceed from the eastern side of the Big Horn Range is utilized for irrigation in the town of Sheridan and the tributary region, while a considerable amount is also required in the Big Horn Basin to the west. The preservation of these watersheds is intimately bound up with the prosperity of the regions to which they give fertility and value.

MINING.

Mines in this reserve have not yet been extensively developed, but expectations are large. If they are even partially realized, as it seems probable they will be, the preservation of timber for their use is essential. Mines can not be operated without timber, and the cost of transporting it from other forest regions to the Big Horn would be altogether prohibitory.

AGRICULTURE.

The elevated situation and the climate of this reserve make it totally unfit for agriculture, nor has it received any development of this kind whatever.

GRAZING.

The Big Horn Range was estimated to support last summer 3,000 head of cattle and about 450,000 sheep. The figures for the latter are those given by the State scab inspector. From $1\frac{1}{2}$ to $1\frac{1}{2}$ acres are required to support a sheep in the Big Horn during the summer, and the number of sheep corresponds closely with the estimate of 600,000 acres of pasturage already given. Injury to growing trees of larger size from the pasturage of sheep is not to be feared here more than elsewhere, nor are they known to feed upon young seedlings of coniferous trees, except under stress of starvation. On the other hand, they trample and destroy these young seedlings under their feet in great numbers, so that the satisfactory reproduction of any forest region absolutely demands their exclusion. To deny access to the reserve to the sheep who have been in the habit of pasturing there would involve serious hardship to their owners, and it appears to be unnecessary for the present. But when the time comes for the reproduction of these forests it will be essential to exclude the sheep from specified areas during the process. Regulations similar to those recommended for the Cascade Reserve should be put in force here as soon as trained men can be employed to enforce them.

FOREST FORCE.

One ranger with 4 forest guards and 25 fire watchers should be sufficient to afford a degree of protection similar to that provided, under the plan already submitted, for those reserves which should first be taken in hand.

FOREST MANAGEMENT.

The following outline of treatment adapted to this reserve is offered subject to the corrections which personal knowledge of it would undoubtedly suggest. It is based altogether on the reports of others, since I have not visited this reserve. Forest management in this reserve requires first of all protection against fire. The inflammable nature of the lodge pole pine, already alluded to in many places, makes it specially important to take this matter in hand vigorously from the start. Other silvicultural operations are entirely subsidiary, and must wait. Timber should be sold to supply adjacent demands, which may be expected to increase largely in the future. The system of clear cutting in strips will probably best accomplish the desired result in this reserve, where the reproduction of the forest is vigorous, and the soil and climate are adapted to forest growth. Transportation must be chiefly or wholly by flume or road. No attempt to use the streams for driving purposes has hitherto succeeded on account of the steep slopes between the upper plateau and the plains beneath. The silvicultural character of the lodge-pole pine is comparatively simple, and well adapted to forest management, and little or no difficulty should be experienced in securing a permanent and continuous yield from the Big Horn Reserve.

BOUNDARIES.

This reserve includes at present very little land which does not properly belong within it. Considerable extensions of its lines are plainly indicated by the information available, but in the absence of personal knowledge and a suitable map I am not prepared to recommend new boundaries.

BITTERROOT FOREST RESERVE.

SUMMARY.

Situation: West-central Montana and east-central Idaho.

	Acres.
Area within present lines	4, 147, 280
Adverse holdings, railroad lands	256, 360
	Per cent of total area.
Area of forest land	(?) 95
Area marked by fire	(?) 80
Area badly burned	(?) 50
	Acres.
Area within proposed lines, approximately	4, 238, 160
Inclusions proposed, approximately	90, 880

Force recommended: One ranger, 2 forest guards, 20 fire watchers.

Sources of information: Report of Special Field Assistant J. B. Leiberg, United States Geological Survey. Personal examination July 27 to August 19, 1896.

A rugged and broken mountain region with steep or precipitous slopes, admirably adapted to the growth of forests.

Fire has destroyed, for the present, the productiveness of perhaps half of the reserve.

Questions of water supply are important on the eastern slope.

Mining has attained some development, and is likely to increase.

Agriculture practically does not exist within the reserve.

Grazing is not important except in scattered localities on the western slope.

The commercial development of the eastern slope should be provided for at once.

The Bitterroot Forest Reserve includes the crest and slopes of the continental divide in the southern portion of the Bitterroot Mountains in west-central Montana and east-central Idaho. Its length from north to south is about 105 miles, its breadth from east to west about 85 miles, and its boundary includes an area of 4,147,200 acres. From this total there must be subtracted 256,360 acres of railroad land, besides an unknown, but very small area of mining locations and a few agricultural and timber claims. The continental divide separates the reserve into two parts so distinct from each other that they demand separate treatment.

EASTERN SLOPE.

The eastern slope of the Bitterroot Reserve embraces an exceedingly broken mountain region descending abruptly to the level and fertile Bitterroot Valley. It is traversed by nearly straight canyons of great depth, usually with precipitous sides cut through the granite by glaciers which have now disappeared. It is estimated to include about 80,000 acres. North of the West Fork of the Bitterroot River the rock is granite. To the south the granite is replaced by quartzite and felsitic rocks which contain almost the only known mineral deposits. The climate is severe, but not conspicuously moist. Large amounts of timber have been cut from the reserve, and from the timber lands adjacent by the Bitterroot Development Company (now the Anaconda Copper Mining Company) chiefly for the use of their mines at Anaconda and Butte. At the time of my visit in July and August, 1896, they were shipping daily, from their mill at Hamilton, one train of about twenty-four cars loaded chiefly with mining timber.

As much of the area of the Bitterroot Valley as can be irrigated is valuable agricultural land. Dams have been built on Mill Creek and Big Creek, and others will probably follow on other tributaries.

THE FOREST, EASTERN SLOPE.

The forest is comparatively open, and more or less sharply separated into two forest types. Of the first, the characteristic tree is the western yellow pine, which is said to cover about one-third of the area occupied by this type, while the red fir covers most of the remaining two-thirds. Higher up it is replaced by the high mountain lodge-pole pine type of forest. About 90 per cent of this forest is occupied by the tree from which it takes its name.

The yellow pine in the Bitterroot Valley reproduces itself with a vigor and persistence not known in many portions of its habitat. Young trees are common in the lower portions of the valley outside of the reserve, and at lower elevations in the reserve itself. This tree reaches average dimensions as follows: Height, 90 feet; diameter, 2 feet; length of clear trunk, 40 feet. It is chiefly used for lumber. It is estimated that nearly 50 per cent of all the trees of this species are here unsound, as the result of forest fires.

MIXED FOREST IN THE CLEARWATER BASIN.

East of the summit the Douglas fir (red fir) is a comparatively small tree, with average dimensions as follows: Height, 60 feet; diameter, 1 foot; length of clear trunk, 10 feet. It is but little used for lumber. Its reproduction after forest fires is good, but on the whole it is far less useful than the yellow pine.

The lodge-pole pine has spread widely through the influence of fire. Its reproduction is good, but the trees here, as elsewhere, are small. Its dimensions may be given as follows: Height, 70 feet; diameter, 10 inches, length of clear trunk, 30 feet.

The lowland fir, so called because of its plentiful occurrence in the lowlands of western Oregon and Washington, a tree here chiefly found above the middle altitudes, has average dimensions as follows: Height, 90 feet; diameter, 2 feet; length of clear trunk, 15 feet.

FIRE, EASTERN SLOPE.

The destruction by fire in the last forty years on the eastern slope has been very serious indeed. More than half the lodge-pole pine on the slopes facing the valley south of the main forks of the Bitterroot has been killed. It is estimated that 130,000,000 feet B. M. of Douglas fir (red fir) has been destroyed, together with 5,500,000 of mixed Douglas fir and yellow pine, and 2,500,000 of yellow pine standing alone. This is the case in spite of the fact that yellow pine and Douglas fir are particularly adapted to resist fire by their thick and corky bark. Floods have begun to be felt on account of the destruction of the lodge-pole pine at high altitudes, and still greater loss from this cause is anticipated if the destruction is allowed to proceed. A commendable sentiment against fires exists in the valley. Immediately after the visit of the National Forest Commission in 1896, notices were prepared by the Anaconda Copper Mining Company, offering a reward for the detection of infractions of the laws protecting timber on the public domain, and it was widely posted along trails and in the passes.

WATER, EASTERN SLOPE.

It has been noted that the destruction of parts of the forest has led to floods in the Bitterroot Valley, and that water for irrigation is needed, since nearly every part of the valley which the water can be made to reach will produce agricultural crops. The protection of the forests for this purpose is distinctly necessary.

MINING, EASTERN SLOPE.

Mining has been prosecuted to any extent only south of the main forks of the Bitterroot River. Several hundred mining claims exist in that region, and 500 acres of coal lands have been discovered. The future development of these mineral resources is uncertain, but in any case the protection of the timber supplies which that development will require is important. It has already been mentioned that great quantities of timber have been cut from this valley for the use of the Anaconda Copper Mining Company. Provision should be made by which the production of this timber may be continued under Government supervision, so as to reconcile the development of mines with the preservation of forests. Hitherto the regulations prescribed in the permits under which this timber has been cut have not, as a rule, been observed.

AGRICULTURE, EASTERN SLOPE.

It has been ascertained that there are 1,495 acres of land, more or less accurately described as agricultural, in the reserve, 82 acres of which are under plow. Further development is not probable, since the climate is so unfavorable that even potatoes make an uncertain crop.

GRAZING, EASTERN SLOPE.

A little grazing has been practiced at moderate elevations in the open forest, and provision should be made to permit its continuance so far as the home stock of actual settlers is concerned. Open grassy stretches at high elevations should be protected against the grazing of cattle and especially of sheep. No demand of this kind has as yet been made upon them, and none should be encouraged or considered when made.

WESTERN SLOPE.

The western portion of the reserve lies on the long and gradual western slope of the Bitterroot Mountains, from a little north of the well-known Lolo trail to the Salmon River. It includes an exceedingly broken mountainous country plentifully watered, with occasional stretches dotted here and there by extensive meadows. The more precipitous portions lie along the main divide and in a very steep and rugged region about in the middle of the slope. Its canyons, cut by glaciers which have disappeared, are frequently almost impassable. In places of less abrupt but still very steep slopes it is exceedingly remarkable that the soil does not wash. Frequently altogether without a covering of any kind, it maintains itself upon sidehills with inclinations often of 45 degrees, without a sign of gullying. The absence of torrential rains is probably a reason for this striking fact, and the nature of the rock is another. The latter is granite, except in the southern part, and the coarse and very porous soil which it produces is in general poor and little adapted for anything but the growth of trees. Its climate, moist in the upper portion and subalpine along parts of the western border, furnishes rainfall enough for the prosperity of forests. At present this region produces practically nothing except water for use beyond its own borders.

THE FOREST, WESTERN SLOPE.

The forest over portions of this western part of the reserve is exceedingly dense. It would be extremely rich throughout except for past fires. Its most widely distributed tree is the Douglas fir (red fir), which occurs in all but the loftiest situations. The most prolific areas of its forest are covered by a dense growth of the western cedar, which in places reaches a yield of more than 100,000 feet per acre B. M. Except for old trees of this latter species, the trees which compose these forests are usually sound.

The Douglas fir is very widely distributed throughout this region, except at high altitudes. In mixture with the western yellow pine it occupies dry southern and western slopes in the higher portions and covers considerable areas lower down. Mixed with the lowland fir (white fir), Englemann spruce, and lodge-pole pine on barren ridges, and again with the spruce in wet situations at low altitudes, it shows its wonderful capacity to meet the most various conditions in its surroundings. It reaches here the following average measurements: Height, 100 feet; diameter, 2 feet; length of clear trunk, 40 feet.

The yellow pine is very plentiful on the drier slopes, where it partially occupies the ground, often in mixture with the Douglas fir. Its reproduction, on the whole, is rather slow. Toward the western line of the reserve crescent-shaped bodies of young growth occur in such relation to the old trees that they are believed to occupy the ground protected from evaporation by the shade of the crown of the seed trees from which they spring. The average dimensions of the yellow pine in this region may be given as follows: Height, 80 feet; diameter, 20 inches; length of clear trunk, 30 feet.

The lodge-pole pine forms extensive forests in the less broken and lower regions about Elk City, and occupies with the alpine fir and the limber pine the crests and slopes of the higher ridges. With a variety in the color of its bark ranging from black to white through various shades of red and orange, and a habit which changes from the tall, spiry, slender tree of rich bottom lands to the stumpy, spreading specimens of wind swept ridges, this tree reaches average measurements for ripe trees, in middle situations, somewhat as follows: Height, 90 feet; diameter, 1 foot; length of clear trunk, 30 feet. The larger part of the lodge-pole pine now alive in this region is smaller because it is not yet mature.

The western cedar occurs in dense forests of great richness on fertile bottom lands along the streams, and to some extent also, especially in the form of undergrowth, on the comparatively dry slopes of steep ridges. Slow in growth, but with a fairly vigorous power of reproduction, this tree promises to be one of the most useful in the future history of these forests. Its average dimensions are as follows: Height, 125 feet; diameter, 4 feet; length of clear trunk, 30 feet.

The lowland fir (white fir) is widely distributed over the moister portions of this region, standing in bottom lands along the streams with the spruce and cedar, and high on the ridges with the spruce and Douglas fir. It has as yet comparatively little commercial value even in less scantily peopled portions of its habitat, but it will eventually find its proper place in the markets of the West. It is exceedingly sensitive to fire in youth and middle age, but with its rapid growth and good powers of reproduction it repairs more speedily than most of its associates the damage from this source. Its average dimensions may be given as follows: Height, 125 feet; diameter, 3 feet; length of clear trunk, 40 feet.

Englemann spruce occurs chiefly in moist land near streams and on the high tops of ridges. Its reproduction is good. Occasionally it is found in dense bodies of fine trees, but in general its dimensions may be given as follows: Height, 100 feet; diameter, 20 inches; length of clear trunk, 20 feet.

FIRE, WESTERN SLOPE.

Few regions in the United States have suffered more severely than the western half of the Bitterroot Mountains. Fires have been running over this portion of the reserve for centuries past, and their effects are plainly visible in stretches of grass land denuded of trees but still dotted with the rotting stubs of former occupants. So far as I am acquainted with this region, brushy slopes cleared of trees by fire occupy at least as great an area as the existing forests, while in the southeast and south central portions fires have determined the character of by far the greater part of the whole area. The heavy mass of vegetable debris on the ground, where the forest is dense, makes fires in these places exceedingly hard to extinguish. In many cases to light a camp fire is

almost inevitably to set fire to the forest. Prospectors are undoubtedly responsible for much of the damage from this cause, but the greater fires date from before the period of their arrival. The Indian trails which cross these regions are marked by widespread burns on either hand, and the old date of the damage leaves no doubt as to where the responsibility should lie. It is said that lightning is responsible for a few fires, and there is good reason to believe that it is so.

MINING, WESTERN SLOPE.

Mining on the western slope of the Bitterroot Reserve is so far wholly restricted to the prospecting stage, and few finds of importance have been made, except near Elk City. Placer mining has been followed in that vicinity to some extent, but most of the available ground has been worked out and the region is being abandoned. Near Shoup, a mining settlement of perhaps a dozen cabins on the Salmon River, a little mining is carried on, but so far without conspicuous result. The known mineral belt lies wholly to the south of the Nez Perce Pass.

AGRICULTURE, WESTERN SLOPE.

There are no agricultural possibilities of any consequences, and no special provisions are required in this direction.

GRAZING, WESTERN SLOPE.

The grassy tracts near the summit of the divide in the southeastern portion of the western slope would furnish pasture for considerable numbers of domestic animals if they were more accessible. As it is, the difficulty of reaching them and the urgent need for the reforestation of these denuded mountains make it unwise to encourage their use for other than forest purposes. So far as I am informed no domestic animals are at present pastured upon them. In the vicinity of Elk City rich alluvial meadows of considerable extent have been occupied by individuals or companies for stock raising, and provisions should be made to continue their use in this direction.

FOREST MANAGEMENT.

A very careful study of the forests on the eastern slope of the Bitterroot Reserve should be undertaken without delay. While the greater part of the timber land available for the supply of the Anaconda Copper Mining Company lies outside of the borders of the reserve, it is evident that a demand upon the forests of the reserve will shortly be made to supply deficiencies created by cutting elsewhere. Before that time arrives a thorough knowledge of the silvicultural conditions which determine the reproduction of the yellow pine and Douglas fir should be obtained, and a careful working plan should be drawn up to govern the cutting of these trees. This matter is of very great importance. Here and in the Black Hills Reserve great mining corporations come directly in contact with forest reserves, and the adjustment between them involves many delicate questions. It is strongly recommended that a further study of the eastern slope of the Bitterroot Reserve be undertaken without delay.

The timber cut on the western slope of the reserve, and not used in its immediate neighborhood for the development of the region, must find its only possible outlet to the west, where it will come into compe-

tition with the products of richer and more accessible forest regions. In addition, many of the streams, the only possible means of transportation, are too rough to be easily driven. For the present, therefore, the development of these forests in a commercial way is out of the question. Provision is required for controlling the limited use made of their timber by ranchers in the immediate neighborhood; but otherwise, the task of forest management here resolves itself for the immediate future into protection against fire, the construction of trails, chiefly to that end, and the study and mapping of the forest.

FOREST FORCE.

It has already been recommended that one forest ranger be stationed at Missoula and that he should exercise a limited supervision over the Flathead and Lewis and Clark reserves, while devoting the greater part of his attention to the eastern slope of the Bitterroot Reserve. Forest guards under his direction should be stationed at or near Ovando and Columbia Falls for the Flathead and Lewis and Clark and at Hamilton and Darby for the Bitterroot. Twenty fire watchers should be assigned to the eastern slope. For the present it is recommended that no men be assigned to the western slope. In time guards should be stationed at or near Elk City, Shoup, Indian Post-Office, on the Lolo trail, and other commanding points.

BOUNDARIES.

The present eastern boundary line of the reserve was intended to inclose the whole of the precipitous mountain slopes which follow the western edge of the Bitterroot Valley. The correction here recommended is intended to bring this condition about. The available information regarding the western slope is not sufficiently definite to afford a basis for the recommendation of new boundaries for that part of the reserve, if such are required. The eastern boundary proposed is as follows:

Commencing at the intersection of the line between ranges 19 and 20 west, principal meridian, Montana, with the State line between Montana and Idaho; thence northerly along said range line to the base line; thence westerly along said base line to the southeast corner of township 1 north, range 20 west; thence northerly along the surveyed and unsurveyed range line to the northeast corner of said township; thence westerly along the surveyed and unsurveyed township line between townships 1 and 2 north to the point for the southeast corner of township 2 north, range 21 west; thence northerly along the surveyed and unsurveyed range line to the point for the southeast corner of section 24 in township 2 north, range 21 west; thence westerly along the surveyed and unsurveyed south section lines for sections 23 and 24 in said township to the point for the southeast corner of section 22 in said township; thence northerly along the surveyed and unsurveyed east lines of sections 22, 15, 10, and 3 in said township to the point for the southeast corner of section 34 in township 3 north, range 21 west; thence westerly along the surveyed and unsurveyed township line between townships 2 and 3 north, range 21 west, to the point for the southeast corner of section 32 in township 3 north, range 21 west; thence northerly along the surveyed and unsurveyed east section lines of sections 32, 29, 20, 17, 8, and 5 in townships 3, 4, 5, 6, and 7 north, range 21 west, to the point for the southeast corner of section 32 in township 8 north, range 21 west; thence easterly along the surveyed

and unsurveyed township line between townships 7 and 8 north, range 21 west, to the point for the southeast corner of section 33 in township 8 north, range 21 west: thence northerly along the surveyed and unsurveyed east section lines of sections 33, 28, 21, 16, 9, and 4 in townships 8, 9, and 10 north, range 21 west, to the point for the northeast corner of section 4 in township 10 north, range 21 west; thence westerly along the surveyed and unsurveyed township line between townships 10 and 11 north, range 21 west, to the point for the northeast corner of township 10 north, range 22 west, at which point the line joins the one established as the northern boundary of the Bitterroot Forest Reserve by proclamation of February 22, 1897, with which line it is thenceforth continuous.

BLACK HILLS FOREST RESERVE.

SUMMARY.

Situation: Western South Dakota.	Acres.
Area within present lines	967, 680
Adverse holdings, very large but not known.	
Exclusions proposed, approximate	202, 880
Inclusions proposed, approximate	535, 040
Area within proposed lines, approximate	1, 299, 840
Increase, approximate	332, 160
	Per cent of total area.
Present lines:	
Area of forest land	(?) 85
Area marked by fire	(?) 85
Area badly burned	(?) 25
Proposed lines:	
Area of forest land	(?) 95
Area marked by fire	(?) 85
Area badly burned	(?) 25

Force recommended: Two rangers, 5 forest guards, 60 fire watchers.

Sources of information: Report and statement of H. S. Graves, Special Field Assistant, United States Geological Survey. Personal examination, October 22 to November 4, 1897.

An undulating elevated region, well adapted to the growth of trees.

Fire has determined the condition of the forest over nearly the whole area.

The water supply for mining and irrigation is important.

Mining is the principal industry of the region, and means must be provided for its continuance.

Agriculture is important, and agricultural land should be opened to entry.

Grazing is not largely practiced and does no harm to the forest.

The immediate commercial development of these forests is imperative if the reserve is to be maintained. Special attention is directed to the recommendation on page 42.

The Black Hills Forest Reserve occupies the southern portion of the elevated region of the same name in the western part of South Dakota. Its boundaries include an area of 967,680 acres, of which an unknown but very considerable part has passed into private hands under patents as lode or placer claims. The Black Hills themselves have a length from north to south of 120 miles and a breadth from east to west of 40 miles. Since the lines of the reserve should be extended to cover nearly the whole area of the Black Hills, both in South Dakota and in Wyoming, the descriptions which here follow have been made to apply to the latter.

The topography of the Black Hills consists essentially of a rim of limestone rock surrounding an inner region of schists and slates, with granite at the surface in the center. With the exception of the cliffs and canyons of the limestone and a rugged area in the granite, the outlines of the country are rounded. The soil is rich and the climate

fairly adapted to agriculture. The trade relations of the Black Hills have so far depended almost entirely on mining and its related industries. Agriculture has been supported by a demand created by the mines, and the extensive forest destruction which has taken place has had for the most part the same general cause.

THE FOREST.

The forest of the Black Hills, except in the northwest portion, is rather open. There is commonly some grass under the trees. The principal and almost the only tree of commercial importance is the western yellow pine. In the eastern part of the hills there is some white spruce, and burned areas have been extensively occupied by the quaking aspen. The forest is broken and irregular, with a very large per cent of unsound and misshaped trees. In some cases, as the result of fires, nearly every tree on a considerable tract is unsound. Fifty per cent of defective timber is not uncommon. The amount of standing timber per acre, almost throughout the forest, has been greatly reduced by the long prevalence of forest fires. The dead standing timber throughout the hills is estimated at from 3 to 4 per cent of the whole forest.

The yellow pine here reaches average dimensions as follows: Height, 70 feet; diameter, 18 inches; length of clear trunk, 35 feet. It occurs in the Black Hills without regard to the character of the soil. In nearly all cases the timber, reduced by successive fires, is by no means up to the standard which the soil is capable of producing.

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

The second class of original timber is that which covers the greater portion of the Black Hills. It has about the same development in diameter, but is not as tall as class 1. It averages about 65 to 70 feet in height and has a clear length of 25 to 40 feet. The forest has not grown as dense as that above described. This kind of forest is found in situations more exposed to external dangers, and has been more subject to injury by forest fires than class 1. The forests about Custer and Hill City are representations of this class of timber.

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

Large areas of second growth occur throughout the Hills, with an average density probably not far from seven-tenths of the normal, while that of the original growth is usually five-tenths or less.

The average yield of the original forest is less than 4,000 feet per acre. A careful summary of the standing timber in the different watersheds leads to the following result: Area of standing timber, 2,950 square miles; area already cut, 405 square miles; standing merchantable timber in board feet, 1,440,000,000; fuel and small wood, 13,150,000 cords.

Careful counting of annual rings by the special field assistant assigned to this reserve, Mr. H. S. Graves, indicates that, in general, lumber trees with an average diameter of 17 inches on the stump can not be produced under one hundred and fifty years, nor mine timbers less than eighty or one hundred years. The greater part of the young growth now standing in the Black Hills is of two ages—40 to 50 years

and 80 to 100 years old; and the time which must elapse before what is now too small can be used in mines or for sawing is easily calculated.

Cutting began in the Black Hills about twenty years ago, and has increased rapidly since the advent of the railroad. There are forty-two sawmills in South Dakota and seven in Wyoming, within the boundaries of the hills. These mills are usually small, with a capacity of from 8,000 to 10,000 feet per day, but their total output of sawed lumber is not believed to exceed 20,000,000 feet per annum. The merchantable limit for saw logs is now about 14 inches on the stump, and 10 inches at the small end of the log. The trees will yield, on the average, one and one-half logs apiece. The cutting for these mills is wasteful in the extreme. Quantities of logs have been left on the ground to rot, and on the average not over 50 per cent of each tree is taken. So far as could be discovered none of the sawmill men attempt to follow the regulations prescribed by the Department. This neglect is to some extent forced upon them by the competition of other mill men, and it has been invited by the fact that the interrupted and consequently inefficient supervision of the General Land Office have been wholly unable to secure compliance with the law. So far as known the Homestake Mining Company is the only concern which makes a definite attempt to carry out the regulations of the Department concerning cutting.

Considerable quantities of lumber have been illegally shipped outside the State, chiefly to Omaha, and other points in Nebraska. Great numbers of young and growing trees, which would soon produce mine timber or saw logs if protected, are being cut for fuel in the northern hills, while not less than 30,000 cords per annum, wasted in lumbering in the southern hills, lie rotting in the woods. Means should be taken to bring together supply and demand. The high freight rate on cord wood is one of the principal obstacles.

In addition to the 20,000,000 feet of lumber manufactured in the Black Hills, the consumption of mining timber is estimated at 4,500,000 linear feet, of which the Homestake Company uses 1,750,000 feet. The mining timbers included in this statement are classified under two general heads, 11-inch flats, which must show a thickness of 11 inches when hewed flat on two sides, and 6-inch flats, of which the Homestake Company uses about 1,000,000 linear feet. Smaller timbers, called 3-inch flats, are extensively used in prospect holes, and to some degree in the larger mines. It is estimated that 25,000 cords of wood are used for fuel in various mines throughout the hills.

The reproduction of the yellow pine in the Black Hills is unequaled in my experience by the same tree in any other locality. It is most successful on north slopes and moist ground, and where the soil is exposed but not impoverished. Where a sufficient number of trees are left in such conditions over comparatively small open patches, it is as good as that of the lodge-pole pine, the tree of the United States most prolific in young growth. On larger clearings, where seed trees are scarce or wanting, reproduction is poor. The present method of cutting is admirably calculated to bring this result about, for its tendency is to remove all the old trees that are not unsound, and so hinder the seeding up of the devastated areas. It is often said that the forest is reproducing itself on the cut-over lands. In its just sense this is not correct. Scattered young trees of yellow pine are indeed coming up, but they are full of limbs and stand far apart, and their product will be coarse, knotty material, instead of the clear lumber and mine timbers furnished by the original crop. Right methods of cutting, which

will secure the right kind of reproduction, are simple, and may easily be introduced.

The yellow pine has many enemies, but stands wind well. Comparatively few trees are uprooted, except through the giving way of the rocks encircled by their roots, while specimens broken off on account of rot originating in fire scars are frequent. Damage by lightning is common throughout the hills, and serious injury is being done by insects. Perhaps 3,000 acres of yellow pine have been killed in this way, usually at rather high elevations in the limestone. An insignificant amount of damage is being done by smoke in the vicinity of the mills around Deadwood. Such injury can not be prevented, nor is it of consequence.

FIRE.

Practically the whole area of the Black Hills bears more or less recent marks of fire. An examination of the older trees allows the reconstruction of the history of forest fires during the last one hundred and fifty years. The oldest fire of which record has thus been preserved passed through the hills between 1730 and 1740. The next, a very extensive one, occurred from 1790 to 1800. Indian tradition assigns to the year 1842 a very wide spread fire, from which dates the young growth now about 50 years old in the northern hills and 40 years old in the south. About twenty-five years ago a fire is said to have been started by soldiers during a campaign. In 1881 fire burned from Preacher Springs to Deadwood. Of more recent fires, those of 1893 were the most severe. It results from this long succession of fires that the forest exhibits its real character but rarely. Almost throughout the hills the latter is distorted by the effect of the burning, and only here and there does the capacity of the yellow pine for the rapid production of timber in the Black Hills make itself fully evident.

Among the causes of forest fires, lightning and malice are both uncommon. There is no record that prospecting has caused any fires, unless prospectors are grouped with campers, who are responsible for very many. Railroads, the habit of burning brush, and the sawmills have each been the source of severe burning. It is plain that no measures short of the establishment of a permanent forest force will suffice to check this evil.

Where the fires are not sufficiently severe to destroy the standing timber their action often results in a fire scar at the base of the tree, and in consequent unsoundness, which may at times affect 75 or even 100 per cent of the whole growing stock. Another serious injury is the destruction of young growth. The forest is thus kept open, with the result of short trunks and poor timber in the trees which reach merchantable size. Elsewhere the pine is replaced by aspen or white birch or grass through the operation of repeated fires, to the action of which the larger parks and openings throughout the hills are wholly due.

The Homestake Company has of late shown an admirable spirit with relation to fires, and has spent considerable sums in attempting to extinguish them. Elsewhere in the hills the desire to have fires checked is very strong, but as a rule it does not lead to active measures on the part of the inhabitants. Even when such measures are taken, in the face of immediate danger to private property, they are apt to fail of their full result through a tendency to abandon the scene of the fire as soon as the latter is apparently, but not actually, extinguished. It is true, however, that any attempt of the Government to cope with this evil will meet with the hearty approval and support of the ranchers

and miners throughout the hills. One of the first steps taken toward checking the fires should be the enforcement of the existing regulations against leaving tops in the woods after lumbering.

The white spruce, the only lumber tree other than the yellow pine, occurs chiefly in the northwestern hills above an altitude of 4,500 feet. It reproduces itself in dense groups after fire, to injury from which it is extremely sensitive. It reaches average dimensions as follows: Height, 75 feet; diameter, 15 inches; length of clear trunk, none. This tree is estimated to occupy altogether about 15,000 acres.

Other trees are the aspen (conspicuous on many burns), the burr oak, an elm, and a small ash.

WATER.

Irrigation is little practiced within the hills, but the water of Spearfish, Stockade, Beaver, and Sand creeks, among others, is taken out at the edge of the hills for this purpose. Within the hills the chief industrial use of water is for milling, and for this purpose it is already scarce.

For a reason not yet thoroughly established, the past few seasons have shown a progressive drought in this region, so that considerable numbers of ranches, especially in the southwestern portion of the hills, have been abandoned for lack of water. This result is locally attributed to the destruction of the forests, but the data necessary to a conclusion are not yet at hand.

MINING.

Mining is the chief industry of the Black Hills, upon which the prosperity of the whole community may be said to depend. It is largely concentrated near the cities of Lead and Deadwood, in the northern part of the hills; near Keystone, in the central hills, and it exists in many localities scattered throughout the eastern portion. There has been little mineral development in the west and south. Without mining few of the industries of the Black Hills would survive, except illegal cutting of timber for export from the State; and it is manifest that whatever measures of forest management may be undertaken must provide for a continuance of mining.

AGRICULTURE.

In the schist and slate regions agricultural lands occur only near streams, except where the contours of the country are extremely mild. The soil is very productive. In the limestone region the higher ground is more particularly adapted for agricultural use, especially about the head waters of streams. There is some good land still bearing trees, but, as a rule, the agricultural land throughout the hills is open. The products are hay, oats, and vegetables, with some corn and wheat. There is a good market, chiefly in the mining communities, to which the products of the Black Hills ranches are essential. There are, altogether, from 450 to 460 of such ranches, located for the most part on placer claims of 20 acres each. A ranch of 160 acres thus consists of eight placer claims, taken up by eight men, and deeded over, by previous agreement, to one of the number. The procedure recommended on page 47, in Part II, of this report for allowing agricultural lands to be entered is of the first necessity in this reserve. In the case of land already settled upon, title should be given to the present occupant by means of the usual precedence accorded after surveys in view of actual occupancy.

GRAZING.

Considerable areas of grazing land exist, especially in the southern hills. It is estimated that 5,000 head of cattle and horses are pastured, with little or no injury to the forest. Practically all grazing land is the result of fire; and the process by which a forest is converted into open prairie is visible in its various stages almost throughout the hills. Unless grazing should lead to the setting of fires for the purpose of improving or extending range or pasture land, the pasturage of cattle and horses should be allowed under suitable restrictions. Sheep should be rigorously excluded.

FOREST FORCE

It has already been recommended, on page 46 of Part II of this report, that 1 forest ranger be stationed at Deadwood and another at Custer, with 5 forest guards at Deadwood, Rochford, Custer, Sheridan, and Bear Gulch. Sixty fire watchers at local points complete the force recommended.

The Black Hills afford a better opportunity than any other forest reserve for the immediate application of forest management. Mining assures a constant demand for timber. Either this demand must be met, and that without delay, or the reserve will be reduced in area to an extent which may force its abandonment. To illustrate: Very large blocks of mineral lode claims are being located in the best timbered portions of the hills. These claims are fraudulent, and are made solely for the sake of the timber. These facts are perfectly well known throughout the hills, and it is generally asserted, and with great particularity, that these fraudulent claims are being located for or by the Homestake Company, and this contention is supported by the fact that no other party is in position to lumber most of them advantageously. The Homestake has already surveyed a railroad line to one body of these claims in the northeast portion of the hills. The evident intention is to cut off the timber and then abandon the claims; but if a decision of the Commissioner of the General Land Office forbidding the use of timber except in connection with the particular claim upon which it is cut should be enforced, these claims will be patented, and the great areas they cover will be lost to the reserve. There is but one way out, and that lies in the line of immediate action.

I am informed that the unexpended balance of the appropriation under which the special forest agents and supervisors are appointed will be sufficient to continue the present force during the remainder of this fiscal year. I recommend that in place of the supervision, necessarily desultory and ineffectual, now exercised by a few men over the great area of the reserves in Washington, Oregon, California, and Arizona, a forest service composed exclusively of trained men be organized at once to take charge of the Black Hills Reserve. The advantages of this course are evident and undeniable. An actual example of forest management will be afforded. The beginning of the sale of Government timber will be made. Public opinion in one of the reserves where it was most strongly antagonistic will be secured to the reservation policy, and an opportunity will be provided to test the advantages of scientific and conservative forestry. It is confidently believed that the whole expense of the force recommended for the Black Hills may be paid, almost from the beginning, by the sale of timber. This recommendation is made only with the distinct proviso that trained men of active habits, familiar not only with Western conditions, but with

forestry as well, are contemplated in making it. The transfer of the present force of special agents and supervisors would altogether fail to meet these conditions. It is not believed that Government forest management in the Black Hills under such a transfer could be anything but a failure.

FOREST MANAGEMENT.

The immediate advantages offered by the Black Hills for the inauguration of Government forest management are many and important. There is a good market for products of all grades. The reproduction of the forests is admirable under good conditions. The various age classes of trees are all present, which is the first condition for a continuous yield. Transportation by rail is well developed, and there are good roads in plenty as compared with other reserves, and public opinion throughout the hills is strongly in favor of the protection and management of the forests by the Government. Sawmill men, for example, assert that they would prefer to pay a stumpage rate of \$1 per 1,000 feet, in place of the present rate of 25 cents from mineral claims and nothing at all from Government land, for the sake of security against prosecution and definite possession of the timber. It not infrequently happens at present that timber is cut by sawmill men merely to get it away from others, even when they do not need it themselves.

The system of management recommended rests on these principal conditions:

1. A definite working plan must be prepared, approved, and adhered to.
2. No trees may be selected for cutting except in accordance with this plan.
3. No trees may be cut except when designated for cutting by a forest officer.

Other essential conditions of good management are provided by law.

The silvicultural system adopted should be a form of cutting on restricted areas, combined with improvement cutting, and should be based on a stump diameter of not less than 12 inches. Under such a system properly enforced, the local demand for lumber, mine timber, and supplies for settlers may be met with safety to the forest, and an assured yield in the future will replace the present distant but not doubtful prospect of an approaching scarcity of timber.

Reference is made to the admirable and exhaustive report of Mr. Graves for further particulars concerning the forests of the Black Hills and their management.

PUBLIC SENTIMENT.

Public sentiment throughout the Black Hills is ready to welcome active steps by the Government looking to the prevention of fire and for the sale of timber in larger amounts than are provided for by the rights accorded to settlers and miners under the law. Similar opinions were freely expressed at length and in detail by men in control of some of the largest mining plants in the Hills. The conclusion is plain. Failure on the part of the Government to take advantage of this favorable state of the public mind will mean the loss of an unparalleled opportunity, and, very probably, the ultimate loss of the reserve as well. The necessary appropriation is now available, suitable men can be found, and there does not appear to be any reason why the hope and expectation of intelligent men throughout the Black Hills should not be met without delay.

BOUNDARIES.

I have to recommend the extension of this reserve to include the whole wooded area of the Black Hills. If the recommendations previously made in this report are adopted, any objections to an extension of the boundaries may easily be overcome by the wide distribution of brief notices stating the rights and privileges of settlers, miners, and others in the reserve. These notices should be in every post office, both here and in the whole region affected by the reservation policy.

The area within the proposed lines is stated in the summary. These lines are as follows:

Beginning at the southeast corner of township 1 north, range 6 east, Black Hills meridian; thence north 4 miles to the northeast corner of section 13 of said township; thence west 1 mile to the northwest corner of said section; thence north 2 miles to the northeast corner of section 2, township 1 north, range 6 east; thence east 1 mile along the township line to the northeast corner of section 3 of said township; thence north 3 miles to the northeast corner of section 22 of township 2 north, range 6 east; thence west 2 miles to the southeast corner of section 17 of said township; thence north 1 mile to the northeast corner of said section; thence west 1 mile to the northwest corner of said section; thence north 3 miles to the northeast corner of section 31, township 3 north, range 6 east; thence east 4 miles to the northeast corner of section 35 of said township; thence north 2 miles to the northeast corner of section 23 of said township; thence west 1 mile to the northwest corner of said section; thence north 1 mile to the northeast corner of section 15 of said township; thence west 1 mile to the northwest corner of said section; thence north 1 mile to the northeast corner of section 9 of said township; thence west 1 mile to the northwest corner of said section; thence north 4 miles to the northeast corner of section 20, township 4 north, range 6 east; thence west 1 mile to the northwest corner of said section; thence north 2 miles to the northeast corner of section 7 of said township; thence west 1 mile to the northwest corner of said section; thence north 2 miles to the northeast corner of section 36, township 5 north, range 5 east; thence west 1 mile to the northwest corner of said section; thence north 1 mile to the northeast corner of section 26 of said township; thence west 2 miles to the southeast corner of section 21 of said township; thence north 1 mile to the northeast corner of said section; thence west 3 miles to the southeast corner of section 13, township 5 north, range 4 east; thence north 1 mile to the northeast corner of said section; thence west 1 mile to the northwest corner of said section; thence north 2 miles to the northeast corner of section 2 of said township; thence west 3 miles to the northwest corner of section 4 of said township; thence south 1 mile to the southwest corner of said section; thence west 3 miles to the southeast corner of section 2, township 5 north, range 3 east; thence west 6 miles to the southeast corner of section 35, township 6 north, range 2 east; thence north 2 miles to the northeast corner of section 26 of said township; thence west 5 miles to the southeast corner of section 24, township 6 north, range 1 east; thence north 1 mile to the northeast corner of said section; thence west 6 miles to the northeast corner of section 24, township 6 north, range 1 west; thence south 1 mile to the southeast corner of said section; thence west 6 miles to the northwest corner of section 30 of said township; thence south 4 miles to the northeast corner of section 13, township 5 north, range 2 west; thence west 1 mile to the northwest corner of said section; thence south 6 miles to the northeast corner of section 14, township 4 north, range 2 west; thence west 1 mile

to the northwest corner of said section; thence south 1 mile to the southwest corner of said section; thence west 5 miles to the northwest corner of section 24, township 4 north, range 3 west; thence south 3 miles to the southwest corner of section 36 of said township; thence east 2 miles to the northeast corner of section 6, township 3 north, range 2 west; thence south 1 mile to the southwest corner of said section; thence east 2 miles to the northeast corner of section 9 of said township; thence south 4 miles to the northwest corner of section 34 of said township; thence east 1 mile to the northeast corner of said section; thence south 1 mile to the southeast corner of said section; thence east 1 mile to the northeast corner of section 2, township 2 north, range 2 west; thence south 2 miles to the southwest corner of section 12 of said township; thence east 1 mile to the southeast corner of said section; thence south 1 mile to the northwest corner of section 19, township 2 north, range 1 west; thence east 1 mile to the northeast corner of said section; thence south 1 mile to the southeast corner of said section; thence east 4 miles to the northeast corner of section 26 of said township; thence south 23 miles to the southwest corner of section 13, township 3 south, range 1 west; thence east 4 miles to the southeast corner of section 16, township 3 south, range 1 east; thence south 3 miles to the southwest corner of section 34 of said township; thence east 3 miles to the southeast corner of section 36 of said township; thence south 5 miles to the southwest corner of section 30, township 4 south, range 2 east; thence east 4 miles to the northeast corner of section 34 of said township; thence south 3 miles to the southwest corner of section 11, township 5 south, range 2 east; thence east 8 miles to the northwest corner of section 18, township 5 south, range 4 east; thence south 4 miles to the southwest corner of said township; thence east 12 miles to the southwest corner of township 5 south, range 6 east; thence north 6 miles to the northwest corner of said township; thence east 3 miles to the northeast corner of section 4 of said township; thence north 4 miles to the southwest corner of section 10, township 4 south, range 6 east; thence east 2 miles to the southeast corner of section 11 of said township; thence north 20 miles to the northwest corner of section 1, township 1 south, range 6 east; thence east 1 mile to the place of beginning.

Excluded from this area is the following interior area thus described:

Beginning at the southeast corner of township 5 north, range 3 east, Black Hills meridian; thence north 3 miles to the northeast corner of section 24 of said township; thence west 6 miles to the northwest corner of section 19 of said township; thence south 2 miles to the southwest corner of section 30 of said township; thence west 1 mile to the northwest corner of section 36, township 5 north, range 2 east; thence south 4 miles to the southwest corner of section 13, township 4 north, range 2 east; thence east 5 miles to the southeast corner of section 15, township 4 north, range 3 east; thence north 2 miles to the southwest corner of section 2 of said township; thence east 1 mile to the southeast corner of said section; thence north 1 mile to the northeast corner of said section; thence east 1 mile to the place of beginning.

CASCADE RANGE FOREST RESERVE.

SUMMARY.

	Acres.
Situation: Western Oregon.	
Area within present lines	4,492,800
Adverse holdings, railroad land	461,920
	Per cent of total area.
Area of forest land	(?) 95
Area marked by fire	(?) 75
Area badly burned	(?) 20

Revised lines can not be recommended without further study and a map.

Force recommended: Two rangers, 5 forest guards, and 30 fire watchers.

Sources of information: Report of F. V. Coville, botanist of the Department of Agriculture. Report of Henry S. Graves to G. Pinchot. Personal examination, August 27 to September 1, 1896.

A rugged mountainous region, densely timbered on the western slope, with much open land cleared by fire, and suitable for grazing.

Fire has done, and is still doing, very serious injury.

Irrigation is but little practiced on either slope.

Mining has little present or prospective importance.

Agriculture can attain little development within the reserve.

The grazing of sheep should be permitted tentatively and under careful restrictions.

The commercial development of this reserve is not demanded for the present.

The Cascade Range Forest Reserve occupies a narrow and irregular strip along the crest and on both slopes of the Cascade Mountains in western Oregon, and extends from near the Columbia River to within about 20 miles of the California line. Adjoining it on the north and west is the Bull Run timber land reserve, which, for the purposes of this description, may be considered as forming part of its larger neighbor. The Cascade Range Forest Reserve has an area of 4,492,800 acres, and includes 461,920 acres of railroad land, of which 34,560 acres are now in litigation. The Bull Run timber land reserve, with an area of 142,080 acres, includes 24,160 acres claimed as railroad land, but as to which a suit is now pending. The eastern slope of the Cascade Range is comparatively dry, and the forest is generally open enough to furnish pasturage, while the forest on the western slope is exceedingly dense and affords grazing only in the numerous areas which have been burned. The trade relations of the reserve have, so far, been restricted to the cutting of small amounts of timber on the western slope and to supplying settlers and ranchers outside of the reserve from the forests of yellow and lodge pole pine east of the summit. It will be convenient to describe the two slopes separately.

THE FOREST, EASTERN SLOPE.

The forest on the eastern slope is open and grassy in its lower part, dense and composed of smaller trees higher up, and interrupted throughout by burned areas, often of great size, on many of which grass has entirely replaced the forest. The principal trees are yellow pine and Douglas fir (red fir) in the lower portions, and lodge pole pine and lowland fir (white fir) at higher elevations. Occasionally the latter tree predominates in a mixed forest of Douglas fir, Engelmann spruce, larch, hemlock, and mountain white pine (silver pine). The Douglas fir is here a tall tree with a long, clear trunk. In the open its reproduction is vigorous, but less so under cover. It is of much smaller size here than on the western slope. The yellow pine forms the bulk of the forest at moderate elevations. Below 4,000 feet its reproduction is gen-

erally good. It has suffered very severely from the tramping out of its seedlings, in different parts of this slope, by the hoofs of pasturing sheep.

The lowland fir (white fir) is a tall tree, with clear trunk in good situations, and good reproduction throughout.

The mountain white pine (silver pine) occurs at moderate elevations in mixture with the Douglas spruce and various firs. It is a tall tree with long, clear trunk, of great value for lumber and with good powers of reproduction.

The larch reaches a diameter of from 4 to 5 feet. A tall tree with a very short crown, it reproduces itself admirably, seeding up many burned areas, if not interfered with by sheep, to the north of the Metolius River.

Lodge pole, or black pine, here, as elsewhere, is a small tree with remarkable powers of reproduction. It occupies situations avoided by more valuable trees, but is apt to disappear and be replaced by grass and brush as the result of repeated fires.

Engelmann spruce occurs chiefly in hollows and basins. Its reproduction is excellent near seed trees, and the young seedlings bear shade well. In places it is an important factor in the forest.

The black hemlock is a subalpine tree with good reproduction, but without commercial importance at present.

The white-bark pine occurs on the summits of the mountains, and need not be considered here. Other trees are the western cedar, amabilis fir, and western hemlock.

FIRE, EASTERN SLOPE.

Fires have done more injury in this reserve than all other causes put together. It is believed that fire has occurred in every township within the reserve and in nearly every section, and it is evident that many hundred thousand feet of timber have been destroyed. Fires increase, in general, proportionately to the extent of human occupation of any region up to the time when a change of public sentiment takes place. After that time the safety of the forest increases in proportion to the density of population. Protection against fire is made difficult at present by the absence of trails and by the nature of the forests.

The larger number of fires on this slope are said to be kindled by campers and Indians. Sheep men have undoubtedly been responsible for many fires in the past, and, as noted by Mr. Coville, the broken character of the forest which permits them to graze their herds on this reserve would not have existed without the agency of fire.

Fires started in heavy timber are often exceedingly difficult to extinguish. Such a fire was burning in the vicinity of the Lake of the Woods, in the southern part of the reserve, August 27 and 28, 1896, and was carefully studied at that time. At 6 p. m., although it was said to have been started on the morning of the same day, it had already burned holes from 2 to 3 feet deep, following the roots of dead trees, and was slowly spreading along the surface. The vegetable litter on the ground was dry; but, except for the dead timber standing and prostrate in the woods, this fire would have died out of itself. It was kept alive and enabled to spread chiefly by the fallen logs. Where such a log lay on the ground the fire either crept along its under surface near the ground if the bark had fallen, or if the bark remained it moved usually beneath it, reappearing at intervals along the trunk and igniting the dry humus and litter within reach. Half-rotten logs carried

the fire with bright flame even when the bark had not fallen. Dead standing stubs from 50 to 90 feet high assisted powerfully in spreading the damage, for the fire ascends such trunks beneath the bark, reappearing at intervals, and burning fiercely under the chimney-like draft established. Instead of falling at once such stubs break off high above the ground from time to time and scatter burning fragments far and wide. In heavy winds the blazing bark is detached and carried far ahead of the main fire, and so forms a powerful factor in carrying and spreading the conflagration. To extinguish this particular fire, which was said to have been wantonly started by a party of campers, would have required the labor of several men for at least a day.

Fires in the open yellow pine do much less serious damage and are far easier to control.

WATER, EASTERN SLOPE.

The effect of forests on irrigation in the lava area of the southern portion is probably not important, since all rain sinks at once into the ground and reappears in the enormous springs which dot the country here and there. Farther north the question is different. The testimony on this point is conflicting, but by far the greater weight of evidence tends to show that the flow of streams has already been seriously influenced by forest fires. The supply of water from this slope is very important to local settlements and should be protected.

MINING, EASTERN SLOPE.

I am not aware that mines of any importance have been developed or that prospects for such development exist.

AGRICULTURE, EASTERN SLOPE.

Agriculture within the reserve can never be important. A few ranches are included by the boundaries, but, so far as known, little cultivation is carried on, as the climate is unfavorable.

GRAZING, EASTERN SLOPE.

The most important question touching the reserve at this time regards the pasturage of sheep. During the past summer about 190,000 sheep were grazed within the reserve, two-thirds of which occupied ranges on the eastern slope. The careful investigation of Mr. Coville, botanist of the Department of Agriculture, the study by Mr. Henry S. Graves under my direction in 1896, and other trustworthy evidence leave no room to doubt that the pasturage of sheep on any area constitutes, so long as it lasts, a prohibitory tax on the reproduction of the forest.

It can not be questioned that sheep grazing in this reserve owes its existence directly to forest fires. Without such fires the openings where the sheep feed would never have been made, nor, after they were made, would many of them have been kept so free from trees. It is almost equally certain that sheep herders in the past have been in the habit of setting fires, although the evidence at hand goes to show that of late years this practice has been largely discontinued. Grazing in fresh burns is apt to be followed by the discoloration and cheapening of the wool.

Sheep do not feed on the leaves or seedlings of coniferous trees, except in the way of desultory nibbling or when at the point of starvation. The harm which they do is of another character altogether. The

seedlings of conifers are small and very susceptible to injury during their early life. When a band of sheep passes over an area on which such seedlings grow the trampling of the sharp hoofs not only cuts and bruises the young trees, but it also exposes their roots, and so leads directly to their destruction. On dry slopes, where reproduction is difficult at best, the passage of a band of sheep makes it simply impossible until a new crop of seedlings can replace those which have been destroyed. It is in this way, and not at all by injury to the old trees (an alleged fact frequently contradicted by sheep men), that sheep hurt the forest.

In so far as sheep tend to destroy or prevent a dense forest cover, they injure the water supply, and that they have done both to some extent, at least indirectly, is evident. The effect of their action is not believed, however, to have been seriously felt hitherto. In this connection it may be well to add that actual observations at Fort Klamath and Government Camp, quoted by Mr. Coville, indicate that snow lasts about six weeks longer in the forest than in the open.

It is believed that the reproduction of considerable parts of the eastern slope may be postponed with safety to the forest, and that in consequence sheep herding may there be permitted under suitable restrictions. The importance of this industry to the three counties where the sheep are chiefly owned (Wasco, Crook, and Sherman) is so great that its sudden prohibition within the reserve would work great hardships. Under the circumstances, the wiser course appears to be to permit the pasturage of definite numbers of sheep on definite ranges for the present, and in a tentative spirit, throwing the burden of the prevention of the forest fires upon the sheep owners, and in general following the course advocated by Mr. Coville and summarized in Part II of this report. It should not be forgotten that overgrazing will lead to the extension of the ranges by means of fire. For a more extended treatment of this subject, reference is made to Mr. Coville's admirable report, in the conclusions of which I fully concur.

THE FOREST, WESTERN SLOPE.

The forest of the western slope is tall, dense, moist, and rich in valuable kinds of trees. The range is more heavily timbered in its northern and central portions than toward the south, but the forest throughout is very valuable, rapid, or fairly rapid in growth, and of great prospective commercial importance.

The most important tree is the Douglas fir (red fir), which reaches in places a height of over 250 feet and a diameter near the ground of from 10 to 12 feet. It forms very extensive forests on the lower slopes, sometimes almost without admixture of other trees. The reproduction is wonderfully good in places, especially in the open. Up to an elevation of 2,000 feet this is the most plentiful tree.

The western hemlock has great reproductive powers, and young trees of this species are plentiful in the forest, especially on fallen logs and dead stumps. Its wood is valuable for lumber, but has been little used hitherto. Its average dimensions may be given as follows: Height, 125 feet; diameter, 3 feet; length of clear trunk, 40 feet.

The western cedar, while of less size here than nearer the coast, is still a large tree of great economic value. It prefers moist land, has good reproductive powers, both within the forest and in the open, and will be one of the first trees cut in many localities.

The mountain white pine is another lumber tree of importance. It

does not attain large size, but has a long, clear trunk, and produces excellent material.

The lowland fir (white fir) is often not of great size, as compared with other species growing with it, but it has excellent reproduction, and great sylvicultural value as undergrowth.

The lodge-pole pine is less widely distributed on the western than on the eastern slope. It occurs chiefly in portions where its great reproductive powers give it peculiar value.

The noble fir, a valuable lumber tree chiefly known locally as larch, reaches, in exceptional cases, a height of 300 feet, with a diameter of 6 or 7 feet near the ground. It is a common tree throughout the larger part of the reserve.

The sugar pine, whose northern limit is near the center of the reserve, extends also to the eastern slope, near Crater Lake. It is a large tree of the first economic value, but its reproduction in this locality is not strong.

Other trees are the Sitka spruce and the incense cedar, neither of which is common.

FIRE, WESTERN SLOPE.

Fire has done less damage on the western than on the eastern slope. Still, its ravages have been exceedingly severe, and it is of the first importance that they should be checked. Reference is made to the description of a fire in dense forest on the eastern slope. When such fires are assisted by violent winds they travel with great rapidity, and while the wind continues efforts to subdue them are ineffectual. As has already been mentioned in a previous part of this report, the object of organization against fire should be to reach the scene of a conflagration before it has had time to gather strength. Trails, therefore, are of the first importance.

WATER, WESTERN SLOPE.

Water for irrigation is of comparatively little importance except in the eastern part of this reserve. Floods are dangerous, and the protection of the mountain slopes is required on their account.

MINING, WESTERN SLOPE.

Mining is not known to have reached any development, nor to show promise for the future.

AGRICULTURE, WESTERN SLOPE.

Except in the vicinity of Detroit, where the agricultural lands within the reserve are practically all taken up, the climate usually forbids development of this kind within the boundaries. No special measures are required.

GRAZING, WESTERN SLOPE.

About one-third of the sheep pastured within the reserve occupy ranges on the western slope. Still more than those on the east, these bands depend for their livelihood on areas which have been cleared by fire, and from which the presence of the sheep excludes all but the most meagre reproduction. The measures which seem to be required have already been referred to.

FOREST FORCE.

It has already been recommended in Part II that one ranger be stationed at Oregon City and another at Roseburg. Five guards at or near Summit Camp, Detroit, Sisters, Big Meadows, and Fort Klamath, with 30 fire-watchers at local points, complete the list of men assigned to this reserve under the plan heretofore described.

FOREST MANAGEMENT.

Actual forest management will probably first be possible in the upper Santiam Valley, on the western slope, where the character of the reproduction indicates either clear cutting in strips or a system of selection fellings extremely localized. Operations should be delayed until a stronger demand becomes evident.

East of the summit provision will be required to furnish settlers and ranchers with small amounts of timber, but the commercial development of these forests is not at present required. Forest fires and the supervision of sheep ranging throughout the reserve must form the most important objects of management for some years to come. The regulations suggested by Mr. Coville, and quoted in Part II of this report, should be adopted; and it is here repeated that unless a year is to be lost in the enforcement of this reform measures must be taken at once to carry out Mr. Coville's plan. It is earnestly recommended that such action be taken without delay.

BOUNDARIES.

Study of the reserve has developed the fact that the present boundaries are far less faulty than had been supposed. Until more complete examination of them can be made it is recommended that they be allowed to remain without change.

FLATHEAD FOREST RESERVE.

SUMMARY.

Situation: Northwestern Montana.	
Area within present lines	Acres.
Adverse holdings not known.	1,382,400
	Per cent of total area.
Area of forest land	(?) 90
Area marked by fire	(?) 25
Area badly burned.....	(?) 15

Revised lines can not be drawn without further study and a map.

Force recommended: A, limited supervision by the forest force charged with the Bitterroot and Lewis and Clark reserves.

Sources of information: Personal examination, two weeks in June and July, 1896; September 9-25, 1897.

An exceedingly broken mountain region, densely timbered with tall trees on the west side of the continental divide, less densely timbered on the east.

The water supply on the east and the floods on the west furnish imperative reasons for the protection of these forests.

Mining locations are locally numerous, and will increase.

Agriculture is of little importance.

Grazing is of little importance.

Provisions are immediately required under which mining timber may legally be cut, and by means of which the fires which will follow the development of prospecting east of the summit may be controlled. The construction of trails is important.

Situated in northwestern Montana, the Flathead Reserve occupies both slopes of the main divide of the Rocky Mountains from just north of the Great Northern Railroad to the British line. Its boundaries include an area of 1,382,400 acres, none of which falls within the land grant of any road. From the very different character of the east and west slopes of the Rockies within this reserve it will be convenient to describe them separately.

EASTERN SLOPE.

The eastern slope includes a mountain region unexcelled on this continent for the grandeur and simplicity of its lines. Its natural features are of great size and simple plan, and so striking in outline and effect that its extensive and important forest areas form at first sight a comparatively unimportant factor in the landscape. Its rocks are granitic, and the soil which results from their decomposition is in general poor. The climate is extremely harsh. Snow often lies on the ground at the lower altitudes from September to July.

Recently separated from the Blackfoot Indian Reservation, the eastern slope has no trade relations at present. Its economic value in the near future must depend upon supplying the timber required to develop its mines, to which local opinion assigns a hitherto undemonstrated value, and protecting the head waters of the Milk and Marias rivers, both of which are essential to large cattle interests in the range country farther east.

THE FOREST, EASTERN SLOPE.

The forest is composed chiefly, at the lower altitudes, of lodge-pole pine, Douglas fir (red fir), and Engelmann spruce. Higher up, alpine fir and limber pine are the principal elements of the forest, with here and there a considerable proportion of spruce. The spruce serves as a connecting link between the upper and the lower forest types. This forest is distributed wherever its existence is permitted by the slope of the ground and by the absence of the snow slides or avalanches, which, on the higher ground, clear considerable areas of timber, and keep them clear of everything but brush and weeds.

Very dense in many places, the forest here reaches no considerable size as compared with that of the western slope. It is capable, nevertheless, of furnishing great quantities of material indispensable to the development of the mines of this region, and to the support of the Indians on the reservation.

The lodge-pole pine is valuable chiefly for fencing and for the smaller grades of mining timber. It reaches the following average dimensions in this region: Height, 65 feet; diameter, 10 inches; length of clear trunk, 30 feet. Its marvelous reproductive power and its ability to occupy without delay lands cleared by fire have given it a very wide extension, so that it probably exceeds in number any other tree upon the area.

The Douglas fir (red fir), while valuable for its size and the quality of its timber, occurs only in small numbers. Its average dimensions are as follows: Height, 50 feet; diameter, 2 feet; length of clear trunk, 10 feet. Until exhausted, it will be valuable to furnish the larger class of mining timber.

The Engelmann spruce will furnish most of the lumber which may be obtained from this region. It reaches a diameter of 3 feet and over, and its average dimensions may be stated as follows: Height, 60 feet; diameter, 18 inches; length of clear trunk, usually not over 6 feet. The

knotty character of this tree permits it to furnish only lumber of low grade, but its value to the treeless range country farther east is great and will steadily increase. The reproduction of the spruce is fairly good.

The alpine fir, with average measurements of 50 feet in height, 12 inches in diameter, and no clear trunk, will furnish valuable mining timber at the higher elevations, where it forms practically the only forest growth.

Occasional areas, originally cleared by fire and since covered with grass, exist in the lower portions of this region. Long stretches of these parks are now covered with groves of the quaking aspen, a tree of no present commercial value. Under consistent protection from fire these areas may be expected eventually to resume their covering of useful coniferous trees.

FIRE, EASTERN SLOPE.

Owing to the protection afforded by its inclusion within the Indian reservation, this area has suffered comparatively little from forest fires. Corresponding portions of the Rocky Mountains farther south, hitherto unprotected, have lost by fire square miles of forest where the eastern slope of the Flathead will count but acres. With its segregation from the Indian reserve, and the influx of prospectors and miners which will take place as soon as the region is thrown open, forest fires will increase to a very serious extent unless active preventive measures are begun during the coming spring. Fires sweep through the lodge-pole pine with surprising ease, aided by the inflammable scaly bark with resinous exudations, and by the grass and dry waste under the trees. In a majority of cases the trees are killed, but not consumed, and they stand bleached and white for many years, in the end falling gradually across each other until the burnt region is often impassable for horses, and almost so for men. Undergrowth springs up in quantities among the standing and fallen dead trees, but rarely lives to reach any considerable size. Subsequent and usually hotter fires consume green and dead trees together, and burn off completely whatever vegetable soil may still remain. By the succession of such fires, which destroy crop after crop of young trees and gradually exhaust the soil, the open grassy stretches called parks are formed.

Fires in this region occur during the summer and early autumn, and their prevention will be a comparatively easy task if the cooperation of miners and prospectors can be secured.

WATER, EASTERN SLOPE.

Most of the streams of this region are important feeders of the Milk and Marias rivers, whose value to the cattle industry farther east demands the protection of their headwaters. Irrigation, except for grass, must remain unimportant on this slope, and floods are to be feared only to a secondary degree.

MINING, EASTERN SLOPE.

Prospecting has hitherto been illegal on that portion of the reserve which once formed part of the Blackfoot Indian Reservation; but it is widely believed that mines of importance exist, especially in the watershed of Swift Current Creek, and numbers of prospectors are waiting in the surrounding country for permission to enter the region to search for minerals. The protection of the timber for this use is one of the most important reasons for Government care.

AGRICULTURE, EASTERN SLOPE.

The climate is too severe to permit agriculture on the eastern slope, and hence no special provisions will be required.

GRAZING, EASTERN SLOPE.

A few hundred head of cattle have found range here at certain seasons of the year, but because of the small area of grass lands this industry can not reach important proportions. A very simple system of permits, perhaps restricted altogether to residents of the Indian reservation, will suffice.

LIQUOR, EASTERN SLOPE.

The sale of liquor to the Indians has been prohibited in former years within the area now reserved. They have hitherto been protected from whisky traders by the broad strip of rugged mountains, into which the Indians rarely venture, for they are essentially plainmen. But now that a mining population is to extend itself over the mountain strip, in close proximity to the dwelling places of the Indians, the sale of liquor to them will become easy unless a special regulation is issued and enforced. The results to the Indians of an easy trade in liquor do not require to be dwelt upon here. The matter was brought to my attention by the head chief of the Blackfoot Nation, who was and is extremely anxious that action should be taken in the line indicated above.

WESTERN SLOPE.

The western slope of the Flathead Reserve is more moist in climate and more densely forested than the eastern slope. It includes part of the head waters of the Stillwater River, a tributary of the Flathead, and nearly the whole drainage area of the North Fork of the latter stream. The topography is less rugged and abrupt than that of the eastern slope, except close to the continental divide, where the scenery is often grand and beautiful to a most unusual degree.

THE FOREST, WESTERN SLOPE.

The forest, composed chiefly of larch, western cedar, Douglas fir (red fir), mountain white pine (silver pine), Engelmann spruce, hemlock, and cottonwoods, is in sharp contrast, both in size and richness, with the forest of the eastern slope just described. In general character of timber and in the uses of its trees it is not unlike the Priest River Reserve, farther west, except that the forest is somewhat more dense. In places the trees are conspicuously larger in size, but I am not sufficiently familiar with the whole area to generalize with safety. The descriptions of individual trees should, I believe, conform quite closely to those of the Priest River Reserve, to which, accordingly, inquiries are referred.

FIRE, WESTERN SLOPE.

Fire is gradually penetrating this most valuable timber region, and it will continue to encroach more and more rapidly until effective measures against it can be put in action. The difficulty of extinguishing fires is greatly increased by the quantity of vegetable debris which covers the soil and in which they sometimes smoulder for weeks, often unbetrayed by even the slightest smoke.

WATER, WESTERN SLOPE.

The floods of the Flathead River, which form a considerable source of danger to the settlements in the Flathead Valley, must be considerably influenced by the forest condition of the drainage basin of its North Fork. The Stillwater has a similar importance. Both streams may be expected to be of some value for irrigation in the future.

MINING, WESTERN SLOPE.

Mining has made little real progress in this part of the reserve, although a certain number of claims have been developed to some extent.

AGRICULTURE, WESTERN SLOPE.

There is some agricultural land along the North Fork of the Flathead, and perhaps along the Stillwater also, but no special provision is required, beyond that already described, for opening it to entry, nor will the boundaries of the reserve require modification for this reason.

GRAZING, WESTERN SLOPE.

Grazing is not important, since open grass lands do not exist within the reserve to any noteworthy extent.

FOREST FORCE.

An adequate number of forest officers can not be supplied for this region under the appropriation suggested. It needs to be said in this connection that on the eastern slope 3 guards located on Swift Current, St. Marys, and Two Medicine creeks are urgently needed to protect their watersheds from the fires which uniformly follow prospectors in the West.

On the western slope 3 guards on the North Fork, McDonald Lake, and the Stillwater, respectively, should be set at work as soon as appropriations will permit. Twenty fire watchers might with advantage be appointed in this region. The lack of settlers on the eastern slope would make similar action difficult or impossible on that side.

FOREST MANAGEMENT.

East of the continental divide the simple and easily controlled system of cutting in strips seems best adapted to the forests. These strips, of perhaps 100 yards in width, should be located under the supervision of the forest force, should be separated from each other by twice or three times their width, and should be completely cleared of old timber. The trees should be thrown in such a way that their tops will lie together in heaps, and during the wet season these heaps may be cheaply and safely disposed of by burning. The neighboring trees will completely seed the areas, while the uniform direction of the winds will permit the location of the strips in such a way as to avoid serious loss from wind-falls. West of the continental divide a somewhat similar plan of management will be required. It is probable that some form of localized selection, a method at once cheap, simple, and safe, in proper hands, will be preferred, on account of the mixed character of the forest. This method is easily adapted to a system of licenses. It should be worked out in detail for this forest before any cutting is allowed. Special care

will be needed to prevent the hemlock in certain places from driving out other and more valuable kinds of trees.

Water transportation is ample and available on the west, but less so to the east. The Great Northern Railroad gives access to markets both East and West. On both sides of the main range the reproduction of the forest is such as to fit it well for forest management. There does not appear to be a considerable immediate demand for the sale of timber from this region, and except for matters of protection it may safely be numbered among the reserves to be taken up when the resources of the Department for this purpose are made larger.

BOUNDARIES.

Except for a small possible extension to the south, the boundaries of this reserve east of the continental divide are satisfactory. To the west they should be very considerably extended, but the information at hand is not sufficient to warrant the drawing of new lines, nor have the necessary maps been completed.

GRAND CANYON FOREST RESERVE.

SUMMARY.

Situation: North central Arizona.	Acres.
Area within present lines	1,851,520
Adverse holdings, railroad lands	583,360

Part of this reserve should be included in a national park.

Further revision of lines is not possible without further study.

Force recommended: One ranger, 3 guards, 10 fire watchers after other more pressing reserves have been supplied with men.

Source of information: Personal examination, September 28-30, 1896.

A comparatively level high plateau, broken by tremendous canyons, partly covered with yellow pine or stunted growth of nut pine and juniper.

The effect of this reserve on water supply is probably small.

Mines of importance have not yet been developed.

Agriculture is not important.

Grazing has been practiced to some extent and should be regulated.

The commercial development of this reserve is not immediately required.

The Grand Canyon Forest Reserve is situated in north central Arizona, and embraces the finest portion of the Grand Canyon of the Colorado River. With an area of 1,851,520 acres, it includes, within primary and indemnity limits, a total of 583,360 acres of railroad land. Its surface, except in the canyons, is comparatively flat. Much of it is desert or arid land, covered with stunted growth of single-leaf piñon (nut pine) and junipers, but it contains large areas of the western yellow pine, which forms here in Arizona the largest pure pine forest in the world. The climate is for the most part exceedingly dry, and except for pasturage the reserve has so far made little or no contribution to neighboring regions.

THE FOREST.

The forest is composed almost exclusively of the western yellow pine, mixed here and there with the quaking aspen and the dwarf white oak. The more arid portions of the reserve south and east of the Grand Canyon are either bare or covered with stunted trees of single-leaf pine (nut pine) and various junipers. I am informed that north of the canyon the only forest growth is of this character.

The yellow pine reaches the following average dimensions: Height, 80 feet; diameter, 18 inches; length of clear trunk, 35 feet. Young growth is nowhere plentiful, but it occurs here and there in groups outside the cover of old trees. Growth is slow, and the total amount of timber per acre is small.

FIRE.

The open yellow-pine forest suffers comparatively little from fire, except as unsoundness follows wounds made by burning at the surface of the ground. How great this source of loss may be in this reserve it will require lumbering operations to show, but elsewhere, as in the Black Hills, it has been found to be very great.

WATER.

The forests of this reserve have little effect on floods or irrigation, except as their influence may be felt upon the general climate of the region. It is a common observation that showers falling over the desert are evaporated by the hot air through which they must pass to reach the ground. In this way rain may fall in the upper air without benefit to the dry ground beneath. The cooler temperature above forests must tend to prevent this source of loss, and it is probable that in many other ways the presence of these forests is beneficial.

MINING.

Except in Grand Canyon mining is not believed to promise well in this reserve, nor have mines of any importance been developed.

AGRICULTURE.

In the absence of water available for irrigation stock raising is the only cultural use to which this area may be put. No part of the reserve, so far as I am acquainted with it, requires to be excluded on this ground.

GRAZING.

Considerable herds of stock graze near the brink of the canyon. It is reported that their owners illegally inclose public lands. The regulation of this pasturage should be undertaken as soon as the necessary forest force is available.

FOREST FORCE.

Since the Grand Canyon is certainly the most august and wonderful piece of scenery in North America, and probably upon the globe, it is of great importance that its surroundings should not be impaired by fire or by vandalism of any kind. As soon as means are provided by Congress a forest officer should be stationed on the border of the canyon at the Hance trail for the protection of the forest against fire, and to prevent the defacement of the brink of the canyon. Portions of the reserve should be protected under the direction of this officer against grazing of any kind, and especially it should be seen to that the herds of sheep which now occupy portions of the area should be carefully restricted in their range. The reproduction of the yellow pine must be protected if this forest is to survive. Three forest guards and 10 fire watchers would complete the force under the standard adopted for other reserves.

FOREST MANAGEMENT.

Beyond the protection indicated there will be little call for active measures of management within this reserve during the next few years.

BOUNDARIES.

In the absence of specific descriptions of this reserve and of accurate maps of its area, no changes in the boundaries can be recommended at present. I desire, however, to reiterate here the recommendation of the National Forest Commission that a part of the reserve be converted into a national park.

LEWIS AND CLARK FOREST RESERVE.

SUMMARY.

Situation: Northwestern Montana.	Acres.
Area within present lines	2,926,080
Adverse holdings, railroad lands	664,320
	Per cent of total area.
Area of forest land	(?) 85
Area marked by fire	(?) 50
Area badly burned	(?) 15

Revised lines can not be drawn without further study and an accurate map.
 Force recommended: Part of the attention of 1 ranger and 1 guard, and the whole time of 1 guard and 5 fire watchers.
 Sources of information: Personal examination, June 18 to July 8, 1896; October 4-16, 1897.

A broken and comparatively little known mountain region, with valuable forests of varied character.
 Fires have done and are still doing serious injury.
 Danger from floods and from the lack of water for irrigation both demand the preservation of these forests.
 Mining is unimportant now, and shows little promise.
 Agriculture is almost altogether forbidden by the climate.
 Grazing may be permitted for a time in carefully restricted localities.
 Some provision is required to meet probable local demands for timber and fuel, especially on the eastern slope.

The Lewis and Clark Reserve occupies both slopes of the continental divide in northwestern Montana for some distance south of the Great Northern Railroad, together with the Kootenai Range and part of the Mission Range to the west, and a portion of the watershed of the Big Blackfoot and other streams tributary to Clark's Fork of the Columbia. Its boundaries include 2,926,080 acres, of which 664,320 are within the primary and indemnity limits of the Northern Pacific Railway Company. For descriptive purposes this reserve may conveniently be divided by the crest of the Rocky Mountains.

EASTERN SLOPE.

That portion of the Lewis and Clark Reserve which drains into the Missouri comprises the headwaters of the Marias and Sun rivers, and a portion of those of Dearborn Creek, all of which streams empty directly into the Missouri. Bounded on the west by the main range of the Rocky Mountains, its eastward slope is interrupted for a considerable distance by a transverse range, west of which the North Fork of Sun River flows from north to south. Except in the broad valleys of the northern and middle forks of this stream, nearly the whole area is broken

by rugged ridges with abrupt slopes. The soil is unfit to raise anything but grass or trees, for the severe climate precludes agriculture altogether. This region has hitherto made little or no contribution to the settlements eastward except in the matter of railroad ties, considerable numbers of which have been cut from the North Fork of Sun River, and driven down it for the use of a branch of the Great Northern Railroad.

THE FOREST, EASTERN SLOPE.

The forest on the eastern slope consists principally of Douglas fir (red fir), Engelmann spruce, and lodge-pole pine. It is generally open, and in places is broken by the burns of very extensive fires. In the valley of the North Fork, lodge-pole pine, with a mixture of spruce in the moister situations and of alpine fir higher up, constitutes the bulk of the forest, which in many places is comparatively dense and uninjured by fire.

The lodge-pole pine, which has furnished the larger number of ties cut from this region, reaches the following average measurements: Height, 70 feet; diameter, 10 inches; length of clear trunk, 20 feet. This tree probably owes its wide distribution here as elsewhere to the prevalence of fires in the past. It is slow of growth, with admirable reproductive powers, and forms by far the greater portion of the forest.

The spruce is found both on high and low ground, and owes its distribution to moisture and not to altitude. It has average measurements as follows: Height, 80 feet; diameter, 18 inches; length of clear trunk, none. Valuable as a lumber tree because better material is lacking, the spruce occurs in restricted numbers compared with the lodge-pole pine, although the total amount of it in the watershed of Sun River is large.

Alpine fir lives normally at high altitudes, but in places follows the streams to comparatively low situations. At great elevations it usually forms the bulk of the forest, and often exceeds in numbers all other species even at moderate heights. Its average dimensions are: height, 50 feet; diameter, 12 inches; length of clear trunk, none.

FIRE, EASTERN SLOPE.

The eastern slopes of the main range in the northern part of this reserve, and of the spur which bounds the watershed of the North Fork of Sun River farther south, have been practically cleared of timber by fire over the greater portion of their extent. The contrast between the present condition of this unprotected area and the unburned forests of the same slope of the Rockies farther north, where the Blackfoot Indian Reservation has hitherto tended to prevent the general access of prospectors and hunters, is as striking as it is instructive.

In the broad and comparatively flat valley of the North Fork the original forests have been driven from the more level lands, for 12 miles above the junction with the South Fork, by the ravages of ancient fires. To a less extent, on the Middle Fork, open grass lands have been produced in the same way. Otherwise these valleys are well timbered. The prevailing character of their forests has been determined here, as in many other places, almost exclusively by fire and the amount of rain.

Throughout the larger part of the area under discussion the body of decaying vegetable material under the trees is slight, and except for

the very inflammable character of the lodge-pole pine forests the prevention of fires would be comparatively easy.

WATER, EASTERN SLOPE.

The destruction of the forests on this slope will necessarily have its effect upon floods in the Missouri and Mississippi, but its more immediate result will be felt in the grazing regions along Sun River and the tributaries of the Marias and of Dearborn Creek. Nine reservoir sites have been selected within or near the reserve on Sun River and its tributaries. Their future usefulness, and hence the agricultural development of the regions they are intended to serve, will depend upon the protection of the forests within this watershed.

MINING, EASTERN SLOPE.

Prospecting has been followed with but little tangible result in the area under discussion, and the development of mines within it is not anticipated in the near future.

AGRICULTURE, EASTERN SLOPE.

Agriculture, as has been said, can not be successfully pursued here on account of the rigorous climate. The only important natural products of this region which may be confidently expected will come from the forests.

GRAZING, EASTERN SLOPE.

The considerable area of grazing lands situated above the junction of the north and middle forks of Sun River should be made available, at least temporarily, for pasturage. As in the case of other regions, pasturage should be strictly limited and controlled whenever the reproduction of the forest is desired. There is no reason for the exclusion of these lands from the reserve, since their agricultural development is not to be anticipated.

FOREST MANAGEMENT, EASTERN SLOPE.

Railroad ties have been cut from portions of the eastern slope in considerable quantities, and a continued market for this sort of timber is to be anticipated, although the demand will apparently not be large in the immediate future. Water transportation for such products is good, and a considerable proportion of the forest is, or may shortly be made, available for this purpose.

Considerable delay in opening this reserve to development would not be followed by serious inconvenience to the neighboring population. Special permits for grazing should be required under a system similar to that proposed for the Cascade Reserve. Several large herds of sheep are owned just outside the reserve in the valley of Sun River, and the demand for their entrance to the pasture-lands already mentioned would probably follow upon the construction of better roads. For the present it does not seem necessary to consider it.

Clear cutting in strips is indicated as the system of management most likely to assure the safety of the forest until more careful studies can determine the best methods of increasing the proportion of valuable trees. It seems evident that the present forest is the result of years of forest fires, and does not fairly represent the capabilities of the region either as to volume of timber or richness of composition. Both are capable of conspicuous improvement under skillful handling.

WESTERN SLOPE.

West of the main range of the Rockies the Lewis and Clarke Reserve includes practically the whole of the watersheds of Swan River, which empties into Flathead Lake, and of the South Fork of the Flathead River, together with the head waters of the Middle Fork of the same stream. All of these streams flow in a northerly direction. Swan River and the South Fork are separated by the Kootenai Range, which bounds the drainage area of the South Fork on the west. West of Swan River is the Mission Range, while to the south of both these streams are parts of the watersheds of the Big Blackfoot and other streams tributary to Clarks Fork of the Columbia. Less rugged and broken than the Eastern Slope, the Western is still sparsely settled and very difficult of access. It contains some of the least known areas in the United States.

THE FOREST, WESTERN SLOPE.

The valleys of Swan River and of the South and Middle forks of the Flathead River are comparatively uniform in sylvicultural character. That of Swan River may be said to occupy a somewhat intermediate position between the broad agricultural lands of the Flathead Valley, and the steeper and more densely wooded slopes of the valley of the South Fork. It is, however, a true forest region, and almost wholly unfit for agriculture. The lower portions of these valleys are occupied by dense forests of coniferous trees whose principal components are lodge pole pine and larch. Other trees are the western white pine, the Douglas fir (red fir), and the western yellow pine. In the upper stretches of Swan River, as well as in the watershed of the Big Blackfoot, the yellow pine forms over considerable areas practically the only forest growth. The upper portion of the valley of the Middle Fork appears to be covered principally with lodge-pole pine and Engelmann spruce.

A description of the forests of the South Fork will serve to indicate as well the character of the lower valleys of Swan River and the Middle Fork within the reserve.

This forest is a dense, tall, and rich body, composed chiefly of valuable kinds of trees, of which the larch is easily first in economic importance. The reproduction of the less valuable kinds is more vigorous than that of the more desirable species, a condition unfortunately very uncommon in forest regions.

The western larch reproduces itself freely only in the open and on land from which fires have not yet driven all the humus. Impatient of shade, it does not thrive under the cover of other trees. It is rapid in growth, with thick bark, and even in comparatively early youth resists fire well. Its average dimensions are roughly as follows: Height, 150 feet; diameter, 3 feet; length of clear trunk, 75 feet.

The mountain white pine (silver pine), next to the larch in economic value, or perhaps sometimes surpassing it in the early stages of lumber development, here reaches almost the same average size. It is, however, far behind the larch in number of individuals, and, indeed, is by no means common in the Swan River drainage.

The Douglas fir (red fir) occurs, on the whole, at slightly higher elevations than the larch, although it is very frequently found in mixture with it. In the open country it reproduces itself well, but seedlings are not common under heavy shade. Its average dimensions may be given roughly as follows: Height, 125 feet; diameter, 2.5 feet; length of clear trunk, 50 feet.

On swampy lands and in the river bottoms the Engelmann spruce is common. It is a comparatively small tree, slow in growth, and with but moderate reproductive power. Its average dimensions may be given as follows: Height, 100 feet; diameter, 1.5 feet; length of clear trunk, 10 feet.

Wherever the old forest has been destroyed by fire, the lodge-pole pine is very apt to take its place. This tree is singularly liable to be killed by fire on account of its thin and resinous bark, but its wonderful powers of reproduction, perhaps superior to those of any other tree on this continent, enable it to repair damages from this source with astonishing speed. It is frequently found as an undergrowth beneath fire-scarred old trees of larch and Douglas fir (red fir), and its silvicultural function appears to be to prepare the ground for its more valuable successors.

The alpine fir occurs throughout this forest chiefly as undergrowth. Mature trees are infrequent, but the younger ones are common, occupying both moist and dry situations, although with a preference for the former. They do not flourish except under cover of other trees. Old trees reach average dimensions somewhat as follows: Height, 100 feet; diameter, 2 feet; length of clear trunk, 25 feet. This tree has little or no commercial value at present.

In the more level stretches of the upper valley of Swan River the yellow pine has taken almost exclusive possession of the ground, and it is probable that the higher portion of the South Fork drainage is to some extent similarly occupied. The upper valley of the Big Blackfoot in and near the reserve also contains large bodies of yellow pine, and great quantities of lumber from this tree have been cut from its tributaries.

FIRE, WESTERN SLOPE.

Here as elsewhere fire has been followed by the extension of the lodge-pole pine. Considerable burns exist on the South Fork and in the valley of Swan River, near their respective junctions with Flathead River and Flathead Lake. Isolated burned patches are elsewhere distributed through the forests. The South Fork is comparatively an unknown region, little visited and difficult of access, while Swan River Valley contains a good trail throughout its length and is comparatively well known. There is also a good trail down the Middle Fork. In the upper portion of the valley of Swan River and in the region tributary to the Big Blackfoot the prevalence of the western yellow pine, whose heavy bark enables it to resist many surface fires, has had a strong tendency to check the damage from fire, and the same is probably true about the head waters of the South Fork, where the forest is said to be similar in general character.

WATER, WESTERN SLOPE.

Floods in the South and Middle forks will have serious consequences for the Flathead Valley. Swan River, which empties into Flathead Lake, is somewhat less important in this respect. The function of the forests in the drainage basins of these streams in restraining floods will probably be of greater moment to residents of their valleys below the reserve than their effect on agriculture through irrigation.

MINING, WESTERN SLOPE.

Mining has received no considerable extension on any of these streams. Coal has been found, but there are no sufficient reasons under this head for excluding any portions of this area from the reserve.

AGRICULTURE, WESTERN SLOPE.

The severity of the climate makes serious agriculture impossible on the whole slope, with the possible exception of a small area in the Big Blackfoot drainage basin. I am not aware that any corrections of the boundaries are required under this head.

GRAZING, WESTERN SLOPE.

Considerable areas on the head waters of Swan River and the South Fork and in the watershed of the Big Blackfoot are more or less valuable as grazing lands. These areas are for the most part heavily timbered with yellow pine, but they often support a vigorous growth of grass beneath the trees. Regulations for the government of grazing within this reserve, similar in general scope to those recommended in the case of sheep in the Cascade Forest Reserve, will easily and safely make these resources available for stock raising.

FOREST MANAGEMENT, WESTERN SLOPE.

The problems to be met in putting the western slope under right management are somewhat complicated. The topography is very diverse in its effect on the forests, and the latter show conspicuous sylvicultural differences. Cutting in narrow strips in the mixed forests of the lower river valleys will probably lead to the best results, while wider strips in lodge-pole pine, or even clear cutting over blocks of some size in the old forests of yellow pine, may be safe and profitable. It is evident that a detailed study of the whole region should precede any attempt to put it under forest management. Special attention should be given to the conditions which govern the reproduction of the larch, which is in many ways the most valuable tree of the whole reserve. There is no large immediate demand for the forest products of this reserve, but a system of licenses for small amounts of timber is needed at once. Some timber has been illegally cut and driven down the South Fork to market. Hereafter this stream, as well as the Middle Fork and Swan River, will be largely utilized in this way.

FOREST FORCE.

It has been recommended (Part II, page 46) that the forest ranger in charge of the Bitter Root Reserve should exercise a limited supervision over the Lewis and Clark and Flathead reserves also, and that guards should be stationed at or near Ovando and Columbia Falls. A far larger force is required at once, but other reserves in much greater need of immediate protection make necessary this division of the forest force assumed to be available. Other points where guards are needed are Swan Lake and the Hot Springs of Sun River.

BOUNDARIES.

Except for the exclusion of an untimbered area southeast of Heart Butte, amounting to perhaps three townships, no reductions of consequence appear to be required, nor am I aware that the retention of these townships for a time will work hardships to any citizens. More detailed knowledge should be acquired before the final lines are laid down.

MOUNT RAINIER FOREST RESERVE.

A careful examination of this reserve is required to obtain data for the revision of its boundaries, and for the segregation of an area, including Mount Rainier, which should be included in a national park. The extension of the limits of this reserve is desirable in many ways, and will be effected without working hardships to any legitimate interests. Under existing rules and regulations the rights of miners are fully protected. It is believed that no agricultural land of any consequence is included within the present boundaries. Were the provisions recommended in Part II of this report adopted, they would open to entry any such land which may be included without removal from the reserve. It is recommended that steps be taken at the earliest practicable date to examine this reserve thoroughly, both as to its forest and other conditions, and as to the influence of the former upon the drier regions to the east.

OLYMPIC FOREST RESERVE.

SUMMARY.

Situation: Western Washington.

	Acres.
Area within present lines	2, 188, 800
Adverse holdings, approximately	100, 000
	Per cent of total area.
Area of forest land	(?) 95
Area marked by fire	(?) 90
Area badly burned	(?) 25

Revised lines can not be drawn without further study and a map.

Force recommended: One ranger, 5 guards, 50 fire watchers, after other more pressing reserves have been taken in hand.

Sources of information: Personal examination, August 19 to September 3, 1897.

A rugged broken mountain region, covered for the most part with dense forests, the trees of which, on the western slope, reach an average height of 200 feet.

Floods are dangerous to settlers in and below the reserve, whose safety demands the protection of the forests above them.

Mining is of no importance at present, nor is there any clear promise that it will be hereafter.

Agriculture and grazing are but little developed, and their further extension by clearing the forests will involve the destruction of values immensely greater than any they can create.

The commercial development of this reserve will not be required by local needs for several years to come.

The Olympic Forest Reserve occupies nearly the whole of the Olympic Peninsula in western Washington. The region it includes consists of rugged mountains and steep canyons, for the most part densely forested, and is less easily penetrated, perhaps, than any other of its size in the United States. Its larger streams rise in the central mass of mountains whose principal peak is Mount Olympus, and radiate from it like the spokes of a wheel, reaching salt water directly on the east, north, and west, and on the south by way of the Chehalis River. The area inclosed within its boundaries is 2,188,800 acres. This sum is to be diminished by 66,160 acres of railroad lands, together with a considerable number of timber and agricultural claims. The rock is granitic in character, and the mineral soil but moderately productive. It is the rainfall and the deep layer of vegetable mold on the ground which gives the forest of this region its wonderful development. Precipitation is here greater than in any other portion of the United States, and the moisture which it supplies during the growing season fits this region, far beyond most others, for the production of timber.

THE FOREST.

Except the redwood belt of California, the Olympic forest is finer and more productive than that of any other considerable division of the United States, and may fairly be called magnificent. It is composed almost exclusively of coniferous trees, towering often to a height of from 225 to 275 feet. The size of its members and the luxuriance of the undergrowth give it an almost tropical appearance. Douglas fir (red fir), western cedar, Sitka spruce, and western hemlock are its principal trees.

With the slight opportunity for investigation afforded by a short and hurried trip it is impossible to reach an estimate of the volume of timber now standing in the Olympic forest, and it must suffice to say that it amounts to many billions of feet. Individual acres bearing more than 100,000 feet of lumber are common, while in the neighborhood of Port Crescent one-quarter section which had been lumbered is known to have yielded upward of 40,000 feet per acre of cedar alone.

Lumbering within the boundaries of the reserve has attained no importance, so far as I was able to learn. Enormous quantities of timber have passed into private hands around the edges of the peninsula, and these supplies will be sufficient to meet all commercial demands for several years to come.

The Douglas fir (red fir), which is the most important timber tree of this reserve, appears to depend for its distribution upon the action of fire. So radical a statement, however, should be made only with the proviso that further study will be required to confirm or disprove it. The average dimensions of this tree are as follows: Height, 200 feet; diameter, 6 feet; length of clear trunk, 100 feet. Fair-sized trees will cut from three to five merchantable logs of 36 feet in length. A foot-log across the Soleduck River at Wineton, which was 26 inches in diameter at the butt, 134 feet long, and 18 inches in diameter at the upper end, will indicate the size reached even by young trees.

The western cedar is here widely distributed through the lower portions of the forest, but appears to prefer the flatter and less well-drained situations. Its reproduction within the forest is fairly good in places, while young seedlings are of common occurrence in openings cleared by fire. Its average dimensions are: Height, 175 feet; diameter, 6 feet; length of clear trunk, 75 feet. Good-sized trees will cut from two to three 36-foot logs.

The Sitka spruce here reaches enormous dimensions. Diameters of 10 to 12 feet at 4 feet above the ground are common where this tree is abundant, while the average dimensions are: Height, 175 feet; diameter, 5 feet; length of clear trunk, 100 feet. Fair-sized trees will cut from two to four 36-foot logs. The spruce is highly prized for lumbering, and its enormous size, great length and girth of boll, and freedom from knots make it an extremely valuable component of the forest, although in numbers it falls behind the Douglas fir and hemlock.

The western hemlock constitutes almost everywhere the bulk of the forest. It occurs as undergrowth beneath the towering spruces, cedars, and firs, and in many situations grows almost pure over small areas. Its average dimensions are: Height, 150 feet; diameter, 3 feet; length of clear trunk, 75 feet. Its reproduction is extremely good and its growth is moderately fast, but it is not as yet extensively used for lumbering. Hereafter it may be expected to show marked commercial importance, since its wood far exceeds in quality that of the eastern hemlock, which has already a very extensive market.

A striking fact in the reproduction of the Olympic forest is that very few trees start on the forest soil.* Young seedlings of Douglas fir occur only, so far as my experience shows, in openings made by fire from which the vegetable soil has been burned away. Cedar and spruce are most plentiful in the same situations, but are also found in the forests, while young growth of hemlock is exceedingly common everywhere. Young trees which start in the forest appear almost without exception to begin life on stubs or trunks of dead or fallen timber, and to extend their roots gradually down along the rotting wood to the layer of vegetable soil, and through it to the mineral soil beneath.

When the wood upon which the seedlings started has rotted away, the young trees are left standing propped high above the ground by the strong roots which they have formed. These roots gradually grow together to form a trunk, which in the end betrays its origin only by a greater proportionate girth near the ground.

FIRE.

The whole of that portion of the reserve visited by me appears to have been cleared by fire within the last few centuries. The evidence on this point is conclusive. It was at hand wherever I was able to search for it. The mineral soil was found on examination to be overlaid by a layer of charcoal and ashes, which gave evidence of the presence of fire in the past. Continuous stretches of miles without a break were covered with a uniform growth of Douglas fir from 2 to 3 feet in diameter, interspersed with numerous rotting stumps of much larger trees bearing the marks of fire. The young firs were entirely unscarred, but charcoal was found at the roots of some specimens which had been thrown by the wind.

In other places, among forests of the same character, charcoal and ashes appeared beneath the vegetable soil where a trail had been cut into the side of a hill. Charcoal was found directly beneath a growing cedar tree 4 feet in diameter, under which a hole had been excavated in the course of lumbering operations. This mass of evidence acquires a crucial importance with relation to the forest from the fact that in my ten days' visit to this region I did not see a single young seedling of Douglas fir under the forest cover, nor a single opening made by fire which did not contain them. Since not much less than half of the total bulk of the forests in the region I visited consists of this tree, the bearing of such facts upon the future management is direct and important. Next to the cedar, the Douglas fir is the most valuable lumber tree of the region, and any system of forest management which is to succeed must provide for its reproduction.

Fires are dangerous here mainly because of the deep layer of humus which covers the ground and the masses of fallen timber which obstruct the forest in every direction. In many places these prostrate trunks reduce the progress of a man on foot to a small fraction of a mile per hour. Fires which obtain a foothold in such places are extremely difficult to subdue. They burn deeply into the fallen logs, and in hemlock timber often survive even drenching rains. On the trail from Wineton to Beaver a fire which began in August, 1896, survived the winter in this way, and was still burning in February, 1897. But in spite of such difficulties it is possible to extinguish, without undue labor and expense, fires which do not get into the crowns. In that case human efforts are useless. Ground fires are apt to travel slowly, and, with suitable tools, may be successfully attacked.

WATER.

Irrigation has no importance in this region of heavy rainfall, but floods are common, and, with the progress of settlement, threaten to become exceedingly destructive. The beds of the larger streams, so far as I am acquainted with them, show evidence of torrential action, while stories of their destructive floods are everywhere current. It is a common thing for ranchers to set fire to the great drifts of timber which accumulate in the bends of the streams, in order to prevent the flooding of their ranches by back-water from these natural dams. Trees whose diameter is several times the average depth of the streams at ordinary stages are transported and piled up during floods, and only the densely timbered slopes of the upper watersheds prevent these inundations from attaining still more formidable size.

MINING.

Mining does not appear to have reached any development of consequence, nor is there any clear promise of its future extension within the reserve.

AGRICULTURE.

The heavily timbered land in the lower valleys of the streams is capable, when cleared, of producing agricultural crops. Wheat may be raised, but it is so soft as to be unfit for the manufacture of flour. Hops, vegetables, and other crops are produced, but the labor expended in clearing such land is altogether out of proportion to the results. Merely to fell and burn the standing trees, without extracting their stumps, would often involve an expenditure for labor, if the latter had to be hired, of more than \$150 per acre, while the land itself, after clearing, is worth but a fraction of that sum. The destruction of timber for this poor result is appalling, especially since a considerable proportion of the fires started in clearing extend far into the uncleared forests. Natural prairies, undoubtedly caused by repeated fires, exist here and there, and these are the only lands in the reserve known to me which may fairly be called agricultural.

GRAZING.

Grazing has little importance, nor will it probably develop much beyond the small number of animals owned by settlers. Clearing may eventually transform parts of this region of heavy rainfall into dairy lands of some importance. This change may take place on lands held by private individuals, but the forest destruction it involves is so enormous in comparison with the results obtained, that clearing for such purpose within the reserve should not be permitted.

FOREST FORCE.

The forest force required to take care of this reserve on the same scale as that hitherto recommended should include 1 forest ranger, located at Port Townsend, from which point the different portions of the reserve are most easily accessible, and 5 forest guards, at Lake Cushman, Clearwater, Bogachiel, Wineton, and McDonald's. Fifty fire watchers should be engaged in different parts of the reserve.

FOREST MANAGEMENT.

Transportation within the reserve must be chiefly by rail or flume, since the streams, because of floods and the enormous size of the timber, are not easily available for that purpose. The duties of the forest force within this reserve, for the present, should consist in protection against fire, and to that end in the important work of constructing trails practicable for horses. The appropriation for trails should be liberal, since the difficulties of building them, and of traveling without them in this densely timbered region, are very great. A forest map covering the whole area of the reserve should be prepared, together with material upon which to base a future working plan. The economic development of these forests should be delayed until it is called for by the necessities of adjacent regions. When it comes, special precautions against fire will be imperatively needed. The great size of the timber requires the use of steam in nearly all the logging operations, and the thick layer of vegetable material on the ground makes the safe disposal of ashes from the engines, to speak of a single phase of the subject, a critical and not always an easy matter.

BOUNDARIES.

Changes in the boundaries should be wholly in the nature of an extension. Suitable provisions to enable agricultural land to be entered have already been recommended. Further study and a map are required before changes of boundary can be rightly made.

PIKES PEAK TIMBER LAND RESERVE.

SUMMARY.

Situation: Central Colorado.	Acres.
Area within present lines.....	184,320
Adverse holdings not known.	
	Per cent of total area.
Area of forest land.....	(?) 75
Area marked by fire.....	(?) 75
Area badly burned.....	(?) 50

Revised lines can not be drawn without further study.

Force recommended: This reserve should be managed in connection with the Plun Creek and South Platte reserves, which have not yet been studied.

Sources of information: Personal examination, October 10 and 11, 1896.

A steep and lofty mountain region, sparsely covered with open forest, chiefly of Englemann spruce.

Fires have done and are doing most serious injury.

The water supply of Colorado Springs and much adjacent country depends on the streams of this reserve.

Mines are frequent and mining timber has been very extensively cut.

Agriculture does not exist within the reserve.

Grazing is not important.

Provisions are required by which timber for mining and fuel may legally be cut, so far as the safety of the forest will allow.

The Pikes Peak Timber Land Reserve is situated in central Colorado, and occupies a narrow strip of lofty mountain region northeast and southeast of the summit of Pikes Peak. Its boundaries inclose an area of 184,320 acres. Its slopes, sparsely covered with forest growth, are for the most part steep, although the outlines of the range are rounded. It is conspicuously moist in climate when compared with the semi-arid regions to the east. This area supplies water for the city of Colorado

Springs and a tributary region of considerable extent, and its chief, but not its only, importance is believed to lie in this direction. As the nearest source of timber supply for Colorado Springs and the treeless region to the east it has a decided value, which will be immensely increased when adequate protection enables its forests to regain their productiveness.

THE FOREST.

The forest consists chiefly of small and isolated trees of Engelmann spruce, blue spruce, Douglas fir, and limber pine (white pine), while large areas are covered by quaking aspen, usually as the result of fires. The reproduction of this forest, like the growth of its trees, is slow, and in consequence the injuries which it has suffered from indiscriminate cutting for mining and other purposes will be visible for many years to come.

FIRE.

Fires have spread over practically the whole area of this reserve wherever the vegetation was dense enough to sustain them. At present the danger from this source has disappeared over considerable stretches because little or nothing remains to be burned.

WATER.

The fact that this reserve is the source of water supply for a numerous population has already been referred to. Not only its protection, but the restoration of the forest to its original condition is, for this reason, urgently recommended. My visit was too hasty to enable me to secure conclusive data in this direction, but I am strongly of opinion that further study will demonstrate the necessity to which I have just referred.

MINING.

Mining in this region, both within and without the reserve, is exceedingly important, and mining timber has been cut from the reserve without stint. Thus the chief direct value of these forests may be said to be rapidly disappearing. The effect of the exhaustion of this source of timber supply upon mine owners will be serious. Protection against fire and illegal cutting is therefore of vital importance if the value of the reserve for any purpose is to be preserved.

AGRICULTURE.

Agriculture does not exist within the reserve, so far as I am informed. This elevated region is chiefly useful, in this direction, to supply water for lower-lying agricultural lands.

GRAZING.

Pasturage within the reserve appears to be of little consequence.

FOREST FORCE.

The forest force necessary to administer this reserve must depend upon the dispositions made for the Plum Creek and South Platte Forest reserves, which lie near it. Further study will be required before definite recommendations can be made.

FOREST MANAGEMENT.

Aside from protection of the reserve against fire and illegal cutting, no measures of forest management should be undertaken until an adequate study of the forest has been made.

BOUNDARIES.

I am not sufficiently acquainted with this reserve to suggest changes in its boundaries.

PRIEST RIVER FOREST RESERVE.

SUMMARY.

Situation: Northern Idaho and northeastern Washington.	Acres.
Area within present lines	645, 120
Adverse holdings, approximately	285, 000
Exclusions proposed, approximately	4, 000
Inclusions proposed, approximately	425, 000
Area within proposed lines, approximately	1, 065, 000
Increase, approximated	421, 000
Adverse holdings, approximated	200, 000

Present lines:

	Per cent of total area.
Area of forest land	80
Area marked by fire	75
Area badly burned	40
Standing merchantable timber, 4,830,000,000 board feet.	

Force recommended: One ranger, 3 guards, 15 fire watchers.

Sources of information: Report and statements of J. B. Leiberg, special field assistant, United States Geological Survey. Personal examination, July 16-26, 1897.

A mountainous region, partly undulating, partly broken, of great natural adaptation for the growth of forests.

Fire is rapidly destroying that part of the forest which has hitherto escaped.

Questions of water supply are less important than elsewhere.

Mining: Little present, but much prospective importance.

Agriculture: No special measures are required.

Grazing: Not important.

The commercial development of this reserve is not imperative at present.

The Priest River Forest Reserve is situated chiefly in Kootenai County, northern Idaho, with a small portion in northeastern Washington, and is bounded on the north by the British line. It includes within its boundaries an estimated area of 645,120 acres. To reach the sum of lands held by the Government this total must be diminished by the nonmineral part of 290,230 acres of land within the primary and indemnity limits of the Northern Pacific Railroad, and an unknown area covered by squatter claims on lands alleged to be agricultural. Mining claims have been located chiefly in the northern and western portions of the reserve. The total area owned by the Government within the boundaries probably does not exceed 360,000 acres.

From north to south the reserve extends about 55 miles, with an average breadth from east to west of 25 miles. Except for a small portion tributary to the Pend Oreille, almost its whole area is included within the Priest River watershed, by the limits of which it is bounded on the east and west. It contains two considerable bodies of water—Priest Lake, with a length of 18 miles, and Upper Priest Lake, with a length of somewhat over 2 miles. Streams are numerous, and the reserve as a whole is very well watered. The Priest range of mountains, which bounds the reserve on the east, rises to a height of 8,000 feet, and in its upper portion is exceedingly rugged and broken. The ridges which

spring from it are steep, and the whole slope of the eastern half of the reserve is abrupt, as its hard granites and syenites would naturally imply. The Pend Oreille range on the west is composed of softer schist, its slopes are gentler, its soil richer, and its forests denser and more valuable than those of the eastern range.

The rainfall of the reserve is probably not less than 60 inches per annum. At altitudes of 7,000 feet snow sometimes lies to a depth of 20 feet, and the climate as a whole is exceedingly moist. Frost may occur at any season, and the raising of any crop except hay is therefore a precarious undertaking. Climatically this reserve is admirably suited to the production of forests, but, except for the small area in the Pend Oreille watershed, to very little else.

THE FOREST.

In its natural state the forest of the reserve is a dense and extremely productive one, composed almost entirely of commercially valuable coniferous trees.

Three forest types are represented upon the half million acres which include nearly all of the productive forest lands: First, the lowest in altitude, the yellow pine-Douglas fir type, of which the characteristic tree is the western yellow pine, and the most important, commercially and numerically, the Douglas fir. This type covers an area of about 60,000 acres.

Second, the white pine-larch type, of which the white pine (silver pine) is the most valuable species commercially and the richest in mature trees. The western larch, of which by far the greatest part of the young growth of the reserve consists, is here the tree of the future, and will hereafter give its greatest forest value to this area. The forest which it helps to characterize covers about 480,000 acres and lies midway between the lower and the upper types. The latter is the alpine type. It includes the higher and more exposed portions of the mountains and covers about 60,000 acres.

The following tables, which exhibit the present resources of the reserve in timber, are summaries of extremely careful detailed estimates prepared on the ground by Mr. Lieberg. I regard them as both conservative and reliable.

Standing timber and its stumpage value.

Logs, 1,900,000,000 feet, at 50 cents per M.....	\$950,000
Ties, 2,720,000,000 feet, at \$1 per M.....	2,720,000
Poles, 210,000,000 feet, at 50 cents per M.....	105,000
Total.....	3,775,000

Ties are here estimated at 20 feet per tie, and valued at 2 cents each; telegraph poles at 100 feet per pole, and 5 cents each.

Value of timber, now standing, when manufactured.

Logs, 1,900,000,000 feet, at \$10 per M.....	\$19,000,000
Ties, 136,000,000 feet, at 20 cents per tie.....	27,200,000
Poles, 2,100,000 feet, at 25 cents per pole.....	525,000
Total.....	46,725,000

The present merchantable value of the forest consists, first, in its great supply of ripe trees of white pine (silver pine); second, in its old larch; then in its Douglas fir, chiefly valuable, like the larch, for railroad ties; next, in yellow pine; and lastly, in western cedar, chiefly

used for shingles and telegraph poles, and in lodge-pole pine, valuable for fencing, fuel, and small mining timber. Its future value will be derived mainly from the larch, which, as already noted, includes by far the larger part of the young growth. The reproduction of the Douglas fir is also very vigorous, as is that of the lodge-pole pine in places. The young white pine unfortunately does not come in so well, and a careful study will be required to determine what method of removing the old timber will lead most efficiently to the reproduction of this very valuable tree.

The western larch, valuable at present chiefly for ties, and to some extent for lumber, has, when matured, an average height of 175 feet, an average diameter of 3 feet, and an average length of clear trunk of about 80 feet. A good-sized tree will cut from five to seven 16-foot logs. Its reproduction is abundant and wide-spread, and since it possesses qualities which make it extremely valuable as a finishing wood, and in construction, it promises to constitute hereafter the chief value of the reserve.

The mountain white pine (silver pine) is very valuable as a lumber tree. It is said to compare favorably with the white pine of the East, than which it reaches a larger average size. The usual dimensions of mature trees may be stated as follows: Height, 175 feet; diameter, 4 feet; length of clear trunk, 75 feet. A fair-sized tree will cut from five to seven 16-foot logs. Reproduction is moderate and must be considered in deciding on methods of cutting. Planting and other expensive sylvicultural operations are of course entirely out of the question.

The Douglas fir (red fir), while it is one of the most valuable timber trees of other regions, is here chiefly used for ties. Its reproduction is second to that of the larch, and its average size is small. That of the the mature tree may be stated as follows: Height, 100 feet; diameter, 2 feet; length of clear trunk, 50 feet. It is not used for lumber at present.

The western yellow pine furnishes in other regions enormous quantities of coarse lumber. It is used also for railroad ties where more durable woods are not available. Its reproduction, very abundant in some regions, is here comparatively scant. The size of the average tree may be stated as follows: Height, 100 feet; diameter, 2 feet; length of clear trunk, 40 feet. An average tree will cut one 16-foot log.

The western cedar is much in demand for telegraph poles and shingles. It is occasionally used for cross-ties. Frequently unsound at the heart, it is yet a most valuable resource wherever it occurs. Reproduction in this reserve is good, and the trees are of fair soundness and size. The average may be estimated as follows: Height, 100 feet; diameter, 2½ feet; length of clear trunk, 30 feet.

The lodge-pole pine, a tree which owes its wide diffusion through the West very largely to the rapidity with which it seeds up burnt lands, has here taken possession of considerable stretches of the drier localities. Besides its value for fencing, fuel, and mining timber it serves a most useful purpose in preparing devastated land, by the fertilizing fall of its leaves and twigs, for the occupation of more valuable species. It reaches here an average height of 90 feet, with a diameter of 1 foot, and a length of clear trunk of 40 feet.

FIRE.

Priest River Forest Reserve has suffered from fire to an extent difficult to conceive without actual experience. The forest on not less than 200,000 acres has been totally destroyed within the last thirty years.

Except for one area of 1,600 acres on the Lower West Fork, there is probably not a body of one thousand acres on the whole reserve which has not been more or less seriously injured by fire. The timber which has been destroyed exceeds in value several fold that which remains.

These fires have been set chiefly by prospectors, hunters, and trappers. The most complete destruction coincides with curious exactness with the supposed mineral belts of the northern and western portions of the reserve. It is well known that many fires are set by prospectors for the sake of uncovering the rock. Special precautions will be required in nearly all the reserves to guard against this danger.

Fires are dangerous in this reserve from late in April to the middle of October. The completeness of the destruction they effect depends upon the dryness of the forest and the strength of the wind. Those which occur in summer are apt to be the hottest and swiftest. Large numbers of dead trees usually remain standing after any prosperous forest has been burnt over for the first time. The decomposition of their roots in the soil, and the violent winds which prevail in this region at certain seasons of the year, gradually overthrow these trees, which then furnish fuel for subsequent fires. The latter are apt to destroy the forest floor and the vegetable soil far more completely than their predecessors. The young trees which spring up among the dead trunks are killed, and in this way the time when the forest shall take possession of the soil again is often indefinitely postponed.

By assigning to the devastated areas a probable amount of standing timber less than that known to be present on uninjured tracts, a conservative estimate of the loss from fire during the last thirty years has been obtained. Previous to that time this region appears to have suffered little from fire during a hundred years or more, and in consequence it was densely timbered. Two tables are given; one indicates the loss on the basis of stumpage value; the other the value of the manufactured timber ready to ship. The latter shows more accurately the loss to the regions in which these forests stand, since by far the greater portion of the value of manufactured lumber consists in labor, the wages of which, in this case, would have been put in circulation in the neighborhood. It may fairly be said of this loss that it has not as yet been sustained, but it will come to be felt at the time when this timber, if it had been preserved, would have been manufactured. It must necessarily result in the comparative impoverishment of a considerable population. To this immense loss must be added that of the productiveness of the forest soil, which it will take years of immunity from fires to replace, and in addition the increase in value of this young and growing forest during the years since it was destroyed.

Stumpage value of burned timber.

4,490,000,000 feet, at 50 cents per M.....	\$2, 245, 000
245,000,000 ties, at 2 cents per tie	4, 900, 000
6,000,000 telegraph poles, at 5 cents per pole	300, 000
Total	7, 445, 000

Value of burned timber, if manufactured.

4,490,000,000 feet saw logs, at \$10 per M	\$44, 900, 000
245,000,000 ties, at 20 cents per tie	49, 000, 000
6,000,000 telegraph poles, at 25 cents per pole	1, 500, 000
Total	95, 400, 000

WATER.

The regulation of the water supply by forests in this reserve is comparatively unimportant. The rainfall is sufficient for such crops as may be grown, and the danger of floods is, for the present, slight. Priest Lake serves as a storage reservoir, and its level is said to have an extreme fluctuation of but 5 feet. Mention should be made, however, of the increasing floods in the Columbia River, upon which the destruction of forests in this reserve must exert a distinct influence.

MINING.

The special field assistant who examined this reserve, Mr. J. B. Leiberg, has had long and full experience in mining in northern Idaho. I quote his statement of its mineral resources:

At the present time there are known to exist three mineral-bearing belts. One in the region above the upper lake, one in the central portion, and one midway between the lower lake and the south line of the reserve. Two of these belts have their long diameter easterly and westerly, and very likely stretch entirely across the reserve, while the northern one lies in a northerly and southerly direction. A great many quartz claims have been located in the mineral-bearing zones. There are none developed as yet sufficiently to prove the region a commercially profitable one in the valuable metallic minerals. It is quite within the range of possibility that profitable discoveries will eventually be made in this direction.

AGRICULTURE.

A careful estimate places the agricultural lands of the reserve at 9,990 acres. These lands are nearly always found adjoining the streams. As a rule they are wet and swampy, but can be reclaimed by ditching. Nearly all natural meadows, fire glades, and grassy tracts are now settled upon, and the procedure recommended in the first part of this report, if adopted, will open the remaining agricultural lands to settlement. Hay, oats, potatoes, and vegetables may be raised, but the last two, on account of the frosts which may occur in any month, are never sure.

Mr. Leiberg speaks of the agricultural resources of the region as follows:

The Priest River Reserve is a forest region. Its natural peculiarities are such that it can never become an agricultural section, and all efforts to make it such should be discontinued. Its chief value lies in the immense forest growth that it is capable of maintaining, and in whatever of mineral deposits time may disclose. There is no market for farm products within the reserve. Were such articles produced in greater quantities than would supply the home demand they could not be shipped. There is no cheap transportation available to the railway, and if there were the producer would come into competition with like articles from other sections where they can be grown much cheaper.

Agricultural settlement in the Priest River basin dates back but seven years, and only 70 acres are under plow. Of the 1,200 acres of agricultural land tributary to the Pend Oreille, less than 200 are cultivated.

Probably every considerable body of accessible white pine timber is completely covered by squatters' claims, ostensibly for agricultural purposes, yet not 5 acres have been cleared of living timber. The obvious intention is to hold these lands for the timber they contain, and probably to abandon them when it has been cut. Every bona fide settler within the reserve should be protected, but claims of this sort are not contemplated by the law, and measures should be taken to render them void.

GRAZING.

Since there are no suitable areas of grass lands in the reserves, grazing is not likely to assume importance in the future. At present it has none beyond the pasturage of the domestic stock of residents, and no measures further than the general rules applicable in all similar cases are required to deal with it.

FOREST FORCE.

The forest force required to administer the reserve, on the scale recommended for other reserves in a previous portion of this report, should consist of 1 ranger, who should also be charged with the care of such additional reserves as are required by the present condition of the forests of northern Idaho, and of 3 guards and 15 fire watchers. The guards should be stationed, 1 at the foot of Priest Lake, 1 near the mouth of Reeder Creek, and 1 near the head of the upper lake. Each should be required to provide himself with a light rowboat carrying sail, in lieu of one of the two horses prescribed for other localities.

FOREST MANAGEMENT.

The first requirement for successful forest management in this reserve is the consolidation of the Government holdings. As already noted, railroad lands occupy a total of 290,230 acres, scattered throughout the reserve, while very considerable areas are claimed or held as mining or agricultural land. The settlement of this matter will require prolonged and delicate negotiations with the Northern Pacific Railroad. The railroad has a very complete knowledge of the value of its lands. A similar knowledge must be acquired by the Government before it can deal upon equal terms.

Water transportation within the reserve is unusually good. Logs, ties, and poles will eventually be moved in large quantities by way of Priest River and the Great Northern Railroad. Such demand as may exist at present for the timber of the reserve has little or no importance except as it may be concerned through settlers with the future development of the region. Immediate action which will place this timber on the market is therefore unnecessary; and it is undesirable in view of the delicate questions of reproduction involved. Further study of the reserve is plainly indicated before its resources can be opened to use. For the present active measures should consist in the study of the forest and the preparation of a working plan and the protection of the area against fire. Local demand for the timber on the reserve should make itself felt before action is taken to supply it.

When the time comes to place this timber on the market, from a fifth to a third of the mature standing timber will probably be available for use, under conservative and skillful treatment, without injury to the forest. The exact amount will depend upon the form of management adopted, which, in turn, will be decided by the amount of ripe timber in each locality, the reproductive power and silvicultural character of the trees, and the nature of the demand. Careful account must also be taken of the fact that the soil in many parts of the reserve is extremely thin, and that in others it becomes arid by exposure to the sun. All these considerations indicate a form of management called localized selection, which has the advantage, important in this case, of permitting the selection and felling of those trees which are most desirable for the lumbermen over considerable areas at the same time.

In all sales of timber to be made in this reserve, every tree sold should be marked by a member of the forest force with the forest brand already referred to, and the buyer should be required to subscribe to the conditions of a permit covering the following points:

1. No timber shall be cut or removed until payment has been made and the receipt presented to the local forest officer.
2. The timber sold must be removed within a specified time upon pain of forfeiture.
3. All lumbering must be done in accordance with the general rules in force and with any special regulations which may be prescribed for particular areas.
4. Special care must be exercised to avoid damage to all the timber not sold, and the permittee must assist in extinguishing any forest fire which may occur within specified limits.
5. A system of fines must be provided for injury to the growing timber and for minor violations of the rules. Serious offenses against the regulations must work forfeiture of the permit.
6. Liquor must be excluded from the camps of the permittee, because of the danger from fire which intoxication entails.
7. The occurrence of a fire in the timber sold to a permittee may lead to the forfeiture of the permit and the money paid therefor, at the discretion of the executive officer, with the approval of the chief forester.

BOUNDARIES.

Except for a small area of agricultural land¹ on the southeast corner of the reserve, nearly the whole of which has passed out of Government hands, no changes in boundaries are required for the purpose of excluding lands now within the reserve. On the other hand, I have to recommend the inclusion of 425,000 acres situated on the eastern slope of the Priest Range of mountains, the summit of which forms the present eastern boundary. The same reasons which justify the present Priest River Reserve apply to the inclusion of this strip, which consists of rugged mountains, broken and almost wholly unfit for agriculture and covered with forests more or less seriously injured by fire. Along the Kootenai River, after it becomes the proposed eastern boundary of the reserve, are a small number of settlers. Under the regulations already in effect, and with the additions recommended in my report, the rights of these settlers will be fully protected, and the agricultural development of the region they have settled will be limited only by its capacities in that direction. The proposed addition is shown on the accompanying map.

The new boundary lines recommended are as follows: Beginning at a point on the present southern boundary line of the Priest River Forest Reserve at the southeast corner of section 33, township 57 north, range 3 west; thence northerly 2 miles along the section line to the southeast corner of section 21 of said township; thence easterly 3 miles along the section line to the southeast corner of section 24 of said township; thence northerly 1 mile to the northeast corner of said section; thence easterly 2 miles to the southeast corner of section 17, township 57 north, range 2 west; thence northerly 1 mile to the northeast corner of said section; thence easterly 1 mile to the southeast corner of section 9 of said township; thence northerly 1 mile to the northeast corner of said section; thence easterly 2 miles to the southeast corner of section 2 of said township; thence northerly 1 mile to the northeast corner of said section; thence easterly 1 mile along the township line

to the range line between ranges 2 and 3 west; thence easterly 6 miles to the northeast corner of township 57 north, range 1 west; thence 36 miles northerly along the standard meridian to the southeast corner of township 62 north, range 1 west; thence westerly 1 mile to the southeast corner of section 35 of said township; thence northerly 12 miles, to the northeast corner of section 2, township 63 north, range 1 west; thence easterly along the township line between townships 63 and 64 to its intersection with the west bank of the Kootenai River; thence along said west bank to its intersection with the international boundary; thence westerly along said boundary to its intersection with the present eastern boundary of the reserve.

SAN BERNARDINO FOREST RESERVE.

SUMMARY.

Situation: Southern California.

	Acres.
Area within present lines	737,280
Adverse holdings, railroad lands	261,760
Title in dispute	106,880
	# Per cent of total area.
Area of brush and forest land	(?) 95
Area marked by fire	(?) 95
Area badly burned	(?) 40

Revised lines can not be drawn without further study.

Force recommended: Part of the attention of 1 ranger and 1 forest guard and the whole time of 1 guard and 6 fire watchers.

Sources of information: Personal examination, September 23 and 24, 1896.

An elevated mountain region, with steep slopes covered with brush, and a plateau summit bearing valuable forests.

Fires prevail and must be checked, even at great cost.

The water supply from this reserve is essential to the prosperity of southern California.

Mining is not important.

Grazing should be prohibited.

Provision is required to meet local demands for timber and fuel.

The San Bernardino Forest Reserve occupies the eastern portion of the mountain range of the same name. It is bounded on the east by the Cajon Pass and on the south by the San Gorgonio Pass and a fertile valley, of which San Bernardino is the chief town. With a total area of 737,280 acres, this reserve includes 261,760 acres claimed as railroad land, the title to 106,880 acres of which will not, it is believed, be sustained. It is a region of steep slopes, with a broad and comparatively level summit of the range. The climate in the lower portion is very dry, while on the heights the rainfall is considerable. This reserve has furnished small amounts of timber to the settlers below and has been pastured to some extent.

THE FOREST.

The forest consists chiefly of yellow pine, which here reaches average dimensions approximately as follows: Height, 80 feet; diameter, 2 feet; length of clear trunk, 30 feet. Other trees of importance are the sugar pine, the big-cone fir, Coulter pine, the knob-cone pine, and several evergreen oaks. Very large areas on the slopes are covered with chaparral, while the level plateau on top is chiefly occupied by valuable forest growth. Compared with those of the Sierra Reserve the trees are small, and those on the southern edge of the upper plateau show

more strikingly than any other tall trees with which I am acquainted the damaging effect of heavy winds. The reproduction of the whole forest is slow, and injuries are correspondingly serious.

FIRE.

Fire has affected the character of the forest probably throughout this reserve. It is not unlikely that the great stretches covered with chaparral once carried valuable forest growth, and other injuries to the utility of the whole region are apparent. Fires in the chaparral are difficult to subdue, on account of its impenetrable character and because of the absence of sufficient roads and trails.

WATER.

Irrigation and electric-light enterprises have taken possession of many of the valleys on the southern slope of the San Bernardino Range. These undertakings, and in fact the welfare of the whole adjacent population, depend on the water of streams which rise in this reserve. Consequently the influence which must be exerted on the prosperity of the rich agricultural country along the base of the San Bernardino Range by the protection or destruction of its forests is of the first importance. Not only the wonderful fertility of the fruit orchards from San Bernardino to Los Angeles depends altogether upon the water supply from the San Bernardino and Sierra Madre mountains, but their safety from the action of torrents is intimately connected with the protection of the mountain slopes. The orange orchards at Pasadena have already suffered from this cause, which, in the absence of efficient checks, promises to increase.

MINING.

The area covered by this reserve has been thoroughly prospected, but I am not informed that mines of importance have been developed, nor does it appear that any change in the boundaries of the reserve is required on this account.

AGRICULTURE.

Agriculture practically does not exist within the reserve, but it has already been noted that agriculture without it depends very largely upon the water which it supplies.

GRAZING.

Grazing lands are found on the flat summit of the range, but the importance of the forest to irrigation is so great and the danger to it from pasturage, especially of sheep, is so serious that its use in this direction should not be encouraged.

FOREST FORCE.

It has been recommended that a forest ranger be stationed at San Bernardino and forest guards at Pasadena and Hemet, to have charge of the four forest reserves of southern California. While this force is exceedingly small, it is believed that a fair distribution of the total appropriation suggested will not permit it to be increased.

FOREST MANAGEMENT.

Efforts in the line of forest management must be devoted chiefly to protection against fire and to supplying the requirements of ranchers for fuel and timber. A careful study of the reproduction of this forest must be made before the cutting of live trees can be safely undertaken on any large scale.

BOUNDARIES.

I am not sufficiently acquainted with the reserve, either personally or from the reports of others, to suggest any changes in its boundaries.

THE SAN JACINTO FOREST RESERVE.

SUMMARY.

Situation: Southern California.	Acres.
Area within present lines	737, 280
Adverse holdings, railroad lands	373, 550
	Per cent of total area.
Area of forest and brush land	(?) 95
Area marked by fire.....	(?) 95
Area badly burned.....	(?) 50

Revised lines can not be drawn without further study and a map.

Force recommended: One guard, 4 fire watchers, and a part of the attention of the ranger stationed at San Bernardino, after other more pressing reserves have been taken in hand.

Sources of information: Personal examination, September 24 and 25, 1896.

A mountain region rising above an arid plain, clothed with brush and open forest. The spread of fires results in changing the forest into brush. Its restoration will be difficult.

Fertile irrigable lands surround the reserve on all sides, to which the protection of the streams is essential.

Mining has been little developed.

Agriculture is not important within the reserve.

Grazing is not important within the reserve.

Provision should be made to supply the settlers and ranchers in the irrigated region below the reserve with timber and fuel.

The San Jacinto Forest Reserve is situated in southern California, south of the San Geronio Pass, which separates the mountain region of which it forms a part from the San Bernardino Mountains to the north. With a total area of 737,280 acres, it includes 373,550 acres of railroad land, or approximately one-half its whole extent. The San Jacinto Range is in general smooth in topographic features, and rugged only in the upper part. The climate is dry, especially on the eastern slope, below which lies the desert.

THE FOREST.

The forest is composed chiefly of yellow pine, which here reaches average dimensions, approximately, as follows: Height, 80 feet; diameter, 2 feet; length of clear trunk, 30 feet. This tree has been cut for lumber to some extent, but difficulties of transportation have prevented the development of the San Jacinto forest on any large scale. Other trees are the big-cone fir, the incense cedar, and Coulter pine. Several species of evergreen oaks occupy the lower slopes to the west, and the sugar pine is said to occur in small numbers. The reproduction of the forest is in general slow and rather poor, and its recovery from injury by fire and cutting is a matter of very considerable periods of time.

FIRE.

Fires have extended over the larger part of the reserve, and, as a result of their action, many square miles of it are now covered with brush. When the latter takes fire it is exceedingly difficult to deal with, because the brush itself is hard to penetrate and means of communication are few. I am unable to offer any estimate of the damage done to standing timber, but there can be little question that the percentage of unsound trees is very greatly raised wherever fires prevail.

WATER.

The chief importance of this reserve is for protection of streams, which furnish the water for irrigation in the very productive ranches which lie below the reserve. The latter is, in fact, surrounded on all sides by lands which need only water to be extremely fertile. Near Hemet, on the western side, one irrigation company has already built a very large dam, and expects to furnish 5,000 inches of water. The protection of the upper slopes above the stream used by this company is essential to the prosperity of the ranchers whom it serves, and the same general statement applies to many other streams. I did not learn that floods have reached any considerable importance, but it is probable that further investigation would show the contrary.

MINING.

Mining has had little or no development in this reserve until now, nor am I informed of any considerable promise for the future.

AGRICULTURE.

With the exception of occasional openings, such as Strawberry Valley, agriculture within the reserve is of little or no importance. Outside of its limits a very large area of agricultural land depends upon the water supply which it furnishes. Fencing and fuel for the ranchers living on this land are also derived from the reserve, which would be immensely more valuable in this direction if its forest had been protected from fires.

GRAZING.

Grazing has been practiced to some extent within the reserve, but further investigation is needed before definite statements can be made.

FOREST FORCE.

The forest force required to care for this reserve under the present scheme consists of the forest ranger at San Bernardino, and 1 guard at Hemet, together with 4 fire watchers. The interest of surrounding ranchers in the protection of these forests will furnish very material aid in the prevention of fires, which must for some time to come be the chief function of a forest service here.

FOREST MANAGEMENT.

Supplies of timber for settlers on all sides of the reserve will eventually be drawn from it. A simple system of licenses should be devised and enforced as soon as practicable, in order to enable ranchers and others legally to obtain indispensable timber and fuel from the forest,

although its chief importance will probably consist in the protection of the water supply. Further study must precede any definite recommendations for the management of the forest on this reserve.

BOUNDARIES.

I am not prepared to recommend changes in boundaries. It is altogether probable that a complete examination of the reserve will indicate the necessity for such changes, although not of any considerable extent.

SIERRA FOREST RESERVE.

SUMMARY.

Situation: Central California.	Acres.
Area within present lines	4,096,000
Adverse holdings, railroad lands	195,000
	er cent of total area.
Area of forest land	(?) 85
Area marked by fire	(?) 50
Area badly burned	(?) 20

Revised lines can not be drawn without further study.

Force recommended: For the present the jurisdiction of the superintendent of national parks in the Sierras should be extended over the whole reserve.

Sources of information: Statements of John Muir and his writings. Personal examination, September 5 to 18, 1896.

A steep and rugged mountain region, densely forested at moderate elevations with one of the richest and most beautiful forest floras of the earth.

Fire has done and is still doing serious injury.

The prosperity of the valley of California to the west depends very largely on irrigation from the streams which rise in this reserve.

Mining has little present importance.

Agriculture practically does not exist within the reserve.

Sheep grazing has been extensively practiced, to the serious injury of the forest. It should be prohibited altogether.

The commercial development of this reserve is not imperative at present.

The Sierra Forest Reserve lies on the long and gradual western slope of the Sierra Nevada in California, and extends across the range down its exceedingly abrupt eastern side. With a total area of 4,096,000 acres it contains 195,200 acres of railroad lands. Topographically the area consists of steep, rugged canyons, separated by more or less gently sloping plateaus, with here and there mountain peaks and ridges of exceptional steepness and grandeur. The rock is granite and the soil produced by its disintegration is generally dry and poor. The climate of the western slope is moist enough to support what is perhaps the most beautiful coniferous forest in the world, although others are denser and richer in timber. To the east of the range the air rapidly loses its moisture, precipitation falls off, and rain finally ceases almost altogether along the desert areas on both sides of the Nevada line.

Lying, as it does, within easy reach of the fertile and populous valley of California, the Sierra forest is of great economic importance. Extensive lumber operations have started in various parts of it, and the time is probably near when the commercial demand for the timber of the reserve will require and permit its economic development.

THE FORESTS.

The forests of the Sierras grow almost without exception on glacial moraines. They are open as compared with those of the Coast Range of Washington and Oregon, but the trees which compose them are

striking in size, beauty, and value. Four principal forest types may be distinguished.

Lowest of all is the forest of gray pine, which is distributed in altitude from 500 to 4,000 feet above the sea. Very little of the reserve is occupied by forests of this type. Higher up is the main pine belt, characterized by the sugar and yellow pines, growing with the red fir, incense cedar, and sequoia, and mingled with considerable quantities of the amabilis fir, which descends out of the higher zone it distinguishes to mingle with the lower forests. Next above is a forest type, characterized by the white and amabilis firs, which are found up to an altitude of 9,000 feet, and still higher is the subalpine forest, occupied by four pines of little economic value and other mountain forms.

The gray pine is found within altitudinal limits of 500 to 4,000 feet. It reaches an average size of 40 feet in height and 2 feet in diameter, with a length of clear trunk of 15 feet. Its peculiar method of branching gives it to some extent the shape of a deciduous tree, while its small size and the coarse and knotty character of its wood prevent it from reaching economic value.

The knob-cone pine is chiefly interesting from its curious ability to protect its progeny against fire. Its cones persist upon the trees and remain closed for years, until the heat of a forest fire opens them and allows the seeds to scatter. A young growth thus springs up after the parent trees have perished, and the perpetuation of the species is assured in the face of difficulties under which almost any other tree would succumb. This pine grows at elevations from 1,500 to 2,000 feet, and reaches an average size which may be roughly stated as follows: Height, 30 feet; diameter, 1 foot; length of clear trunk, 10 feet.

The sugar pine is not only the most beautiful tree of its genus on the globe, but perhaps the most valuable economically as well. It flourishes between altitudes of 3,000 and 7,000 feet, and reaches average dimensions, under favorable circumstances, of 20 feet in height, 6 feet in diameter, and 100 feet in length of clear trunk. Where transportation is available it is extensively used for lumber, which fetches an extremely high price. Elsewhere, large numbers of trees are felled for the manufacture of shakes (rough, hand-made shingles), which bring prices sufficient to lead to the destruction of great numbers of superb trees. The shake industry is wasteful in the extreme, since but a small per cent of each tree felled is used, and very often, when a fallen giant is found to split indifferently, the per cent of waste reaches 100. The reproduction of the sugar pine is abundantly sufficient to secure the perpetuation and increase of the species under skillful treatment.

The western yellow pine, distributed in altitude from 2,000 to 10,000 feet, is by some botanists separated into two species. Its average dimensions at moderate elevations are as follows: Height, 175 feet; diameter, 5 feet; length of clear trunk, 50 feet. The yellow pine is a lumber tree of the first economic value in other portions of the United States, but is here less considered because of the great supplies of still better material which are at hand. Young growth is common at moderate altitudes.

The Douglas fir (Douglas spruce, red fir) occurs chiefly in the lower portion of the yellow-pine belt. It reaches here an average height of 175 feet, an average diameter of 5 feet, and an average length of clear trunk of 50 feet. It may be remarked that many of the trees of this and other species in the Sierras, standing, as they do, more or less free from crowding, have a less height of clear trunk than the same species in other localities.

The incense cedar is most common in the lower portions of the sugar-pine belt, where it is oftenest found on rather moist soil. This tree reaches an average height of 125 feet, an average diameter of 6 feet, and an average length of clear trunk of 15 feet. Its wood has qualities which would render it exceedingly valuable as a lumber tree were it not for the attacks of a species of fungus, which perforates the heart wood in perpendicular channels, and so ruins the timber value of a considerable proportion of the whole stand. The libocedrus has good power of reproduction.

The Sequoia, the largest and most majestic tree on the earth, occupies in the Sierras a belt some 260 miles in length along the axis of the range, the major part of which lies within the forest reserve. This superb tree reaches in old specimens the following average dimensions: Height, 275 feet; diameter, 20 feet; length of clear trunk, 125 feet. Except where it is being destroyed by lumbermen, as in the valley of Kings River, the numbers of this tree show no tendency to decrease. It appears to have no enemies but wind and fire. Its reproduction is everywhere fairly good, becoming excellent toward the south. It seems equally adapted to wet and dry localities, stands drought well, and gives unmistakable evidence that it is gradually extending the limits of its habitat.

The white fir and the noble fir occur at elevations of from 5,000 to 9,000 feet. Of marked promise commercially, these two trees have hitherto been less used than will be the case hereafter. Young growth of the white fir is especially abundant. This tree reaches average dimensions as follows: Height, 175 feet; diameter, 4 feet; length of clear trunk, 50 feet. The noble fir is somewhat larger, with these dimensions: Height, 200 feet; diameter, 5 feet; length of clear trunk, 75 feet.

The lodge-pole pine (tamarack), a tree of comparatively little economic importance, is found between elevations of 7,000 and 9,000 feet. Its thin and resinous bark makes it an easy victim to forest fires, which often flame through the tops, killing the tree, but usually consuming only the leaves, or at times some of the smallest twigs also. It grows chiefly in pure forests, and reaches average dimensions as follows: Height 60 feet; diameter, 1.5 feet; length of clear trunk, 10 feet.

The mountain white pine reaches its best development at altitudes of 10,000 feet. It is distinctively an alpine tree, and resists admirably the winds and severe climate of great altitudes. Its average dimensions are as follows: Height, 80 feet; diameter, 5 feet; length of clear trunk, 40 feet.

The black hemlock has small economic value, but is conspicuous for grace and beauty. It is found chiefly in groves without admixture of other species, and reaches average dimensions as follows: Height, 70 feet; diameter, 3 feet; length of clear trunk, 20 feet. The white-bark pine and the limber and foxtail pines are other alpine species of small size and of no economic importance.

To the east of the range the principal tree is the single leaf piñon nut, or piñon pine, which often covers tens of thousands of acres in continuous belts between altitudes of 2,000 and 8,000 feet. It is a small tree, with an average height of 15 feet, and its edible nuts furnish one of the principal sources of food supply for the Indians on both slopes of the range.

FIRE.

The forests of the Sierras are less open to destruction by fire than they would be if the trees stood nearer together and the vegetation were more dense. The scars of ancient conflagrations are found nearly

throughout the reserve, but the old trees usually survive in spite of them. Nevertheless the damage done to the growth of timber and the reproduction of the forests is very marked, and, in addition to the surface fires, cases are not rare where the forest has been wholly destroyed by fiercer conflagrations. The surface soil in this range is granular or powdery, and excessively dry when deprived of its covering of humus, and the damage which the fires do has reference in the majority of cases to their effect upon the soil.

Fires are dangerous throughout the dry season, and their prevention is a matter of considerable difficulty. That it is possible to check them, however, is abundantly demonstrated by the results of the protection afforded in the Yosemite, General Grant, and Sequoia National Park by troops of the Regular Army.

WATER.

The agricultural prosperity of the San Joaquin Valley depends almost entirely upon the streams which have their rise in the Sierras. The interests at stake are exceedingly large, and they have influenced public opinion in California to a marked degree. The intimate relation between the forests and irrigation led the California delegation in Congress to object to the suspension of the reserves established by President Cleveland in their State, and as a consequence the California reserves are intact. Floods have already begun to demand attention in various parts of the State, and the protection of the Sierra forest is urgently required both to maintain and to control the water supply.

MINING.

Mining retains but little development in the Sierras now that the placers of the foothills have been exhausted, and no difficulty in the management of the forests is anticipated on this score.

AGRICULTURE.

Agriculture does not and can not exist within the reserve except over very limited areas within a few of the canyons, the total of which is so small as to require very little special consideration.

GRAZING.

Grazing has taken on its chief importance through the extensive pasturage of sheep over the whole area of the Sierras, except where it has been controlled and prevented by United States troops. The result of sheep pasturage upon the dry, loose soil of these mountains is most serious. Forest reproduction is difficult at the best in the higher portions of the mountains, and sheep render it wholly impossible wherever they pass. The loosening, and even transportation, of the upper soil by their feet goes on to an extent difficult to conceive of until it has been seen. I have found a wagon road rendered almost impassable by the stones pushed into it from the hill-side above by the passage of a band of sheep. During a trip across the Sierras on foot it became exceedingly difficult to follow the trail wherever these animals had passed. The harm sheep do in the Sierras is far greater than that known to me in any other region in the United States, and it is imperative that they should be

excluded from all portions of the reserve. This measure not only is demanded by the facts but will be heartily supported by the Californians themselves, who realize the danger to their prosperity which sheep-grazing in the Sierras entails, and would be glad to have it cease.

FOREST FORCE.

For the present, the best protection which could be given to the Sierra Reserve would be obtained by extending the jurisdiction of the military superintendents of the Yosemite and other national parks to the other forest lands of the Government. This course is strongly recommended. If it is not practicable to follow it, the appointment of 1 forest ranger, to be stationed at Visalia; 5 guards, one each in the watersheds of the Stanislaus, San Joaquin, South Fork of Kings, South Fork of Kern, and Kern Rivers; and 50 fire watchers at local points would place the personnel of this reserve on the footing already recommended for others.

FOREST MANAGEMENT.

The transportation of forest products from the Sierra forests has hitherto proceeded chiefly by railroads and flumes. The great size of the timber prevents it from being driven down the streams, even were this method compatible with the safety and prosperity of the irrigated lands below. The enormous quantity of valuable timber present in this reserve is, for the most part, not needed for immediate consumption. Great lumbering enterprises in the big trees of the Sierras and the redwoods of the Coast Range (the lumber from both of which is known as redwood), together with other minor lumber operations, have sufficed to supply the demand. The measures of most urgency here will consist in protection against fire, the construction of trails, and the satisfaction of local demands for small amounts of timber.

BOUNDARIES.

All the information I have indicates that any revision of boundaries should increase rather than decrease the area of this reserve. Further study will be necessary before such lines can satisfactorily be drawn.

STANISLAUS FOREST RESERVE.

North of the Stanislaus Forest Reserve are considerable tracts of country which at one time bore extensive forests. The neighborhood of Lake Tahoe has been cleared and its timber used in the Comstock group of mines, but it remains a forest region capable of bearing forests again. Such regions are as eligible for forest reserves as though they were covered with trees, because only under Government care can they ever regain the value and usefulness which they have lost. Other adjacent areas in the northern Sierras should also be examined with a view to their inclusion in the Stanislaus Reserve. It is recommended that a study of this region be pushed forward, with this object in view, during the coming summer.

TETON FOREST RESERVE.

SUMMARY.

Situation: Northwestern Wyoming.

	Acres.	
Area within present lines	829,440	
Adverse holdings not important.		
		Per cent of total area.
Area of forest land		65
Area marked by fire		(?) 60
Area badly burned		(?) 40

Revised lines can not be drawn without further study.

Force recommended: This reserve should be provisionally placed in charge of the superintendent of Yellowstone National Park.

Sources of information: Report of T. S. Brandegee, special field assistant, United States Geological Survey. Statements of Henry Gannett, geographer, United States Geological Survey. No personal examination.

A rugged, broken mountain region, sparsely covered with open forest chiefly of lodge-pole pine, through which runs a broad valley of grazing land.

Injury from forest fires has been and continues to be very serious.

The protection of streams for irrigation is not of great importance here.

Mining has but little importance.

Agriculture is practiced little or not at all.

Grazing may probably be permitted in Jackson Hole.

Provision should be made to supply settlements in Jackson and Pierre holes with necessary lumber.

The Teton Forest Reserve is situated in northwestern Wyoming, contiguous to the Idaho boundary line, and has a length from east to west of 54 miles and a breadth from north to south of 24 miles. The total area included within its boundaries is 829,440 acres, nearly the whole of which is unburdened by adverse rights.

The striking feature of the topography is the Teton Range, which traverses the reserve from north to south and reaches an altitude of 13,370 feet. On the west the country descends rapidly to the valley of Pierre River and on the east to Jackson Hole. The latter is a level valley from 5 to 10 miles in width, crossing nearly the whole breadth of the reserve from north to south. It contains many lakes, the largest of which, Jackson Lake, is 10 miles long by 3 miles wide. The whole area of the reserve is drained by Snake River, which flows through Jackson Lake and Jackson Hole from north to south.

The climate is exceedingly severe, so much so that agriculture, except for the cultivation of forage plants, is said to be impossible. The rainfall, although no measurements have been made, is probably considerable, as would be indicated by the elevation, the mountainous character of the reserve, and the condition of the forest.

THE FOREST.

The general character of the forest is broken and open. The trees are small, and the merchantable timber of the whole area trifling in amount compared with other reserves on the western slope of the continental divide. Four-fifths of the forest is composed of lodge-pole pine, with Engelmann spruce, Douglas fir (red fir), quaking aspen, and two cottonwoods as the other principal trees.

The lodge-pole pine is here a small tree, with average measurements as follows: Height, 60 feet; diameter, 1 foot; length of clear trunk, 25 feet. It is distributed from the lower portions of the reserve to an altitude of 9,000 feet, and furnishes fencing and rough building materials.

The larger trees alone produce saw timber. The future economic value of the reserve must depend chiefly upon this tree.

The Engelmann spruce occurs in moist situations from 7,000 to 10,000 feet in altitude, chiefly near the streams. It is abundant in places, and furnishes the larger proportion of logs cut in the reserve. Its average measurements are as follows: Height, 100 feet; diameter 2 feet; length of clear trunk, none.

The Douglas fir (red fir) is not a common tree, nor anywhere locally abundant. It occupies for the most part dry situations, and resists fire exceedingly well. The average dimensions of mature trees are as follows: Height, 80 feet; diameter, 2 feet; length of clear trunk, 15 feet.

The quaking aspen and two cottonwoods are abundant, but for the present not economically important. The quaking aspen is next in abundance to the lodge-pole pine, and has approximately the same distribution, while the cottonwoods occur chiefly along streams. The latter occasionally reach a diameter of 4 feet, with a height of 75 feet.

FIRE.

The whole area of the reserve is said to have been repeatedly burned over, with great damage to the forest. The inflammable character of its principal tree, the lodge-pole pine, here gives the fire question striking importance, as it does wherever this tree forms a considerable element of the forest growth.

WATER.

Since the reserve contains only grazing and forest lands, irrigation, which has hitherto assumed no importance, is not expected to develop to any marked extent in the future.

MINING.

There has been no mining development of consequence within the reserve.

AGRICULTURE.

As has been indicated, agriculture is without importance in this reserve, and no measures need be taken with a view to its extension in the near future.

GRAZING.

Many thousand acres of grazing land are included in Jackson Hole, and some provision will be required to regulate pasturage, unless it is decided to exclude this area from the reserve. Since I am not personally acquainted with this reserve I am not prepared to make a specific recommendation upon the subject.

FOREST FORCE.

I am not prepared to make specific recommendations. The extent and situation of the reserve appear to indicate that it should be provisionally assimilated to the Yellowstone Park Forest Reserve. In that case special regulations will be required to open the reserve itself and all its resources to conservative use.

FOREST MANAGEMENT.

The present source of demand for the timber of the reserve are the settlements in Jackson and Pierre Holes. The poor quality of the timber makes it certain that no large trade in forest produce can be

developed within the reserve for some time to come, but eventually water transportation by way of the Snake River and its larger tributaries will make this forest economically important for the less thoroughly timbered regions down the river.

WASHINGTON FOREST RESERVE.

SUMMARY.

Situation: Northern Washington.

	Acres.
Area within present lines	3,594,240
Adverse holdings, railroad lands	48,240
	Per cent of total area.
Area of forest land	(?) 90
Area marked by fire	(?) 40
Area badly burned	(?) 15

Revised lines can not be drawn until complete reports are available.

Force recommended: One ranger, 4 guards, 30 fire watchers.

Sources of information: Personal examination, July 26 to August 10, and August 16-18, 1897.

An excessively rugged and broken mountain region covered with a comparatively open growth east of the main divide, and with a rich, dense, and exceedingly productive forest of tall trees on the western slope.

Irrigation to the east and the prevention of floods on the west demand the protection of these forests.

Mining locations are frequent, but only one mine of the first rank is in operation.

Agriculture is not important within the reserve.

Grazing may reach some small development on the eastern slope.

Provisions are immediately required by which mining timber may legally be cut, and the construction of trails is of pressing importance.

The Washington Forest Reserve is situated in northern Washington, and has a total area within its boundaries of 3,594,240 acres, of which 48,240 acres are railroad land. It occupies both slopes of the broken and rugged Cascade Range and extends down into the flatter country on the east and west. The rock is chiefly granitic in character and the soil thin and poor. The remarkable forest growth on the western slope is due to the exceedingly heavy precipitation of moisture which the prevailing westerly winds bring from the Pacific. On the eastern slope the climate is much drier, the trees smaller, and the ravages of fire conspicuously greater.

The trade relations of this reserve have hitherto been limited to the commerce which has followed one or two large mines and the small amount of timber which has been cut on the Skagit and some of its tributaries.

EASTERN SLOPE.

The forest on the eastern slope of the Cascades changes from scanty and open groups of yellow pine in the lower regions to the east, through dense forests of Engelmann spruce and Douglas fir (red fir) to the scanty subalpine forest flora of hemlock and white-bark pine near the timber line. It differs so conspicuously from the richer and moister forest of the western slope that it will be better to consider separately the eastern and western aspects of the Cascade Range.

FIRE, EASTERN SLOPE.

Very considerable areas of the eastern slope have been totally denuded by fire of the valuable kinds of trees. Repeated burning of the forest is followed by dense and vigorous thickets of alder, willow, and dwarf

maple, which occupy the ground and prevent the re establishment of the larger trees. Fires destroy the vegetable mold, rich and heavy in the upper portion of this slope, and with it the fertility of the ground disappears. It is restored only after years by the fall of leaves and other waste from the small vegetation which almost everywhere follows fire, and then, when the richness of the soil has been in a measure reestablished, the slow process of the return of the commercial species can begin.

Fires are dangerous throughout the summer season. In the lower, drier parts of this slope the danger continues longer, but is less severe; while higher up the complete destruction of the forest by fire can happen only during the periods of exceptional dryness.

The prevention of fire here demands, first of all, means of communication. Travel through the dense growth of shrubs on burnt-over lands is slow, or sometimes even impossible, while the steep slopes and the ruggedness of the ridges make good trails the first necessity for any measure of forest protection.

WATER, EASTERN SLOPE.

Irrigation is practiced in the valley of the Methow River, where the land is suitable for it, to some extent. It depends almost entirely for its water supply on streams which rise within the reserve. Floods have not yet become dangerous on the eastern slope, but the configuration of the ground makes it probable that they will do so hereafter if the destruction of the forest is allowed to continue. The influence of these streams in the floods of the Columbia is not, however, to be disregarded.

MINING, EASTERN SLOPE.

Practically the whole area included within the reserve is mineral bearing, although the discoveries hitherto have not, with one or two exceptions, been of much importance. Prospects are very numerous, and faith in the future value of the region for mining is enthusiastic and widespread among the people of the State. Timber for mining will be plentiful on the western slope for many years to come; but to the east the destruction of the higher timber lands by fire will make the development of many leads difficult, or even impossible. Here, as elsewhere, mining requires timber, and furnishes an imperative reason for the protection of the forest.

AGRICULTURE, EASTERN SLOPE.

Except for the valley of the Methow and the few strips of land already settled upon along the shores of Lake Chelan, the value of the eastern slope for agriculture is very small. Considerable areas of open yellow pine forest have grass under the trees along the eastern edge of the reserve and may eventually be used for pasture, but since sufficient hay must be cut to support the stock during five months of the year, the cattle industry is not likely to become widely developed in this region for the present. The general measures heretofore recommended will be entirely sufficient to make the agricultural resources of the eastern slope available for use.

GRAZING, EASTERN SLOPE.

In addition to the considerable areas of grass land, more or less sparsely covered with trees, which exist in the watershed of the Methow River within the boundaries of the reserve there is, in the

neighborhood of Lake Chelan, some pasturage land which is now used for the grazing of sheep. It is not believed, however, that any but nomadic cattle raising can be extensively developed. The revision of the eastern boundary should exclude considerable areas of the grass land in the Methow Valley, just mentioned, but provisions will still be required to enable residents to run their cattle in the forests under suitable restrictions. The information available at present indicates that the grazing of sheep in this reserve should not be permitted.

WESTERN SLOPE.

The western slope of the Washington Forest Reserve differs conspicuously from the eastern slope in its forests, climate, and commercial possibilities. It is an area of high mountains, excessively rugged in its western portion, and with steep slopes throughout. It is well watered, and includes the upper drainage basin of streams which flow through rich agricultural regions farther west. Hitherto its timber has been little used except for mining, and, to some extent, for shingles and lumber, but on the whole the development of the forests has not yet begun.

THE FOREST, WESTERN SLOPE.

The heavy rainfall which the westerly winds bring and deposit upon the western slopes of the Cascade Mountains is the chief cause of the wonderful luxuriance of forest growth in this part of the reserve. Its forests are dense, tall, moist, difficult to penetrate, and exceedingly rich in valuable trees. Beginning near the crest of the range with the black hemlock, species after species of useful kinds is added as the land descends, until in the lower portions forests of Douglas fir (red fir), cedar, and western hemlock grow to an average height of not far from 200 feet. Rapid in growth, these forests are also rapid in reproduction. They form a part of the great woodland of the northern Pacific slope, which is the richest coniferous forest of the earth.

Black hemlock is little used for timber. It occurs only in the higher parts of the reserve, and usually without associates. Its reproduction is fairly good, both in the open and under cover of old trees. The average dimensions of mature trees may be given as follows: Height, 50 feet; diameter, 2 feet; length of clear trunk, 15 feet.

The lowland fir (white fir), so called because it is widely distributed in the lower regions to the west, occurs at lower elevations than the preceding species. It reaches average dimensions as follows: Height, 125 feet; diameter, 3 feet; length of clear trunk, 50 feet. Occasionally it occurs in dense groups, almost pure.

The western hemlock is a large tree thriving while under dense shade in youth, and with excellent reproduction in the forests. In the open its reproduction is less vigorous, but still satisfactory. The average dimensions of mature trees may be given roughly as follows: Height, 125 feet; diameter, 3 feet; length of clear trunk, 40 feet.

The western cedar or Pacific arbor vitæ is a large tree of the first economic value. Its average dimensions at moderate altitudes are: Height, 150 feet; diameter, 6 feet; length of clear trunk, 25 feet. Its reproduction under cover is good. Young trees are less common in the open. This tree is extensively used for shingles and for the finer kinds of lumber. It is one of the most highly useful constituents of the Pacific coast forests. Cedar shingles have begun to invade the markets of the East.

The Douglas fir (red fir) derives its sylvicultural value largely from the readiness with which it reproduces itself in the open. Two large burns were observed on this slope, both of which had been followed by a vigorous young growth of this tree. Its average dimensions are as follows: Height, 200 feet; diameter, 5 feet; length of clear trunk, 100 feet. It is perhaps the most valuable timber tree of the Western United States. It is very largely manufactured on Puget Sound and in Oregon, and a large foreign trade has been established.

FIRE, WESTERN SLOPE.

Fire is less dangerous west than east of the summit. That part of the western slope visited by me has suffered comparatively little, but, with the increase of settlement and development, danger from this source threatens rapidly to increase. Fires are peculiarly difficult to handle here on account of the heavy layer of vegetable débris which covers the ground, and in which fires may smoulder for weeks at a time. It is probable that instances are frequent in which such fires survive even comparatively heavy rains. The chief obstacle to fighting fires on both slopes is the absence of proper trails, and the first measure to be taken for their extinction consists in establishing a network of such trails throughout the whole reserve.

WATER, WESTERN SLOPE.

Water for irrigation is but little needed on this side of the range. On the other hand, floods are exceedingly dangerous. The agricultural settlements on the Skagit have suffered seriously from this cause, and it is certain that with the progressive denudation of the head waters of streams flowing west the damage from this source will increase. The protection of these mountain slopes is imperative.

MINING, WESTERN SLOPE.

Mining locations have been made in great numbers almost throughout the western slope, but hitherto the development of valuable mines has been almost wholly wanting. The most prominent instance of such development is the Monte Cristo mine; and it is by no means impossible that others of similar value may be discovered and worked hereafter. No portion of the reserve need be excluded because of mines, since the rights of miners in any event are fully protected. Provision should be made to supply them with mining timber under suitable restrictions.

AGRICULTURE, WESTERN SLOPE.

There is practically no agricultural land here, nor need this phase of the reserve question receive attention at present.

GRAZING, WESTERN SLOPE.

Grazing has little or no importance on the western slope.

FOREST FORCE.

It has already been recommended in Part II, page 46, that a forest ranger be stationed at Hamilton, with guards under his direction at Marblemount, Monte Cristo, Index, and Stehekin, and that 25 fire watchers be distributed at various points. This force, while altogether

inadequate to keep pace with the development which the reserve must attain in the near future, will suffice to cope with some of the more pressing dangers which threaten it. A liberal appropriation for trails should be placed at the disposal of the ranger, one of whose first duties should be to lay out a system of communications throughout his charge. So small a force as is here recommended makes it imperative that the right of the forest officers to call upon settlers and others to assist them in extinguishing forest fires should be so clearly established as to admit of no-evasion.

FOREST MANAGEMENT.

Water transportation by the Skagit and Stillaguamish on the west and the Methow on the east, to mention only a few of the principal streams, may be made available for the forest products of the reserve. For the present, however, no steps need be taken toward the commercial development of the forests of the reserve, except as they are related to mining and settlement. The enormous bodies of merchantable timber in the State outside of the reserve will suffice for commercial needs for some years to come. Provisions are required to supply settlers and others with small amounts of timber, and to regulate the cutting of mining timber in considerable quantities in the regions where it is needed.

East of the summit, protection against fire, the construction of trails, and a careful study and mapping of the forest growth should precede any attempt at a commercial disposal of the timber. The forests on the eastern slope have suffered so severely that their recuperation is of the first importance.


West of the main range the sale of timber supplies should be permitted as soon as the demand arises. It is probable that the first development of the reserve in this direction will be through the sale of cedar for shinglebolts. It is recommended that as soon as possible a careful study of the conditions which govern the reproduction of this tree be undertaken so as to guard, when cutting is begun, against any diminution of its numbers in the forest hereafter.

BOUNDARIES.

It would be possible at this time to recommend the exclusion of some land in the Methow Valley and the inclusion of other areas which should be added to the reserve. In the absence of suitable maps, however, it is thought to be wiser to allow the boundaries to remain as they are for the present. The progress of public sentiment in favor of the reserves will hereafter make suitable corrections of their boundaries more acceptable than they could be at this moment.

WHITE RIVER PLATEAU TIMBER LAND RESERVE.

SUMMARY.

Situation: Northwestern Colorado. 

	Acres.	
Area within present lines.....	1, 198, 080	
Adverse holdings not important.		
		Per cent of total area.
Area of forest land		(?) 75
Area marked by fire		(?) 75
Area badly burned		(?) 50

Revised lines can not be drawn without further study and a map.

Force recommended: One ranger, 4 guards, and about 20 fire watchers, after other more pressing reserves have been taken in hand.

Sources of information: Personal examination, October 6-9, 1896.

A high plateau region, cut by deep canyons, partly covered with forest, chiefly of Engelmann spruce.

Fire has cleared a considerable proportion of the forest, and keeps it clear. Irrigation below the reserve demands the protection of its streams.

Mining is not of great importance.

Agriculture does not exist within the reserve.

Grazing may be extensively developed with safety to the forest under suitable restrictions.

Timber supplies from the reserve are urgently needed at but few points.

The White River Plateau Timber Land Reserve is situated in north-western Colorado, and covers an area of 1,198,080 acres. It lies in an elevated region locally known as the Flat Tops, and embraces parts of the watersheds of the White and Yampa rivers, both of which flow into the Green, and of the Grand, which unites with the latter to form the Colorado. The high plateau which constitutes the larger part of this reserve is overtopped by a number of high mountains, of which Pagoda and Pyramid peaks are among the best known. It is a region of canyons intersecting more level stretches. Its climate is too harsh for agriculture, and its trade relations have been of small importance hitherto. A small amount of timber has been cut within the limits of the reserve.

THE FOREST.

The original forest with which this reserve was clothed appears to have consisted chiefly of Engelmann's spruce, although the prevalence of fires through many years has made it difficult to retrace the forest history of the plateau. Considerable areas are here and there covered with lodge-pole pine, while the yellow pine and the blue spruce are common in places along the streams. Frequent parks interrupt the forest. It appears unmistakably, on examination, that the trees which surround these parks are gradually encroaching upon them. These trees are necessarily of hardy species, adapted to maintain themselves against the dryness and severity of the conditions which they must face. As a rule, these trees are small. I am unable to give specific dimensions, but the following figures will convey my impression. The average size of Engelmann spruce is: Height, 80 feet; diameter, 1 foot; length of clear trunk, none. The blue spruce is at times larger, since it chiefly occupies moister and more favorable situations. The dimensions of the lodge-pole pine are: Height, 50 feet; diameter, 8 inches; length of clear trunk, 15 feet. For the yellow pine: Height, 60 feet; diameter, 14 inches; length of clear trunk, 25 feet. It should be added that in places Engelmann spruce grows in dense forests, averaging over 100 feet in height, with not less than 40 feet of clear trunk, but such groups are rare.

FIRE.

The parks which form so characteristic a feature of this region undoubtedly had their origin in the fires which have swept across them for many years. Occasionally fragments of old trees in the parks, as well as the fact that groups on the edge of open land are almost always surrounded by young growth, indicate plainly that the forest was once more extensive than at present. My opinion, subject to correction by the results of longer experience, is that with even moderate protection

a much denser growth of timber will occupy the Flat-tops, and that its presence will have a most decided influence on the flow of the streams, the water of which, lower down, is extensively used for irrigation.

WATER.

Irrigation is practiced on at least two sides of the reserve, and indications are plain that the presence of a dense forest on this area would be exceedingly valuable in this direction. I saw no evidence of severe floods, nor am I informed that such floods are common.

MINING.

Silver mining has been prosecuted to some extent at Carbonate and elsewhere, but I do not understand that, in general, mining has assumed importance in any region of this reserve.

AGRICULTURE.

As already mentioned, the climate is too severe and the supplies of water too scanty to permit agriculture on the Flat-tops. Some few ranches exist on the bottom lands of the river valleys. Provision should be made to permit any unentered land of this character to be taken up.

GRAZING.

The most important economic use possible for the reserve at present is for pasturage. Great quantities of grass exist throughout the Flat-tops, and eventually this area will be used for raising cattle. Since, however, the spread of the forest depends on the protection of the scanty young growth, it would be decidedly unwise to open the whole area of the reserve to pasturage except under suitable regulations suitably enforced.

FOREST FORCE.

Until abundant appropriations become available, a forest ranger located at Newcastle or at Glenwood Springs would be able to administer both this reserve and the Battlement Mesa Forest Reserve south of the Grand River. Four forest guards should be stationed at suitable localities, and a limited number of fire watchers should be employed. I am unable, without further study, to indicate more precisely the location of the guards or the number of the fire watchers that would be required.

FOREST MANAGEMENT.

Some form of localized selection must be used in the spruce timber, while clear cutting in strips or squares will be found to answer all requirements of economy and safety in the lodge-pole pine, and also perhaps in the localities where the spruce forest is dense and high.

Transportation by way of White River and Williams Fork of the Yampa may be made available, while to the southwest roads already exist over which some lumber has been taken from the reserve. It does not appear likely that the resources of this reserve will be in urgent demand to supply neighboring populations except at a few points, such as Meeker, on the western border, where provisions should early be made to supply the necessities of the settlers.

BOUNDARIES.

Without a more careful description of the whole area of the reserve I am unable to make specific recommendations for changes in its boundaries, nor have the necessary topographic sheets been completed by the Geological Survey. It is evident that such changes will be required.

Latin and English names of the principal trees mentioned, arranged in botanical order.

<i>Pinus monticola</i> Dougl.	Mountain white pine.
<i>Pinus lambertiana</i> Dougl.	Sugar pine.
<i>Pinus flexilis</i> James.	Limber pine.
<i>Pinus albicaulis</i> Engelm.	White bark pine.
<i>Pinus monophylla</i> Torr. & Frem.	Single-leaf piñon.
<i>Pinus balfouriana</i> Murr.	Foxtail pine.
<i>Pinus ponderosa</i> Laws.	Western yellow pine.
<i>Pinus murrayana</i> "Oreg. Com."	Lodge-pole pine.
<i>Pinus sabiniana</i> Dougl.	Gray pine.
<i>Pinus coulteri</i> Lamb.	Coulter pine.
<i>Pinus attenuata</i> Lemmon.	Knobcone pine.
<i>Larix occidentalis</i> Nutt.	Western larch.
<i>Picea canadensis</i> (Mill.) B. S. P.	White spruce.
<i>Picea engelmanni</i> Engelm.	Engelmann spruce.
<i>Picea pungens</i> Engelm.	Blue spruce.
<i>Picea sitchensis</i> (Bong.) Trautv. & Mayer.	Sitka spruce.
<i>Tsuga mertensiana</i> (Bong.) Carr.	Western hemlock.
<i>Tsuga pattoniana</i> (Jeff.) Engelm.	Black hemlock.
<i>Pseudotsuga taxifolia</i> (Poir.) Britton.	Douglas fir.
<i>Pseudotsuga macrocarpa</i> (Torr.) Mayr.	Big-cone fir.
<i>Abies lasiocarpa</i> (Hook.) Nutt.	Alpine fir.
<i>Abies grandis</i> Lindl.	Lowland fir.
<i>Abies concolor</i> (Gord.) Parry.	White fir.
<i>Abies amabilis</i> (Lond.) Ford.	Amabilis fir.
<i>Abies nobilis</i> Lindl.	Noble fir.
<i>Abies magnifica</i> Murr.	Red fir.
<i>Sequoia washingtoniana</i> Winsl.	Sequoia.
<i>Libocedrus decurrens</i> Torr.	Incense cedar.
<i>Thuja plicata</i> Don.	Western cedar.
<i>Populus tremuloides</i> Michx.	Quaking aspen.

SHEEP-GRAZING IN THE CASCADE FOREST RESERVE OF OREGON.

By FREDERICK V. COVILLE.

[A report made to the Secretary of Agriculture, and on January 21, 1898, transmitted by him to the Secretary of the Interior.]

INTRODUCTION.

For the past few years a bitter controversy has been waged in Oregon on the question of grazing sheep in the Cascade Range Forest Reserve. Recent legislation by Congress has made it necessary to devise a series of regulations regarding this industry, and in the face of a great deal of diametrically conflicting testimony regarding the effect of sheep-grazing, the Interior Department felt the need of a disinterested investigation of the facts before formulating any detailed set of rules. The aid of the Department of Agriculture was solicited, and the result of our investigation is here presented. A preliminary report was transmitted to the Secretary of the Interior on November 22, 1897.

Hon. Binger Hermann, Commissioner of the General Land Office, furnished me with valuable letters of introduction to several prominent citizens of Oregon who were familiar with the sheep-grazing question.

Mr. John Minto, of Salem, Oreg., gave me a general letter of introduction to the sheepmen of eastern Oregon, which enabled me to secure a large amount of information through channels that ordinarily would have been closed to a Government officer investigating this subject. Among the many others to whose courtesy I am indebted, I must mention particularly Mr. Thomas Cooper and Mr. E. F. Benson, of the western land office of the Northern Pacific Railroad, at Tacoma, Wash., who had recently been conducting an investigation of sheep grazing on the railroad lands.

From Portland and Salem I went by rail and by stage to Klamath Falls, in the southern part of the State, and there procured a pack outfit. The party, consisting of myself, Mr. E. I. Applegate, acting as assistant, and a camp hand, with three saddle horses and five pack horses, entered the southern end of the reserve on July 23. From this time until September 6, when we reached The Dalles on the Columbia River at the northern end of the reserve, we were engaged in a thorough examination of the forests, including not only those portions in which sheep now graze, but other typical portions in which sheep have never grazed. We traversed, besides the well-known parts of the Cascades, some of the most remote and inaccessible portions, traveling largely without trails. We interviewed sheep owners, packers, and herders, cattle owners, and all classes of people, both those who favored and those who were opposed to the permitting of sheep grazing within the reserve. We followed the bands of sheep as they were grazing,

watching their movements, their choice of forage, and the methods of handling them; observed the effects both of recent grazing and of the grazing of former years; made observations upon the devastations caused by fires, saw areas of the forest in every stage, from total immunity from fires to total destruction by them; saw many fires burning, and wherever possible ascertained the cause.

I made four detours from the mountains down into the plains at their eastern base to consult with sheep owners and other well-informed citizens, the longest of these detours being a trip from Sisters to Prineville and thence to Sherar Bridge, August 26 to 30, Mr. Applegate meanwhile prosecuting the investigations in the mountains.

THE SHEEP INDUSTRY OF OREGON.

The first domesticated sheep brought into Oregon came from California in 1843, but from that year until 1860 sheep raising was only a small industry. At about the latter date, however, wool began to assume considerable importance in the region as an agricultural product.

The following table, extracted chiefly from the United States census reports, gives some idea of the growth and importance of the sheep industry in Oregon:

Year.	Pounds of wool produced in Oregon.
1850	29,686
1860	219,012
1870	1,080,638
1880	5,718,524
1890	9,982,910
1895a	12,038,091

a From the Oregon State Census Report for 1895.

The following table, compiled from the reports of the division of statistics, shows the amount of money invested in sheep in the State of Oregon each year since 1870:

Year.	Number of sheep.	Value of sheep.
1870	500,000	\$950,000
1871	419,200	796,480
1872	486,200	1,191,190
1873	584,800	1,476,048
1874	561,500	1,408,750
1875	634,400	1,643,096
1876	710,500	1,413,895
1887	859,700	1,547,460
1878	1,074,600	1,891,296
1879	1,160,600	1,622,142
1880	1,265,100	1,847,046
1881	1,176,433	1,717,592
1882	2,333,162	3,733,059
1883	2,403,157	5,166,788
1884	2,571,378	4,654,194
1885	2,519,950	4,057,120
1886	2,469,551	3,618,139
1887	2,593,029	3,670,173
1888	2,930,123	4,987,069
1889	2,959,424	5,105,894
1890	2,929,830	5,022,344
1891	2,431,759	5,154,114
1892	2,456,077	5,491,789
1893	2,456,077	5,903,182
1894	2,529,759	4,433,403
1895	2,529,759	2,945,905
1896	2,630,949	3,590,983
1897	2,604,640	3,459,222

Following the general progress of agricultural settlement, sheep raising in Oregon was carried on first in the Willamette Valley, in the western portion of the State; later in the Grand Ronde, in northeastern Oregon, and then, crowded out of these fertile places by the more profitable occupations of agriculture proper, the sheep owners moved their flocks to more and more remote parts of the State, especially to the great sage plains in its eastern portion, where the ordinary processes of agriculture are confined to small areas, chiefly irrigated land, and the country is for the most part so dry as to be adapted only for grazing.

The distinction between range sheep and farm sheep must be clearly understood. In a thickly settled agricultural region, in which all or nearly all the land is cut up into farms, or ranches, as they are called in the western United States, it is a common practice to keep on each ranch a small number of sheep, from a few individuals to a few hundred. These are inclosed in fenced pastures, and do not therefore require a herder. Range sheep, on the other hand, are pastured, or grazed, on the great areas of unfenced public or Government land, popularly known as the open range, the outside range, or simply the range. Because this land is not fenced, and because unprotected sheep would be liable to destruction by wild animals, especially coyotes, or prairie wolves, these range sheep are accompanied and cared for by a man who is called a sheep herder, or simply a herder. As a matter of economy each herder is intrusted with as many sheep as he can properly manage, commonly two or three thousand. Such an aggregation of sheep is called a band. The terms flock and shepherd are seldom heard in the range-sheep region of Oregon.

Twenty years ago the sheep that were owned on the treeless plains of eastern Oregon, at points remote from the forested mountains, were pastured in fall, winter, and spring, just as they now are, upon the open range, but during the hot and dry summer months, when on the summits of the plateaus the grass tops were dead, water for the sheep was wanting, and the heat was oppressive, it became imperative that the sheep be kept in the bottoms of the deep, rock-walled canyons which form the drainage channels of the region. Here were found water, fresh grass, and shade, which carried the sheep through the summer in good condition. But as sheep raising, being a profitable industry, became more popular it was found that these canyons, on account of their limited area, could furnish summer range for only a portion of the sheep that could readily find pasturage on the winter range. In order therefore to utilize more of the winter range it was necessary to increase the summer range, and this it was found possible to do by driving the sheep in late spring or early summer to some of the cool, well-watered, grassy, timber-covered mountains that adjoin the plains. By this modification of the yearly routine the possibilities of sheep raising of the plains were enormously increased. For example, that portion of the plains which extends from Antelope to Bakeoven, in Wasco County, which, under the old system, could carry only 6,000 sheep, now carries 25,000 sheep.

SUMMER SHEEP GRAZING IN THE MOUNTAINS.

Outside an unimportant amount of grazing carried on in the vicinity of The Dalles as much as thirty years ago, the mountains first resorted to for summer range were the Blue Mountains, which are situated in the northeastern portion of the State and east of the principal sheep-grazing area of the plains. First, beginning about twenty-five years ago, only the lower slopes of the mountains were used, but little by little

the increasing need of additional summer range forced the sheep farther and farther into the mountains, and, finally, to their very summits.

The summer pasturage afforded by the Cascade Mountains to the west of the plains soon began to attract the attention of sheep owners. First the foothills, then the middle elevations, and finally the higher slopes were occupied, a condition which has existed since about 1886. A similar occupation of Gearhart, Warner, and other mountains in southern Oregon, south of the plains, has taken place within the past few years.

THE CASCADE RANGE FOREST RESERVE.

In the session of the Oregon State legislature for 1888-89, Judge John B. Waldo, of Macleay, a member of the legislature, introduced a joint memorial asking the Congress of the United States to set aside as a forest reserve a certain specified tract in the Cascade Mountains. This memorial passed the Oregon house of representatives, but failed in the senate. The matter subsequently came up in the form of a petition to the President, and by a proclamation under date of September 28, 1893, he finally set aside the proposed lands as a forest reserve, which have since become known as the Cascade Range Forest Reserve. This reserve, which contains 4,492,800 acres, extends in a north and south direction almost across the State, embracing the main ridge of the Cascades and a broad strip on either slope. It is about 235 miles long, with a width varying from 18 to 60 miles.

From the time the Cascade Reserve was created there was a difference of opinion among the people of Oregon regarding the effect of sheep grazing within its limits, one party to the controversy maintaining that the sheep were a serious detriment to the interests for which the reserve was created, the other maintaining that they were not. The first official action taken by the Government was the issuing of regulations, under date of April 14, 1894, governing all the forest reserves, and among other details prohibiting the "driving, feeding, grazing, pasturing, or herding of cattle, sheep, or other live stock" within any of the reservations.

The effect of these regulations in excluding sheep from their customary grazing lands in the Cascades gave rise to vigorous and continued protests from those interested in the sheep industry. These protests finally resulted in a letter under date of February 10, 1896, from the Oregon delegation in Congress to the Department of the Interior, recommending that in lieu of the present reserve three smaller reserves be made, about Mount Hood, Mount Jeffer-on, and Crater Lake, and that the balance of the Cascade Reserve be thrown open. Action favorable to this recommendation, however, was never taken by the Department.

During the summer of 1896, under special instructions from the Attorney-General of the United States, dated January 10 of the same year, several arrests were made of sheep herders, sheep owners, and others grazing sheep on the reserve. Later these cases assumed the form of civil instead of criminal proceedings, and on September 3, 1896, suit was brought in the United States district court of Oregon against several owners to enjoin them from grazing within the reserve. These suits were pending for several months, until in May, 1897, the Attorney-General, in view of probable early legislative action by Congress involving a new scheme of the administration of the reserve, issued instructions that the injunction suits be discontinued. On June 4, 1897, the expected legislation by Congress became a law in the form of a provision in the

sundry civil appropriation act authorizing the Secretary of the Interior to make all necessary regulations for the government of the forest reserves.¹

In a series of regulations governing the forest reserves, issued from the General Land Office under date of June 30, 1897, the following provisions are made:

The pasturing of live stock on the public lands in forest reservations will not be interfered with so long as it appears that injury is not being done to the forest growth and the rights of others are not thereby jeopardized. The pasturing of sheep is, however, prohibited in all forest reservations, except those in the States of Oregon and Washington, for the reason that sheep grazing has been found injurious to the forest cover, and therefore of serious consequence in regions where the rainfall is limited. The exception in favor of the States of Oregon and Washington is made because the continuous moisture and abundant rainfall of the Cascade and Pacific Coast ranges make rapid renewal of herbage and undergrowth possible. Owners of sheep are required to make application to the Commissioner of the General Land Office for permission to pasture, stating the number of sheep and the location on the reserves where it is desired to graze. Permission will be refused or revoked whenever it shall appear that sheep are pastured on parts of the reserve specially liable to injury, or upon and in the vicinity of the Bull Run Reserve, Crater Lake, Mount Hood, Mount Rainier, or other well-known places of public resort or reservoir supply. Permission will also cease upon proof of neglect as to the care of fires made by herders, or of the violation by them of any of the forest-reserve regulations.²

These regulations, however, were issued so late in the season that the provision regarding permits was ineffective for the summer of 1897, as those who pastured on the reserve had already entered it before the regulations had been issued.

FACTS BROUGHT OUT BY THE INVESTIGATION.

CHARACTER OF THE PERSONS ENGAGED IN THE BUSINESS.

All the sheep owners in eastern Oregon appear to be American citizens, at least upon inquiry I could learn of none who are aliens. Some of the owners, as with our farming population in all parts of the country, are of foreign birth, but have become naturalized. In earlier years, too, some of the herders were French or Portuguese. Many of the owners are prominent, influential citizens of the highest character.

A popular impression prevails that the sheep herders of Oregon, like those of some other parts of the United States, represent a low class of humanity. This impression as applied to the majority of sheep herders ten years ago was perhaps correct. At the present time, however, many exceedingly bright and wholesome young men have undertaken sheep herding in default of opportunities for more desirable work, and as a whole they probably average as well in character as the men engaged in other branches of agricultural industry.

COST OF MAINTAINING A BAND OF SHEEP.

Under present conditions a sheep owner with one or two bands can seldom conduct his business profitably if he follows a nomadic life, and in general it is a prerequisite of success that an owner shall have for winter headquarters a permanent and commodious, properly fenced ranch, provided with a house, one or more hay barns, and several substantial corrals. It must have enough arable land to grow the hay nec-

¹ See a review of the subject in a letter from Hon. Binger Hermann, Commissioner of the General Land Office, to the Secretary of the Interior, published in the Portland Oregonian for May 23, 1897.

essary for wintering his sheep. Such a ranch represents a capital of about \$5,000 or \$6,000. The following is a fair estimate of the cost of running, that is, maintaining, a band of 2,000 ewes for a year in a typical place in Sherman County:

Taxes, 21 mills per dollar, on an assessed valuation of \$2 per head	\$84
Herder, 12 months, at \$30 per month	360
Packer, 5 months, at \$30 per month	150
"Grub," that is food provisions, for the herder and packer, at \$10 per month each	170
Rental of winter range, 6 months	100
Shearing, at 5 cents per head	100
Wheat hay sufficient for 40 days, at the rate of 3 tons for 100 sheep, at \$7 per ton	420
Salt, 100 pounds per week, at 50 cents per 100, plus \$1 per 100 for freighting to summer range during 20 weeks	46
Hauling wool to the railroad, at 40 cents per 100 pounds, the estimated clip, that is, the amount of wool sheared, being 8 pounds per sheep	64
Extra help for 1 month during the lambing season, that is, the season when the lambs are born, at the rate of 1 man for 200 ewes, at a salary of \$30 per month	300
Outfit for herder and packer, including horses, pack saddles, tent, and bedding	25
Bucks, that is, rams, at the rate of 2 bucks per 100 ewes, replaced every 2 years, at an average cost of \$10 each	200
Summering bucks, which are run in bands separate from the ewe bands, at \$1 each	40
Total	2,059

The actual expenditure on a band of sheep of course varies with many conditions, such as the distance of the ranch from a railroad, the owner raising his own hay or acting as his own packer, the necessity of renting private range, the size of the band, etc., but in general the estimated cost of running sheep is 75 cents to \$1 per head. Sheep owners are accustomed to estimate that the cost of running a band of sheep will be paid by the sale of the wool, while the increase represent probable profits.

Sometimes sheep are leased, the annual rental varying from 40 cents to \$1 per head, according to the condition of the wool and mutton market, the lessee returning to the owner as many ewes as he received, and taking the increase as part of his profits. Sometimes, particularly when the lessee is a young man getting a start in the business, the rental paid is half the wool and half the increase.

The sheep of eastern Oregon are chiefly of Merino stock, but the increasing profitableness of good mutton sheep has induced many of the owners to introduce Shropshire blood. This movement appears to be successful, particularly with careful management of the bands. An annual increase of 90 to 100 per cent is quite feasible and is really secured by sound methods, where careless methods give an increase of only 50 per cent to 60 per cent.

YEARLY ROUTINE.

The yearly routine of a band up to the time of starting for the mountains in the spring may be given briefly as follows: When the sheep are brought back in the autumn from their summer range during the month of October, the bands are readjusted, the breeding ewes going in one group, the wethers, lambs, and dry ewes in another. For about a month—usually beginning between October 20 and November 1—the bucks are allowed to run with the ewes. They are herded on range land near the owner's ranch, seldom going more than a day's drive from headquarters. At this season the fall rains have started the grass,

and often a luxuriant growth takes place before it is checked by the cold of winter. When the snowstorms begin, commonly toward the middle of December, the sheep are kept within corrals at the ranch and fed upon hay. The snow lies upon the ground for a period varying from six to forty days, according to season and elevation. When the snow has disappeared the same system of ranging is pursued as in the autumn until about the middle of March, when the lambing season begins. The period of gestation is twenty-one weeks. The lambing continues for about a month. After all the lambs are weaned and the males castrated, the shearing of the adults begins and keeps up until it is time to start for the mountains. The shearing is done on the ranch and the wool afterwards hauled to the shipping point. The practice, common in some regions, of driving the sheep to the shipping point and shearing them there is not generally followed in the Oregon plains.

Between May 15 and the end of the first week in June, when the grass of the plains begins to dry up, the bands, again readjusted (ewes and lambs together) and commonly varying in number from 1,800 to 2,700, the average being about 2,200, are driven toward the mountains. The average rate of travel is about 8 miles per day, varying with the heat, the feed, and the watering places. The usual practice is to start a band early, between daylight and sunrise, and let them travel slowly, grazing as they go, until about 9 o'clock. They then lie down, during the warmer part of the day, until 3 or 4 o'clock in the afternoon, when they start again and go on till sundown or a little later. They are watered once a day, if possible. Seldom earlier than the 10th of June and seldom later than the 1st of July they reach their summer range in the timber.

The bucks are kept in summer in inclosed pastures, or sometimes, when an owner has a large enough number to warrant it, or when several owners put their bucks together, they are run in bands, but they are always kept separate from the ewes and lambs.

DUTIES OF HERDERS AND PACKERS.

It is the duty of the packer, who is often also the owner, to find new grazing places as fast as the feed is eaten off by the sheep, to move camp to these spots, and to keep the herder or herders (one man sometimes packing for two bands) and himself supplied with provisions. A saddle horse and two pack horses are commonly used by the packer.

The herder's duty is to keep his band on good feed, keep the sheep in one body, bring back those that have strayed away, look out for the appearance of disease and apply the necessary remedies, and join the packer in the cooking and other camp work. If the sheep are to graze 2 or 3 miles from camp (about the maximum distance) and in the forest, they are often driven away as early as sunrise, but if the grazing is nearer camp, and especially if it is on open meadow land, the sheep seldom start out before the dew is off the grass. They graze a few hours, lie down during the middle of the day, graze again, and finally return to their bedding ground, situated usually near the camp.

The practice of herders in handling their sheep varies widely. Some are constantly with their bands, watching them closely throughout the day, carefully guiding them from one choice piece of feed to another, keeping them rounded up with a dog, and sleeping among them at night. Others leave a band to pick out their own feeding area, to take care of themselves largely, and even to select their own bedding ground, attending only in a general way to their location and seeing that the band

does not divide. Sheep managed in this way are said to be better able to take care of themselves, to be less easily frightened by wild animals, to be less worried by the dogs, to trample the feed less, and to come out in quite as good condition at the end of the season. Each system doubtless has its advantages.

The bedding grounds, on which the sheep "bed down," as it is called, at night, are selected on a piece of dry, level, or gently sloping, smooth ground. At dusk the sheep come in, crowding and bleating and raising a cloud of dust. They gradually arrange themselves, and one by one they lie down, close together, and little by little the bleating grows less till they all are silent and asleep.

At the end of a week, commonly, sometimes two weeks or sometimes only two or three days, the feed within easy range of camp is exhausted and the camp is moved to a new place. This moving of camp continues all summer, some of the bands in suitable situations remaining in one general locality, others making long circuits over a much larger territory. A particular piece of ground is usually grazed over only once, as a second grazing is seldom of any value. If, however, the first grazing is sufficiently early in the season, a fresh growth may follow and furnish an excellent second crop. In general, the progress of camps during the season is from the base of the mountains toward their summits, keeping pace with the growth of the vegetation that follows the melting of the snow.

LOSS OF SHEEP DURING THE SUMMER.

From various accidental causes a few sheep in a band are usually lost during the summer, a loss of 1 per cent being common. Occasionally larger losses occur. The principal causes of death are bears, wolves, falling rocks, poisonous plants, and lightning. Grizzly bears come at night and usually kill several sheep at a visit. The only wolves of the higher mountains are the large timber wolves. They kill few sheep during the summer, but in the autumn, about the time the sheep are leaving the mountains, they begin to run in packs and are more bold. A late band of sheep sometimes suffers severe loss from this source. On steep, rocky mountain slopes a sheep is frequently killed by a rolling rock loosened by some sheep grazing on a higher part of the slope. Sheep are sometimes killed by eating water hemlock (*Cicuta vagans*), larkspur (*Delphinium*), rhododendron (*Rhododendron californicum*), or laurel (*Umbellularia californica*). The first two are herbaceous plants growing at low elevations on the eastern slope of the Cascades, usually below the timber. In the spring of 1897 about 200 sheep died in a band that had been grazed in a great patch of larkspur on one of the western spurs of the Tygh Hills, in Wasco County. The other two plants are, respectively, a shrub and a small tree that grow on the humid western slopes in the forests. Rarely a band of sheep, driven to cover in a storm, is struck by lightning with serious results. In July, 1896, 168 sheep were killed in this way in a thunder storm on Crane Prairie. The sheep had huddled together for shelter from the rain in a little grove of lodge-pole pines, where they were struck by two successive lightning bolts.

Formerly large losses were occasioned by the disease known as sheep scab. A State quarantine and inspection law, however, caused a decided decrease in its prevalence, and, finally, another still more powerful factor—the lowering of the price of wool, resulting in a total lack of profits on scabby sheep—has now made the disease almost unknown.

STATISTICS OF SHEEP GRAZED WITHIN THE RESERVE.

One of the first pieces of information it was desired to secure was a reliable estimate of the number of sheep ranged within the reserve. The estimates secured from different sources varied so greatly, however, that all were necessarily treated as unsatisfactory, and it was resolved to take an actual census on the ground. This was done by repeated inquiry of herders, packers, owners, and residents having a definite knowledge of the various bands. The data thus secured include the name of each owner or lessee, the number of his bands, the number of sheep in each band, the place on which they were grazing when the record was made, and the county in which the sheep were owned. The publication of all the details is unnecessary and undesirable, but a summary of the data gives the following statistics:

The total number of sheep recorded as ranging on the Cascade Reserve is 188,360, contained in 86 bands—an average of 2,190 sheep per band. Classified by size, the bands are as follows:

Size of band.	Number of bands.	Size of band.	Number of bands.	Size of band.	Number of bands.
a 1,000	2	2,000	b 28	2,700	3
1,400	2	2,100	1	2,800	1
1,600	4	2,200	3	2,900	1
1,700	1	2,300	4	3,000	2
1,800	5	2,400	3	3,200	1
1,900	2	2,500	b 22	3,500	1

a This means not less than 950 nor more than 1,049. The same relation holds for the rest of the table.

b The exceptionally large number of bands containing 2,000 and 2,500 is due to the fact that only estimates instead of an actual count of the number of sheep in some of the bands could be made by those from whom the information was secured, and that in making these estimates a person is much more likely to say 2,000 than 1,900 or 2,100, or 2,500 rather than 2,400 or 2,600.

Bands of less than 1,600 are usually owned by young men who are making a start in the business; bands of more than 2,700 by owners who are ranging their sheep in unusually open country or who are injudiciously trying to save the hire of an additional herder. Of the various expenses entailed in running a band of sheep the wages of the herder and packer, the cost of their provisions, and the cost of their outfit are fixed charges, whatever the number of sheep in the band. With a small band the net profits per head are therefore less. With a larger band the net profits per head increase until the band reaches such a size, varying with the herder and the nature of the region, that the number of strayed and lost sheep increases greatly and the others impede each other to such an extent in grazing that they produce neither a large amount nor a good quality of wool. The net profit per head then decreases, and an owner usually prefers to divide the band, purchasing enough additional sheep to make two bands of suitable size.

Classified by counties in which the sheep are owned, the statistics are as follows:

County*	Number of bands.	Number of sheep.
Wasco.....	66	142,770
Crook.....	11	24,660
Sherman.....	9	20,930

Classified by the districts (to be described hereafter) into which the reserve may be divided for range purposes, the statistics are as follows:

Range district.	Number of bands.	Number of sheep.
Mount Hood.....	40	86,400
Three Rivers.....	36	79,330
Upper Deschutes.....	10	22,630

The total number of owners ranging sheep in the Cascades the past season was 60, or, more strictly speaking, there were 50 individual owners, 2 lessees, and 8 pairs of partners. It is possible that a few of those recorded as owners may in reality be lessees.

Of these 60 owners, 41 owned single bands, containing 1,000 to 3,500 sheep; 15 owned two bands each, containing 3,400 to 5,000 sheep; 3 owned three bands each, containing 5,000 to 7,980 sheep; and 1 owned six bands, containing 13,450 sheep.

The sheep ranges of the reserve lie in seven counties, as follows:

County.	Number of bands.	Number of sheep.
Wasco.....	34	72,160
Crook.....	22	49,850
Klamath.....	1	1,600
Clackamas.....	6	14,240
Linn.....	7	13,790
Lane.....	14	32,220
Douglas.....	2	4,500

It will be observed that the sheep ranged in the Cascade Reserve are chiefly in the hands of small owners; that these owners live in the counties of Wasco, Crook, and Sherman, all on the east side of the Cascade Mountains; and that of the seven counties in which the sheep are grazed, three—Wasco, Crook, and Klamath—are on the east side of the Cascade crest, while four—Clackamas, Linn, Lane, and Douglas—are on the west slope.

A small percentage of the sheep grazed in the reserve—perhaps 15,000 to 20,000—are known as "Washington sheep." These are not, as might be supposed, sheep owned in the State of Washington, but sheep owned in the State of Oregon, which in earlier years were taken across the Columbia River into the Cascade Mountains of Washington for the summer pasturage. The Washington State legislature passed an alleged quarantine law stipulating a sixty-day quarantine period for all sheep entering the State. This was an effectual barrier against the sheep from Oregon, and they were compelled to find summer grazing south of the Columbia. Many of them went into the Cascade Reserve, and thus for the past two summers have swelled the customary total.

CHARACTER OF GRAZING LANDS.

The acreage per sheep required for grazing throughout the summer is exceedingly variable, depending on the kind and character of the vegetation. In a rich meadow, not too wet, half an acre for each sheep may be sufficient; in sterile lodge-pole pine forests 10 acres may be required.

To a herder the plants on which sheep graze are of three classes—grass, weeds, and browse. The name grass is applied not only to true grasses, but to all plants resembling grass in appearance, especially

sedges and rushes. Under the head of weeds are included all herbaceous plants that do not have the general appearance of grasses, a difference due chiefly to their broader leaves. Browse is a name applied to shrubs and young trees, the leaves and twigs of which are eaten by sheep. The vegetation of the different ranges is made up of varying combinations of these three classes of forage.

As characterized by their vegetation, the summer grazing areas of the reserve may be classed under four heads—forests, burns, meadows, and balds.

The nature of the grazing in the virgin forest land varies, of course, with the character of the forests. For present purposes they may be divided into three—the yellow-pine forests, the lodge-pole pine forests, and the heavy west-slope forests. The distribution of these forests is a matter of climatic conditions dependent upon elevation and upon the heavy rainfall on the west slope of the Cascades and the light rainfall of the eastern slope. In general, these conditions are maintained throughout the whole length of the State, the principal exceptions occurring where, in the lower gaps of the mountains, the rainfall conditions of the west slope lap over upon the eastern slope.

The yellow-pine forests lie at low elevations along the eastern slope of the mountains, and constitute the first timber entered by the sheep in approaching the mountains from the plains. The principal species of tree is the yellow pine (*Pinus ponderosa*). The individual trees usually stand well apart and there is plenty of sunshine between them. The vegetation consists of a rather poor quality of bunch grass and other scattered herbaceous plants, and a very scattered undergrowth made up chiefly of chamise (*Kunzia tridentata*). In their upper elevations the yellow-pine forests are dense and often contain a considerable amount of Douglas spruce (*Pseudotsuga mucronata*) and California white fir (not treated as a form of *Abies concolor*), with an undergrowth of snow brush (*Ceanothus velutinus*), manzanita (*Arctostaphylos patula*), and chinquapin (*Castanopsis chrysophylla minor*).

The lodge-pole pine forests lie also chiefly on the eastern slope of the mountain, at a higher elevation than the yellow-pine forests, and present a very different character. The trees are small, thin-barked, and very easily killed by fire. The underbrush, made up chiefly of a creeping manzanita (*Arctostaphylos nevadensis*) and the waxy currant (*Ribes cereum*), is never dense, and often is entirely wanting over large areas. Grass is sparse and not of the best quality. The best grazing plants are lupines. In the lodge-pole pine forests the trees are usually set close together; so close, indeed, that it is often difficult, and sometimes impossible, to ride through them on horseback. At a still higher elevation than the lodge-pole pine, extending, indeed, almost to timber line, is the belt of black hemlock (*Tsuga pattonii*), a usually open forest with underbrush of two huckleberries (*Vaccinium scoparium* and *V. membranaceum*), or, especially at high elevations, wholly devoid of underbrush. Almost no grazing is carried on in this hemlock belt, though the bands of sheep often traverse it on their way across the mountain crests to the west slope.

The heavy west-slope forests are deep, dark, and dense, and consist chiefly of a mixture of the Douglas spruce (*Pseudotsuga mucronata*) and the white fir (*Abies grandis*), with often considerable quantities of other trees. These forests bear a usually dense undergrowth and exceed in humidity both of the forests mentioned above. The grazing in the west-slope forests consist chiefly of weeds and browse, the latter made up largely of vine maple (*Acer circinatum*).

The burns that occur in the Cascades depend largely upon the character of the forests in which they lie. For sheep-grazing purposes burns in the yellow-pine forests are of small importance one way or the other, as very little permanent change in the vegetation is effected by them. The scant grass and underbrush do not make a destructive fire, while the bark of the yellow pines is so thick and so nearly devoid of resin that only under exceptional circumstances is a mature tree killed. The sapling, however, up to an age of 15 or 20 years, are readily killed by fire, and frequently an old tree well supplied with resin about some injury near the base takes fire there year after year, gradually burning deeper and deeper until the tree is destroyed. These scars are commonly known as fire cracks.

On rocky slopes in the higher elevations of the yellow-pine forests, where there is a large admixture of white fir and Douglas spruce and the underbrush is thicker, a forest fire is often extremely destructive to the timber, and is followed by a very dense growth of shrubs, made up chiefly of snow brush (*Ceanothus velutinus*), manzanita (*Arctostaphylos patula*), willow (*Salix nuttallii*), and chinquapin (*Castanopsis chrysophylla minor*). Sheep do not browse readily on any of these shrubs, and they frequently form thickets so dense that a band of sheep can not be driven through them. A fire in such a forest, therefore, is distinctly detrimental to the interests of sheep owners.

In the lodge-pole pine forests burns are extremely common and their effect upon the timber is very pronounced. The trees have a thin bark, and are easily killed without being burned up. In a few years the bare poles rot at the root just beneath the surface of the ground and are blown over by the wind, forming an inextricable tangle of small logs, sometimes extending for miles, which it is difficult for sheep to cross, and which at this stage furnish very little grazing. A second fire among these dead logs, when dry, burns them to ashes and opens the country, though it destroys whatever humus there may be upon the surface of the ground, usually only slight in these forests. After the first burning a dense growth of seedlings usually covers the ground among the dead trunks, but with the second burning these seedlings, too, are destroyed. After a few years, commonly from three to five, an area denuded by the two burnings has become covered with a growth of short sedges, often with an admixture of small vetches. The return of the pines to such an area is extremely slow, there being no old trees to seed the area thoroughly, and certain conditions not now well understood in detail evidently preventing chance seedlings from getting a start in the sod. These old grassy burns in the lodge-pole pine forests form such a distinct type of vegetative covering that they deserve a special designation. They will be referred to in this report as fire-glades.

The burns in the west-slope forests are very destructive to timber if they occur at a dry season, when the deep litter feeds the flames and everything burns rapidly. By the second year they are usually covered with a dense growth of weeds and browse, often interspersed with tall grasses. Within a few years, however, on account of the humidity of the climate, they grow up with underbrush, if they are not again burned, developing a growth of saplings in a few years; but if repeatedly burned, supporting only a dense growth of underbrush. The exceptional conditions under which the reproduction of these forests is slow are referred to on page 143.

Natural meadows are areas on which, on account of an excess of moisture, timber does not grow. The word meadow, therefore, as used

in this report, means always a natural wet meadow, and the name will not be applied to fire glades nor to open dry slopes. The vegetation of meadows is in most instances made up principally of grasses and sedges. Most of the meadows in the Cascades occur at middle elevations, especially within the belt of the lodge-pole pine on the eastern side of the range and the heavy west-slope forest on the other side.

The balds are comparatively limited in extent and lie altogether, so far as our observation went, on the west slope of the Cascades. They consist of the dry summits of spurs and detached peaks, which, though well supplied with moisture at most seasons, are drained very rapidly when the summer drought begins, and become so dry on their summits that they will not support a forest growth. The grazing upon these summits is excellent, and consists largely of what is known as mountain bunch grass (*Festuca vaseyana*).

It should be mentioned here, with reference to the different types of sheep-grazing lands above described, that the vegetation is by no means uniform over each one. Especially are local differences in vegetation due to differences in soil, and wherever the soil is made up of a very poor quality of volcanic ash, which renders the surface exceedingly dry for the greater part of the summer, underbrush, grasses, and all herbaceous vegetation may be almost entirely wanting. Areas of this description are frequent both in the lodge-pole pine forests and at higher elevations in the black hemlock belt. The surprising lack of good grazing at or near timber line in the Oregon Cascades, particularly their more southerly portions, is also attributable chiefly to this cause.

LOCATION OF GRAZING AREAS.

For convenience of reference the ranges may be divided into three districts, the Mount Hood district, the Three Sisters district, and the Upper Deschutes district. The Mount Hood district extends from the Columbia River southward to about the latitude of the northern edge of the Warm Springs Indian Reservation; the Three Sisters district from Mount Jefferson, at the southern edge of this Indian reservation, to and including the southern head waters of McKenzie River, about latitude $44^{\circ} 10'$; and the upper Deschutes district from the latter line southward to and including Diamond Lake, about latitude $43^{\circ} 5'$. Each of these districts is subdivided into ranges, the principal ones of which may be briefly named and located as follows:

Mount Hood.—White River, Gate Creek, Three-Mile Creek, Badger Creek, Boulder Creek, Salmon Prairie, Zigzag Creek, Clear Lake, Clackamas Buttes, Hood River.

Three Sisters.—Mount Jefferson, Three-Fingered Jack, Fish Lake, Mount Washington, McKenzie River, Horse Creek, Three Sisters.

Upper Deschutes.—Willamette Cow Pastures, Crane Prairie, Davis Lake, Crescent Lake, Diamond Lake.

White River.—A stream rising on the southeast side of Mount Hood and flowing into Deschutes River. The grazing along this stream lies at different elevations and includes almost every type of grazing land except balds. It is up through the watershed of White River that most of the sheep are driven which are pastured in summer south, southeast, and southwest of Mount Hood, and north of the Warm Springs Indian Reservation.

Gate Creek.—One of the affluents of White River rising within the reserve, but most of it lying outside of the reserve. The grazing is

similar to that on White River, but the proportion of yellow pine forest is larger.

Three Mile Creek.—Same as Gate Creek.

Badger Creek.—Same as Gate Creek.

Boulder Creek.—Same as Gate Creek.

Salmon Prairie.—A large natural meadow west of the summit of the Cascades on the head waters of Salmon Creek, lying just south of the Oak Grove road. A claim of private ownership is pending on this land, and sheep owners who graze on it are from time to time warned off. Farther down the stream are large burns.

Zigzag Creek.—One of the affluents of Sandy River, heading on the southwest side of Mount Hood. The grazing lies at great elevations, and is varied in character between dense west-slope forests, burns, and small meadows.

Clear Lake.—A range just east of the summit of the Cascades on the extreme head waters of Clear Creek, which flows into the Deschutes a few miles south of White River. It was not visited by us.

Clackamas Buttes.—A range on the west side of the Cascades near the head waters of the Clackamas River. Not visited.

Hood River.—A river draining the eastern slopes of Mount Hood. The range is a large one, varied in character, the best part of it lying near the northeastern corner of the Cascade Reserve.

Mount Jefferson.—A range on the slopes of Mount Jefferson near the southwestern corner of the Warm Springs Reservation and on the crest of the Cascades. The grazing is chiefly in old burns and in the open forests. The Mount Jefferson range includes also a mountain a short distance to the westward, known as Minto Mountain.

Three Fingered Jack.—A mountain on the crest of the Cascades between Mount Jefferson and the Santiam-Prineville road, similar in its character to Mount Jefferson. It is commonly known simply as "Jack."

Fish Lake.—A range lying near the Santiam-Prineville road, on the western slope of the Cascades and on the head waters of the Santiam and McKenzie rivers. It is varied in character, including balds, heavy west-slope forests, burns, and a small amount of wet meadow.

Mount Washington.—A range lying on the slopes of Mount Washington, between the McKenzie and Santiam roads. It is varied in character, being made up chiefly of lodge-pole pine forests with many old burns and some meadows.

McKenzie River.—A range lying in a westerly direction from the Three Sisters on the west slope of the mountains, similar in its character to the Fish Lake Range.

Horse Creek.—A range lying also on the head waters of the McKenzie River, but farther to the southward than the McKenzie River Range proper, and in a direction southwesterly from the Three Sisters. It consists of forested mountain slopes and a large area of bottom land, the latter partly open meadow and partly forested.

Three Sisters.—A range lying near the crest of the Cascades, in about latitude $44^{\circ} 10'$, and extending chiefly down the eastern slope toward the head waters of Squaw Creek and Tumelow Creek. It is chiefly made up of natural meadows and old burns in lodge-pole pine forests.

Willamette Cow Pastures.—A range on the western side of the Cascades between the southern head waters of the McKenzie and the head waters of the Willamette to the southward. It is similar in character to the Fish Lake Range.

Crane Prairie.—A large natural meadow or series of meadows on the head waters of the main branch of the Deschutes. This is sometimes known on the maps as the West Fork, but more commonly known in the region as the Big Deschutes, or simply Big River. Crane Prairie is the principal source of this river. Early in the season Crane Prairie is too wet for the pasturage of sheep, and in an occasional season sheep can hardly get on it at all.

Davis Lake.—Like the following, one of the reservoir sources of the Deschutes. It lies on the line between the counties of Klamath and Crook. The range consists chiefly of meadows lying along the west side of the lake. Early in the season, and sometimes in very wet years throughout the season, the grazing land is so wet that sheep can not be driven upon it.

Crescent Lake.—A lake lying about 10 miles southwest of Davis Lake. The range consists mostly of meadows lying to the northeast of the lake, the best known being the one called Sanderson meadows.

Diamond Lake.—A body of water lying immediately west of the summit of the Cascades at the western foot of Mount Thielson and one of the sources of the Umpqua River. It is about 15 miles in a direct line north of Crater Lake. The range consists in part of meadow-land at the south end of the lake, but chiefly, as on the east side of the lake and on the lower slopes of Mount Thielson, of burns.

Each of the ranges above described is divided into smaller ranges, the names of which it seems unnecessary to detail here, as they are wholly local in their use and do not appear on any maps.

SHEEP FORAGE.

In addition to their classification into three kinds of grazing plants—grass, weeds, and browse—the herders make one important distinction in the quality of feed. It is “light” feed, fattening quickly, but producing a “soft” fat, which is easily lost again if the sheep are compelled to travel long distances, or it is “strong” feed, not fattening so rapidly, but producing a “hard” fat, which enables sheep to be driven long distances without losing much in weight. A good packer and herder, where feed is plenty, selects the feeding grounds with these conditions in view, and always puts his sheep in good condition for long drives, in general giving them light feed in the early part of the summer and hardening them toward the close of the season. In general, weeds and swamp grasses are light feed, while the dry-ground bunch grasses, chamise, and acorns are strong feed. Light feed is more abundant in spring, strong feed in the autumn. Light feed is made up chiefly of succulent vegetation containing a preponderance of freshly developed nitrogenous matter; strong feed of vegetation containing a preponderance of substances, particularly starch and other carbohydrates, fully elaborated for storage purposes in the plant. Light feed is comparable with green fodder, strong feed with grain.

Sheep, when driven by hunger, will eat almost any green or even dead vegetation, but it is rarely that they reach such a condition in the Cascade Reserve. As a rule they make a distinction in the choice of food from the vegetation over which they range. The following are the plants to which, from their abundance or general suitability, my attention was more particularly drawn:

Bear grass (*Xerophyllum tenax*).—The young stems and even the seed pods of this plant are readily eaten by sheep, but the tough leaves are seldom touched, and their rough margins make the mouths of the sheep sore. It was not seen south of Mount Washington.

Bluejoint grass (Calamagrostis inexpansa cuprea).—This is one of the principal grazing plants for sheep in Salmon Prairie. It grows frequently in other similar situations.

Butterweed (Senecio triangularis).—An abundant plant in meadows and along streams. Sheep are very fond of it.

Clover (Trifolium longipes).—A favorite forage plant of sheep in and about the meadows. Several other species of clover occur.

Dwarf birch (Betula glandulosa).—Sheep browse upon this shrub as high as they can reach, often when the plants are small eating them to the ground and sometimes killing them. It grows in meadows at middle elevations.

False hellebore (Veratrum viride).—This, popularly known as "wild indian corn," is a plant of which sheep are extremely fond, particularly in the spring when the young shoots and leaves first appear. The roots of this plant are poisonous, but no cases of poisoning from this source were met with. It is usually found in the meadows.

Fireweed (Chamaenerion angustifolium).—A common plant in burns, both in the west slope forests and in the lodgepole pine forests of the eastern slopes. When young it is a favorite food of sheep.

Huckleberry (Vaccinium membranaceum).—Sheep browse readily on the leaves and twigs of this kind of huckleberry, one of the tallest and most abundant species. It is very abundant on the south slope of Mount Hood and in the various other localities frequented by huckleberry pickers. It is a characteristic shrub of somewhat open slopes and burns in the heavy west-slope forests.

Lungwort (Mertensia sibirica).—This was a plant of wet situations in the west-slope forests and was readily cropped by the sheep.

Lupine or ten-finger (Lupinus rivularis).—This and other species of *Lupinus* are eagerly eaten by sheep. *Lupinus laxiflorus* is the one most widely distributed. In some parts of the lodge-pole pine forest it is abundant and an important sheep forage.

Oak (Quercus garryana).—When the sheep are driven out of the mountains in the autumn in the Mount Hood grazing district they pass through a belt of this oak, which grows mingled with the yellow pines at their lower elevations and along the streams at a still lower altitude. The trees are then shedding their acorns, which are commonly produced in great abundance. The sheep are extremely fond of these acorns, and they often gorge themselves with them.

Pea vine (Lathyrus).—Various species of this genus occur throughout the Cascades, and almost all of them are readily eaten by sheep and are excellent fatteners. *Lathyrus oregonensis* is abundant in fire-glades of the lodge-pole pine forests.

Pine grass (Carex pennsylvanica).—The most abundant and characteristic plant of fire-glades in the lodgepole pine forests, under suitable conditions, as at the southern end of Diamond Lake, forming a fairly dense turf. It is not considered a superior forage plant for sheep, though when it first shoots up in the spring they readily eat it. When the burned area of lodgepole pine is upon a sandy soil the plant is more scattered, and, together with a small *Stipa*, is known as "sand feed." Sheep scatter widely upon it and can with difficulty be held together, doubtless searching for more palatable food. From the fact that this sedge often grows thinly in the lodgepole pine forests it is often known as "pine grass," a name applied also to various other slender grasses that grow in the same situation.

Rose (Rosa gymnocarpa).—This is one of the favorite browsing plants for sheep in the heavy west slope forests.

Sedge (Carex).—The larger part of the so-called grasses of which the meadows are made up consists of various species of this genus. Many of them are eaten readily by sheep.

Sunflower (Balsamorhiza deltoidea).—A characteristic plant of the yellow-pine forests, said to be an excellent sheep food.

Sunflower (Wyethia).—A plant abundant toward the northern end of the Cascades in the lower elevations of the yellow pine belt, particularly in treeless openings. It is a favorite spring food of sheep.

Three-leaf or deer-tongue (Achlys triphylla).—One of the characteristic plants of the heavy west slope forests, and a favorite food plant of the sheep.

Valerian (Valeriana sitchensis).—A common plant of moist open slopes, and burns in the west slope forests; closely eaten by sheep.

Vancouveria (Vancouveria hexandra).—A herbaceous plant of the heavy west slope forests, very much liked by sheep, and, so far as we could learn, not distinguished by a popular name.

Vine maple (Acer circinatum).—This is one of the favorite browsing plants of sheep, and grows in abundance in the heavy west slope forests. We did not meet with it south of the Mount Hood Range district.

Wild-cat grass (Stipa).—This is one of the characteristic grasses of fire-glades in the lodgepole pine forests. Sheep graze upon it, but it is not considered good food.

Wild cheat (Bromus).—A favorite grass, common in burns in the heavy west-slope forests.

Wild tansy (Achillea millefolium).—A favorite food of sheep, found in a great variety of situations, usually in open ground. It is very eagerly sought after by the sheep in spring, but later in the season it becomes dry and less palatable.

Willow (Salix).—Many species of willow grow in the Cascades, and the leaves and twigs of most of them are eaten rather readily by sheep. *Salix nuttallii* is a characteristic species of burns in the heavy west slope forests. The others grow chiefly in meadows and along streams.

Wire grass (Juncus balticus).—This plant, which grows in meadows, is eaten by sheep, but not with much relish.

EFFECTS OF OVERGRAZING.

The effect of a moderate amount of grazing on the lands of the reserve is the same as the effect of the judicious removal of a grass crop from a fenced pasture by grazing, or from a meadow by cutting, namely, that a forage crop is secured without material detriment to the land and the herbaceous vegetation it bears. I say advisedly "a moderate amount of grazing," for there is not the slightest question that in many countries of the Old World and in some localities of the United States overgrazing is a serious injury to the forage crop and to the young growth of forests. By "a moderate amount of grazing" I mean grazing only to such an extent that the forage crop does not decrease from year to year. In general, overgrazing in the Cascades has only been begun, or perhaps the facts are better expressed by the statement that up to the present time overgrazing is limited to a few areas in a part of the Mount Hood district and a part of the Three Sisters district. For example, a small range on the west slope of the Cascades, near Mount Washington, containing an area of about a section, formerly maintained a band of sheep eight weeks, but now can support them only about half as long. Overgrazing on a very small scale can be seen almost anywhere in a sheep country on bedding grounds and along

well-worn routes of travel for sheep. In such situations are commonly seen the primary bad effects of overgrazing, namely, the weakening or killing not only of the herbaceous vegetation, but of shrubs, seedling trees, and the smaller saplings.

The principal bad effects of overgrazing are to be attributed rather to trampling than to actual close cropping. There are very few plants which from simply being eaten off will fail to grow again, but where repeatedly trampled, particularly in wet weather, when the plants are soft and the roots are easily pressed out of the ground, almost any plant will suffer. Two bad effects are observable from overgrazing—the washing of the soil and the killing of the vegetation, followed by the substitution of other less valuable forage plants.

Almost the whole territory contained in the Cascade Forest reserve is made up of a rather loose soil of volcanic origin. It does not wash and gully very seriously, even when exposed to the action of water. Up to this time the damage in the mountains due to this cause has amounted practically to nothing in any of the localities visited by us.

The killing of the natural vegetation through trampling and overgrazing has only barely been begun, and the result, which is always to be expected—namely, the substitution of useless weeds for the original vegetation—has not yet occurred. The principal evidence of overgrazing thus far is in the decrease of the amount of pasturage afforded by particular ranges. As cited above, a portion of the Mount Washington range known as Bunch Grass Ridge originally maintained a band of sheep eight weeks, but it now keeps a band only about half as long. The same may be said of a large portion of the range that lies immediately to the east of the Three Sisters, an area which is crossed by many bands of sheep in going to and from the western part of the Three Sisters Range district.

While overgrazing in the mountains has not reached the point of extensively damaging the range, in many portions of the plains to the east of the mountains the opposite is true. Along Hay Creek, for example, are gullies 20 feet deep in the hard adobe or gumbo soil, which have been washed out by the water pouring down from the adjacent hills, long since denuded of grass by overgrazing. The washing has taken place since the region was settled, and principally within the last fifteen years. The actual substitution of useless introduced weeds for the valuable native forage plants may be seen on a large scale on the Tygh Hills, north of Tygh Valley and west of the Deschutes River, a substitution which under present conditions is bound to continue.

One of the first evidences of overgrazing in the mountains is the restlessness of sheep herders, who, finding a customary range becoming short, drive their bands to some other range which they expect to find in better condition. Disappointed, they drive on to still another range, and so the bands follow each other about, wearing out their sheep by overdriving, and leaving the range with their stock in a very exhausted condition.

Over most of the reserve the actual damage to the young growth of timber is, up to the present time, confined chiefly to small areas, such as bedding grounds and routes of travel. In such situations the young pines low enough to be reached and nibbled by the sheep may be seen standing crooked and incapable of developing into sound trees of a healthy growth, while seedlings are trampled out entirely. The trouble from this source, however, is constantly misunderstood on both sides. I passed through an area of forest land on McKay Mountain, a western spur of the Blue Mountains, lying in a direction northeast from Prine-

ville, where sheep had been grazed for twenty-three years. This is the oldest sheep range in Crook County. In these forests were frequent areas of young saplings of thoroughly healthy and symmetrical forms which unquestionably had not received the slightest injury from sheep grazing. At the same time along the road were seen frequently the gnarled and stunted pine saplings, which showed clearly what doubtless occurred over wider areas where overgrazing and trampling were similarly carried to an extreme.

The forest conditions on this Blue Mountain spur might form the text for a long discussion on the effects of forest grazing, but there is room here for only a brief comment on a phase of the question that is likely to escape popular notice. Under ordinary conditions when an opening is made in a forest by the death and fall of an old tree, and more sunlight comes down to the ground, a dense growth of saplings springs up to fill the opening. These saplings competing with each other for the light, send up straight tall trunks, and the one or two trees that finally excel the others and fill the opening possess tall limbless trunks which make the best of saw logs. If for any reason the seedlings in such an opening are injured so that only a few live and develop into saplings, they grow into limb-covered trees valueless for lumber. In the Blue Mountain spur the effect of sheep grazing will be seen in the next generation of timber. On those areas in which for any reason the sheep have not killed the seedlings, a good quality of timber can be cut, while those areas on which most of the seedlings are now being tramped out every year will bear trees but not lumber.

FOREST FIRES.

Whatever may be the amount of damage due thus far to overgrazing, the popular mind has associated with the forest grazing of sheep, if not distinctly as an effect, certainly as a necessary accompaniment, a kind of forest damage immeasurably more disastrous up to the present time than overgrazing, and now almost universally recognized as a public calamity, namely, forest fires. Without reference to the truth or fallacy of this popular belief regarding the cause of forest fires in sheep-grazing districts, the subject is one of such far-reaching effect on the welfare of a State and the communities of which it is made up that to ascertain the causes of forest fires and to devise means for their prevention are pressing and fundamental necessities. As already stated, in our investigation the reserve was traversed from the southern to the northern end. I am confident that there does not exist in the whole reserve a township of forest land in some part of which forest fires have not occurred, and it was difficult to find even a single square mile in which the evidences of fire, recent or remote, were not present. We contemplated an estimate of the acreage of burned areas, but this plan, for several reasons, was necessarily abandoned. It is possible, therefore, to make only the general, but no less positive, statement that, in addition to areas burned over with comparatively little damage to the commercial timber, the reserve contains hundreds of thousands of acres on which the timber has been wholly destroyed by fire.

Especial attention was paid in our field examination to the subject of forest fires. Whenever possible we ascended the highest peaks and from them examined the adjacent country for the purpose of ascertaining the location of forest fires. In this way we saw about forty fires in various parts of the reserve, some of them large, most of them small. The effect of fires upon different types of timber has already been described (see page 130).

In connection with the relation of forest fires and sheep grazing it was necessary to examine with the greatest care into the causes of forest fires.

EARLY FOREST FIRES.

Historically considered, we must look to the Indians as the first manipulators of forest fires in this region. It is a clearly established fact, based on observation, that the Indians of the Willamette Valley, in western Oregon, were accustomed, before the advent of white men in that region to as late a period as the early forties, to set fire to the grass for the purpose of burning it off. Their object in doing this is supposed to have been chiefly (1) to cause a fresh growth of grass in the autumn upon which enormous quantities of wild fowl descended to feed, particularly geese, and (2) for the purpose of killing and roasting for food the great quantities of grasshoppers that in certain years fed upon the grass. Similar uses of fire by the aborigines in other parts of the western United States have been recorded, by which they were enabled to keep certain large areas denuded of timber. Upon the cessation of these fires, by reason of the intervention of white settlers, the timber has begun again to encroach upon such areas, and in the Willamette Valley, for example, we now see frequent groves of Douglas spruce and white fir about fifty years of age, of remarkably uniform and symmetrical growth, which have developed through their natural seeding without human assistance.

Just how many of the old burns in the Cascade Reserve are to be attributed to the Indians it is impossible to say, but several fire glades were seen which must have antedated by several decades the settlement of the country by whites—fire glades in which the evidence of fire was confined to pieces of charred wood that lay beneath the surface of the ground, hardly showing the lines of the long-since rotten logs to which they belonged. Such fire glades occur on the ridges south of Huckleberry Mountain, southwest of Crater Lake, which is well known to have been a favorite resort of the aborigines for many generations. In general, however, the number of fires of sufficient age to be attributable to this period is small. The Indians probably can not be accused of starting fires to a large extent accidentally, or of setting fires indiscriminately, but it is undoubtedly true that at certain seasons it was their custom to set fires in the mountains intentionally and systematically in connection with their fall hunting excursions, when deer were driven together and killed in large numbers.

A second great source of fires in the Cascades was the early road-building across the mountains to connect eastern with western Oregon. A broad band of fires usually accompanied such an enterprise. At that time the amount of destruction this caused was not appreciated because most of those who were connected with the building of these roads were from the Eastern States where timber was abundant, and where the first prerequisite of agricultural progress was to burn off timber in order to clear the land for farming purposes. The details of an interesting method of felling large trees of Douglas spruce (*Pseudotsuga mucronata*) were learned from some of the old inhabitants. The trees are large, commonly 6 feet in diameter at maturity, and the cutting of them was too expensive and difficult a task. The method of felling the tree was to bore a hole with a long augur diagonally downward to the heart of the tree, and to bore another similar hole diagonally upward from the base of the tree, connecting with the first. A live coal was then dropped into the hole, the draft through the two augur holes causing the wood

to take fire, and a roaring conflagration followed which burned away a large portion of the tree trunk. It was seldom that an ax had to be used to fell the tree, as the fire almost always ate away a sufficient portion of the trunk to cause it to fall.

These early causes of fires, however, are now matters of history, and need to be taken into consideration at the present time only in so far as they explain the origin of many of the old well-known burns that antedate the era of sheep grazing in the Cascades.

RECENT FIRES AND THEIR CAUSES.

Of the fires of the present period it may be said, in the first place, that they are by no means confined to sheep-grazing areas. Parts of the southern Cascades in which sheep have never been grazed were found to be riddled with fires, and in general it may be stated that forest fires in this region increase proportionately to the increase of human occupancy, whether the occupants are sheep herders, campers, road builders, prospectors, or any other class of men.

Travelers, campers, and Indians.—It will be of interest to give a somewhat detailed account of the causes of the fires observed by our party in the course of our travels through the mountains. The greatest number of fires I should attribute to the class of people known as "travelers"—families without a definite place of residence, usually illiterate and poor, who journey about in covered wagons from one State to another or from one portion of a State to another, grazing their horses on the public lands and occasionally by an odd job earning a little money with which to buy provisions. We repeatedly saw camp fires which had been left by these people, and which under suitable conditions might have caused disastrous forest fires. At the time of year when the forest litter and the underbrush are dry, a strong wind suddenly springing up very frequently causes one of these abandoned camp fires to develop into a highly destructive agency.

It is clear that a very large majority of the fires in the Cascade forests are due to carelessness rather than to maliciousness, and the efforts of the Interior Department must undoubtedly be chiefly directed rather toward preventing carelessness in handling fires than toward the detection of malicious fire setters. From the people who showed a willingness to give information as to the causes of fires it was extremely rare to learn of a case in which a fire had been known to be set maliciously, though fires known to have been due to carelessness were matters of everyday comment.

Camping parties, particularly those made up of young and inexperienced people from towns, are a fertile source of forest fires. These parties commonly go into the woods for a summer outing, often making the chief object of their pleasure the hunting and fishing afforded by the region. Some of these parties are made up of young men who go into the woods for the special purpose of hunting, but who have little experience in woodcraft and no knowledge of the proper method of handling a camp fire. They are often referred to as hunters, but it is known that real hunters of experience and that old campers of experience are extremely careful in these matters. Perhaps the designation "alleged hunters," applied to them by an old rancher and woodsman of eastern Oregon, will sufficiently distinguish them from real hunters.

The Indians from the two Indian reservations at the east base of the mountains—the Klamath Reservation and the Warm Springs Reserva-

tion—still go into the mountains in the autumn to pick huckleberries and to hunt. I received information of the most diametrically opposite character regarding these Indians with reference to forest fires, being assured by some that the Indians were invariably careful to put out a fire before leaving, by others that they set fires indiscriminately. I had little opportunity to learn definitely how many fires should be attributed to this source, but I may say that I saw a brightly burning fire at a recently abandoned camp of Warm Springs Indians on Salmon Prairie. The day was rainy, however, and it is possible that under other conditions they would have extinguished the fire before leaving the camp. I am strongly inclined to believe that the Indian agents should see that when they issue permits to the Indians to go off the reserve it should be distinctly with the understanding that they are to set no forest fires and that they are to be personally responsible if they transgress this regulation.

Road improvement.—On August 4, while we were traveling on the west slope of the Rogue River—Fort Klamath road—we passed, between White Horse Creek and the Crater Lake Fork of the road, a distance of about 3 miles, six fires that evidently had been set to burn stumps or fallen dead trees out of the road. One of these fires was burning close to standing timber, had already destroyed several logs upon the ground, and was roaring through the top of a small black hemlock. It might very easily have been carried into a large area of standing timber, and had a strong wind sprung up no one could have prevented it from doing so. Possibly it afterwards did. Not far above we found a man with a two-horse wagon and tools who was engaged in improving the same stretch of road. He had been prying small logs out of the road with a crowbar, cutting off obstructing tree roots with an ax, and shoveling soil into the holes in the road. It was unquestionably this man, doubtless the road supervisor of the district or some one employed by him, who had set the fires. In reply to a question the man, stopping work on the log he was engaged upon when we met him, said, "Oh, I am going to pick this one to pieces and burn it out after awhile." Whether any of these fires afterwards developed into large forest fires I have no means of knowing. I do know, however, that a fire set for the same purpose along the road near the northwestern corner of Klamath Lake had become unmanageable and burned over a considerable area. When we passed the place the fire had been extinguished and we saw only the destruction caused by it. Regarding this possible source of forest fires, especially with a knowledge of the very disastrous forest fires due to the early road builders, it should be said that officers in charge of such work, if they must employ this means of clearing the road, should use extreme care, should watch the fires closely, and should invariably see that they are finally extinguished.

Lightning.—It has often been claimed that many forest fires are due to lightning. Little credence was at first placed by us in these reports. We found many men who had heard of fires that originated in this way, but only rarely a man who had ever seen one. One day, as Mr. Applegate and myself were upon a peak at the junction of the Calapooia Mountains with the Cascades, looking for forest fires, we saw close by us, not more than half a mile away in the forest, a small fire, considerably larger, however, than a campfire should have been. The region was one remote from the ordinary routes of travel or any place of public resort. We were therefore curious to know how the fire had been started, and, supposing it had been caused by a wandering hunter,

we took our bearings and struck out for the spot down the mountain side through the woods. In due time we saw the smoke a few rods ahead of us, and hurrying along, we soon came up to the place. We were astonished to find no evidence of a camp, and for a moment we were puzzled, until Mr. Applegate cried, "Look at that tree!" The tree was a handsome, live Shasta fir, which had very recently been struck by lightning. The tree was still standing, but pieces of bark and shattered wood had been thrown in all directions through the woods to a distance of at least 200 feet. The tree was exactly 10 feet in circumference. The fire had been confined to the ground and had burned over a small area about 50 by 200 feet, including eleven large trees of black hemlock and the amabilis fir, several fallen dead trees, and probably 200 saplings, most of them small ones. The forest litter and some of the logs were still burning, but on account of the presence of many green saplings in the undergrowth and of a small huckleberry (*Vaccinium scoparium*), the fire was progressing slowly. Indeed, the forest litter was so light that only a very strong wind could have made the fire a destructive one. In other situations or under slightly different circumstances, however, the fire might have proved very disastrous. I have cited this case somewhat in detail, as actual records of lightning fires are rare in this country. Not long afterwards, near the northeast base of Mount Washington, we passed through a thunderstorm of an extremely violent character, in which the strokes were repeated and terrific and many trees in the immediate neighborhood must have been struck. The rainfall accompanying this storm, though evidently sufficient to put out any fire that may have arisen, was much lighter than I have ever seen in the Eastern United States, and I was informed that sometimes not enough rain accompanied such a storm to dampen the forest litter. It is possible that lightning fires may be much more frequent in the Cascades than has been supposed, and the subject is certainly one worthy of further investigation by those who have an opportunity to be in the region frequently.

Other causes.—Near the head of Wood River, on some mountains to the east of the reserve, in the Fort Klamath country, occurred in early August a destructive forest fire. It was impossible for us to examine this fire on the spot, but we were informed on reliable authority by those who had looked into the matter with care that the fire had originated in a camp of some men who were splitting shakes, a sort of large coarse shingle, and they set a number of small fires to keep themselves, so they said, from annoyance by mosquitoes. Whether the escape of the fire was due to mere carelessness, or whether it was intentional, there is no means of knowing. This fire is estimated to have burned over 15,000 to 18,000 acres.

I have known in a few instances of small forest fires starting from smudges which had been set in a pile of rotten logs to protect camp horses from mosquitoes and other insects.

Alleged hunters, in the belief that deer will hunt out smoke to rid themselves of deer flies, are said, and although I have never seen a case I have every reason to believe that many occur, to set single fires and sometimes lines of fires in the woods, particularly in the vicinity of salt licks. In August of this year a fire was burping in the vicinity of a salt lick in Anna Creek Canyon, in a locality away from the route of travel and of such inaccessibility that only a man searching for game is likely to have been there. It is very probable that this fire was set for such a purpose.

RELATION OF FIRES TO SHEEP GRAZING.

It is of primary importance in this investigation that an unbiased opinion should be given on the relation borne by sheep herders to forest fires. It has been alleged that sheep herders systematically set fire to the forest in order to burn off the timber, so that a growth of weeds and grass will spring up to furnish grazing in succeeding years. On the other hand, the publication of this statement within the past year in Oregon newspapers has brought forth most positive denials by stockmen that this practice exists. This phase of the subject was a matter of special inquiry. We asked again and again of all classes of people about this matter, and whenever a man informed us that such a practice existed we endeavored to find out the place, the time, and all other detailed circumstances of the cases with which he was familiar. It was always difficult, when we came down to such details, to secure anything more than inconclusive circumstantial evidence. From the people who were antagonistic to sheep grazing in the Cascades we would have been able to learn of very few cases positively attributable to this cause. With the sheepmen themselves, however, we talked very frankly, and as a result of these conversations I may say, without betraying any confidences and without citing individual cases, that it is undoubtedly true that in the early days of sheep grazing in the Cascades there was a widespread belief among the sheepmen that burning off the forest was of positive importance to the sheep-grazing industry, and that many herders undoubtedly did systematically burn off areas in the forest either where the density of the forest had prevented the growth of suitable grazing plants, or where they had already grazed and were about to remove to another camp, or when they were leaving the forest at the end of the season. How general this practice was it is impossible to say. Many of the sheep herders and packers deny ever having set fires themselves, or ever having known of a fire being set by others. I have no doubt that in many cases such claims are correct.

It is clear that at the present time most sheep herders and packers are extremely careful not to allow their camp fires to spread and not to set fires intentionally. This I attribute to various causes. In the first place, the increase in the West of a knowledge of the importance of protecting our timber resources has been very marked, and rarely does one find a man who is not ready to say that in his opinion the Western forests should be preserved from fire. Governor Lord has urged upon the State legislature the importance of preserving the forests within the State. The following quotation is from his biennial message as published in the *Portland Oregonian* for March 31, 1897:

The frequent destruction of our forests by fires, caused by carelessness or design, should be stopped. Their preservation is a matter of great importance, and if something is not done to prevent it, great injury will result to our timber interests. This is a subject that demands your attention, and some means must be devised for better enforcement of our laws.

The State of Oregon has passed a stringent fire law, the United States Government has passed a still more stringent fire law,¹ and although no criminal convictions have as yet been made under these acts, a knowledge that they would be made on sufficient evidence has been a strong factor in preventing fires from being set openly. Some notices of these laws have been posted at camping places through the

¹ For the full text of these laws, see pages 144 and 145.

forests, but not by any means to such an extent as is desirable. It is undoubtedly true also that the popular accusation of sheepmen as fire setters has acted as an effective warning to them. They realized that unless the reasons for this accusation are removed there is a strong probability of their exclusion from the reserve, and this has led them both to be more careful with fires and to insist publicly that they are careful.

The necessity of forest fires to the summer grazing industry has undoubtedly been overestimated both by the general public and frequently by stockmen themselves. A fire on an occupied range is objectionable because it both burns up the forage and menaces the sheep herder's camp and often the sheep themselves. Cases are known in which a whole camp outfit and provisions have been burned by the accidental spreading of a fire while a herder was away from camp with his sheep, and other cases are known in which sheep have narrowly missed being caught and burned up in a forest fire. Besides this, a single fire in the black pine belt, for example, is followed after a few years by such a growth of saplings among fallen logs as to make it exceedingly difficult to drive a band of sheep through. If the logs are charred, the wool of the sheep becomes blackened by the charcoal dust to such an extent as to decrease the value of the wool often a cent a pound. Furthermore, as already stated under the head of the effect of fires in the upper portion of the yellow pine belt, a fire is often followed by a dense growth of underbrush, which in itself prevents a growth of forage and makes traveling across such an area almost impossible.

Against these statements, however, may be set the indisputable fact that a large amount of the grazing in the Cascades is upon old burns, and that had these burns never occurred the available grazing area would have been reduced by precisely that amount.

The statement is often heard among sheep herders that close grazing is a positive benefit to the forests, because it prevents the spread of forest fires by the removal of the leaves and branches that later make up the dry forest litter. That the forests may be kept clean in this manner is unquestionable, but it is equally unquestionable that this means of preventing forest fires would prove very costly in the end. This has already been discussed under the head of overgrazing.

We did not this year come upon any fires that we could trace to sheep herders or packers, nor did we learn of any fires known to have been set by them. We did, however, see fires that were in localities where sheep had been grazed, and some of them I have no doubt originated from this source, probably having spread by accident, possibly by intent. It is clear that the extent of the practice among sheep men of systematically setting forest fires has been overestimated. It is interesting to note that during the progress of our season's investigation, while we found no fires that could be traced by positive evidence to sheep men, we did see campfires abandoned by travelers, by campers, and by Indians, fires set by road builders and by lightning, and fires set for the purpose of creating smudges.

SLOWNESS OF REFORESTATION UNDER ADVERSE CONDITIONS.

One phase of the forest-fire evil in the Cascades must still be mentioned, the slowness of reforestation in certain areas. On several of the old burns there was evidence that many years had elapsed since the fires that destroyed the trees had done their work and upon inquiry it was found that a surprisingly long period had intervened. I was

informed, for example, that the burn on the upper west slope of the Santiam-Prineville road occurred earlier than thirty years ago. This burn is now grown up to snow brush (*Ceanothus velutinus*) and other shrubs, and no evidences of reforestation are in sight. Some portions of the great burn on the south slope of Mount Hood, I was informed, are more than forty years old, and at present they bear only scattered saplings. It is clear that in many such areas, where the conditions are naturally unfavorable to the growth of trees, reforestation must be extremely slow, and a hundred years is not too low an estimate for the period that must elapse before a young forest covering of even moderate density will return.

MEANS OF LESSENING FIRES.

Before leaving this subject I wish to make certain suggestions, which from my experience I believe will prove useful, in addition to the more special provisions outlined below, in reducing the number of forest fires. Have printed upon cloth, and with suitable catch words for headings, in conspicuous type, notices of the forest-fire laws and their penalties, pointing out especially that not merely is the setting of forest fires punishable by fine and imprisonment, but that leaving a camp fire without extinguishing it is also punishable in the same manner. These notices should be posted at frequent intervals along all the roads that enter or cross the reserve, and at as many camping places as possible. The number of fire notices now in the Cascade Forest Reserve is altogether too small, and some of them, being printed on paper and in an inconspicuous manner, are easily overlooked or destroyed by the elements. There should be twenty notices where there is now but one. Scores of postmasters and other Government employees or persons interested in the preservation of the forests would take pleasure in posting these notices at suitable places.

One or a few convictions under the general forest-fire law of the United States would prove of the highest importance as a warning and a check to carelessness. The malicious fire setter usually so covers up his tracks that it is difficult to secure evidence sufficient to convict, but a conviction for the minor offense of leaving a camp fire without extinguishing it would be extremely easy. Our own party, had that been our business, could readily have secured in several cases evidence sufficient to convict of this offense.

FIRE LAWS.

In order to call more directly to the attention of those who shall receive this report the seriousness of the offense of setting forest fires the text of the Oregon fire law and the Federal forest-fire law is cited in full.

AN ACT To protect timber and other property from fire.

Be it enacted by the legislative assembly of the State of Oregon :

SECTION 1. If any person shall maliciously, with intent to injure any other person, by himself or any other person, kindle a fire on his own land or the land of any other person, and by means of such fire the buildings, fences, crops, or other personal property, or wooded timber lands of any other person shall be destroyed or injured, he shall, on conviction, be punished by a fine not less than twenty dollars nor more than one thousand dollars, or by imprisonment in the county jail not less than three months nor more than twelve months, according to the aggravation of the offense.

SEC. 2. If any person shall without malice kindle any fire in any field, pasture, enclosure, forest, prairie, or timber land not his own, without the consent of the owner, and the same shall spread and do damage to any building, fences, crops, cord wood, bark, or other personal property not his own, or to any wood or timber land not his own, he shall on conviction be punished by a fine of not less than ten

dollars nor more than one hundred dollars and costs, according to the aggravation of the offense, and shall stand committed until the fine and costs are paid.

SEC. 3. Any person who shall enter upon the lands of another person for the purpose of hunting or fishing, and shall without the consent of the owner of said lands, kindle any fire thereon, shall be punished by a fine not less than ten dollars nor more than one hundred dollars; and if such fire be kindled maliciously, and with the intent to injure any other person, such offender shall be punished by a fine not less than twenty dollars nor more than two hundred and fifty dollars, or by imprisonment in the county jail not less than three months nor more than twelve months.

SEC. 4. Any person or persons who shall wilfully set fire to any wooded country or forest belonging to the State or to the United States, or to any person or persons, shall be deemed guilty of a misdemeanor, and upon conviction before a court of competent jurisdiction, shall be punished by a fine not exceeding one thousand dollars, or imprisonment not exceeding one year, or by both such fine and imprisonment: *Provided*, That nothing herein contained shall apply to any person who in good faith sets a back fire to prevent the extension of a fire already burning.

SEC. 5. Upon any prosecution under this act, one half of the fine imposed shall be paid to the person who first gives information thereof to the district attorney for the district in which the offense is committed, and the other moiety shall be paid into the county treasury for the benefit of the common school fund of the county in which said fine is collected.

SEC. 6. It is hereby made the duty of the governor of this State to issue a proclamation on the first day of July of each year, calling public attention to the provisions of this act and warning all persons against violating the same. It is also made the duty of each circuit judge of this State to read the provisions of this act to each grand jury when charging them as to their duties.

SEC. 7. Inasmuch as there is urgent necessity for the protection of timber and other property from fires, this bill shall take effect and be enforced from and after its approval by the governor.

Filed in the office of the secretary of State February 20, 1893.

AN ACT To prevent forest fires on the public domain.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any person who shall wilfully or maliciously set on fire, or cause to be set on fire, any timber, underbrush, or grass upon the public domain, or shall carelessly or negligently leave or suffer fire to burn unattended near any timber or other inflammable material, shall be deemed guilty of a misdemeanor and, upon conviction thereof in any district court of the United States having jurisdiction of the same, shall be fined in a sum not more than five thousand dollars or be imprisoned for a term of not more than two years, or both.

SEC. 2. That any person who shall build a camp fire, or other fire, in or near any forest, timber, or other inflammable material upon the public domain, shall, before breaking camp or leaving said fire, totally extinguish the same. Any person failing to do so shall be deemed guilty of a misdemeanor, and, upon conviction thereof in any district court of the United States having jurisdiction of the same, shall be fined in a sum not more than one thousand dollars, or be imprisoned for a term of not more than one year, or both.

SEC. 3. That in all cases arising under this act the fines collected shall be paid into the public school fund of the county in which the lands where the offense was committed are situate.

Approved, February 24, 1897.

RELATION OF FOREST FIRES IN THE CASCADES TO WATER SUPPLY.

One of the cogent reasons for the preservation of our western forests in general is the importance of a forest covering in conserving and regulating the water supply needed for irrigation purposes. An investigation of the effects of sheep grazing in the Cascade Reserve would not be complete without a consideration of this phase of the subject.

The west slope of the Cascade Range of Oregon has a heavy rainfall, and in the country through which this rainfall flows, chiefly the valleys of the Willamette, Rogue, and Umpqua rivers, irrigation is carried on to only a very small extent, and the water supply is more than sufficient. Therefore, so far as the west slope of the Cascades is concerned, the question of preserving the water supply for irrigation purposes does not arise.

The general question of the extent of the influence of forest denudation on the increase of floods is in such a state of controversy that no specific general conclusion can be drawn. We have no information relative to the west slope of the Cascades that throws any new light on the subject. The closely related subject of the washing and gullyng of soil is also one with which this report has little concern. Within the reserve the damage from this source up to the present time is practically nothing. On the treeless plains to the east, however, deep gullies in the hard soil are frequent. For several miles along the main road through the valley of Hay Creek are gullies with vertical walls often 20 feet in height. This has been torn out by water since the region was settled, principally within the last fifteen years, and is due, without question, to the denudation of adjacent portions of the plains by the removal of the grass through overgrazing.

On the eastern slope the reserve is drained chiefly by the Deschutes River, partly toward the south by the tributaries of the Klamath River. The southern sources of the Deschutes and the principal sources of the Klamath River in the Cascades are in a peculiar country geologically. The soil in this region consists chiefly of pulverized pumice stone or volcanic ashes. Neither melting snow nor rain falling upon this soil is drained off upon the surface, but sinks rapidly and appears in the form of enormous springs near the base of the mountains or upon their lower slopes. These springs are of nearly uniform flow throughout the year, and I question whether the denudation of these pumice-soil areas through forest fires or other causes would have a material effect upon their flow and therefore upon the flow of the streams that depend upon them. These waters are comparatively little used for irrigation purposes, but, assuming that they will be used to a far greater extent hereafter, I question whether special provisions for the preservation of the forest covering in this portion of the Cascades will ever prove necessary in this connection.

In other types of soil, however, such as those which exist from the Three Sisters northward—soils in which the water does not at once penetrate, but which usually flows off on or near the surface—the conditions are entirely different, and while I can present no positive and conclusive evidence that such denudation as has taken place up to the present time has caused a deficiency of irrigation water, I am convinced that further denudation might readily do so. Changes might result which would be of serious detriment to the interests of the country, including all the area from Tumellow Creek northward to the Columbia. At the present time this area is only beginning its development as a grain-raising country, and whenever better methods of transportation are secured, such as are now promised by a railroad system the construction of which has already been begun, the importance of water for irrigation purposes will become constantly greater. I was told by Mr. W. R. Booth, keeper of the tollgate on the eastern slope of the Santiam-Prineville road, a man violently opposed to mountain sheep grazing, that many of the mountain streamlets that formerly flowed throughout the season were now drying up in summer. He cited as examples that Cache Creek carries less and less water every year, and that a streamlet 4 miles northwest of the tollgate, emptying into Blue Lake and finally into the Metolias, in 1893 flowed a full stream, in 1894 less, and in 1895 went dry. It was dry in the fall of 1896 and again in 1897. Mr. O. C. Yocum, who has lived at old Government Camp, on the southwest slope of Mount Hood, for fifteen years, stated that on areas burned within that period, streamlets that before ran all the season now became

dry almost as soon as the snow had gone. These observations, if correct, indicate that denudation of the mountain slopes by forest fires may be expected to influence, perhaps seriously, the flow of their dependent streams.

IRRIGATION IN WASCO COUNTY.

Among the people of the country the only demand that has arisen for a protection of the water supply seems to be confined to a portion of Wasco County consisting of the section between the Deschutes River on the east, the Warm Springs Indian Reservation on the south, and the Columbia River on the north. Here is a strip of territory varying from 10 to 15 miles in width, bounded on the east by the Deschutes River and on the west by the forested area of the Cascade Mountains. This strip of territory is a plateau devoid of trees and divided by east and west canyons into separate blocks. The largest of these blocks is the one lying immediately south of the canyon of White River abutting upon the Deschutes River on the east in a canyon wall nearly 2,000 feet in height. This block is known as the Waupinitia Plain or Juniper Flat. The principal industry of the whole strip is wheat raising. The rainfall is so limited that the wheat crop is frequently a failure, and from the peculiar situation of the plain, drained on three sides and receiving no streams from the fourth, many of the ranches during the summer drought are wholly without water. When the wells "go dry," water for household purposes, and sometimes even for stock, must be hauled by wagon, the ranchers in some cases being compelled to go 8 miles for it, making a round trip of 16 miles. To remedy the difficulty, irrigation ditches are now being constructed to carry water to the ranches to be used chiefly for watering stock, for domestic purposes, and for irrigating a garden patch and a small orchard.

I was told by Mr. Samuel B. Driver, a rancher living near Wamic, on one of the blocks of the plateau north of the Waupinitia Plain, that the adjacent streams—Rock Creek, Gate Creek, and Three-mile Creek—have shown a gradual decline in the last ten years in the amount of their summer flow. This decline he attributes to the trampling of the ground by sheep in the mountains at the head waters of these streams. He believes that within thirty years there will be no water in the stream beds in the fall of the year. To these statements should be offset the contrary evidence of other residents. The sheep men in general, and some of the ranchers, maintained that the decline of water was wholly accounted for by the tapping of these streams with irrigation ditches. As a sheep packer tersely expressed it in the idiom of the region, "Why, the creeks can't *pack* enough water to fill the — ditches."

I made careful inquiry for actual records of summer water levels, but could learn of none. Some valuable information in this direction, however, was secured from Mr. W. N. McCorkle, of Tygh Valley, who for eighteen years has maintained a grist mill on Badger Creek, another of the streams on the head waters of which sheep are grazed in summer. Only one irrigation ditch, carrying 12 inches of water, has been taken out of this stream. About three-fourths of the water carried by the stream in summer is used by the mill. Mr. McCorkle states that this creek has no higher nor more turbid spring floods in recent years and carried no less water in summer than formerly. This is the only information I could secure in the nature of a stream measurement. Certainly the mill owner would have noted any important diminution in a margin of only one-fourth.

The available evidence is not sufficient to settle this question, but the ranchers, while every opportunity for careful consideration of their proposition is due them, must present a stronger case than they have yet presented if they are to maintain their contention.

EFFECT OF FORESTS ON THE MELTING OF SNOW.

The influence of the forest cover of the Cascades on the melting of snow was a matter on which we sought information. During the winter of 1896-97 there was a controversy in the Oregon newspapers in which Mr. John Minto had maintained that the forest covering was of no value in lessening the rapidity of the melting of snow in spring. The points made by Mr. Minto were that in small groves of trees the snow goes off in spring earlier than in surrounding open areas, that the temperature inside a forest is slightly higher in winter than in the open, and that the great snow areas left upon the mountains late in summer are almost invariably outside the forest area. On these premises Mr. Minto based his conclusion.

By actual observation and by the securing of snowfall records and other facts we learn that, while Mr. Minto's premises are of unquestioned accuracy, his conclusions do not follow, and that as a matter of fact over almost the whole timbered area the snow goes off much more slowly in spring than in open areas under the same conditions. It is true, and there are various evident reasons why it should be true, that under a small grove of trees in an open plain the ground becomes bare earlier in the spring than in the open, but it is unnecessary to go into the details here. It is true from actual temperature records that the shade temperature within a forest is slightly higher than the shade temperature in the open, but this is not the only condition that affects the melting of snow. It is true in general that the snow found upon mountains late in summer lies upon open slopes, but this is due to a heavy snowfall, dense drifting, and a retarded melting caused by low temperature at these high elevations or on northerly exposures. The absence of timber does not prevent the snow from melting, but the presence of snow through the whole or nearly the whole year will not allow the timber to grow.

In the Fort Klamath plain, part of which is timbered and part open, we found that the snow disappeared in spring about six weeks earlier in the open than in the forest. At Government Camp, on the southwest slope of Mount Hood, we were informed, the snow lies about six weeks longer in the forest than it does on denuded areas having the same exposure and elevation. Similar information was received regarding various other areas, and the general fact that the timber covering retards the melting of snow is abundantly and conclusively shown.

FUTURE OF SHEEP GRAZING IN OREGON.

Before proceeding to a consideration of the method of dealing with the sheep-grazing question, an estimate of the future of the industry so far as it affects the Cascade Reserve will not be without value. In general, the progress of sheep grazing in the Cascades has been from the north toward the south and from the eastern toward the western slope. The areas over which grazing is likely to extend in the immediate future are westward and southward from the Three Sisters on the west slope and southward to some extent from the Diamond Lake area on the eastern slope. This extension will not be rapid, provided the

number of sheep to be pastured in the Cascades does not continue to increase. If the number does increase and all the present available areas become overgrazed, fires are almost sure to occur in areas now well timbered—fires which are not countenanced by the best element of stockmen, but which will be caused by irresponsible packers and herders.

A general belief prevails that the increasing value of wool and mutton will cause an important and conspicuous increase in the number of sheep, and that the summer grazing land will in a few years become overgrazed. This conclusion at first sight appears plausible, but it must be remembered that Oregon is a country on which other parts of the United States draw very largely for their lambs; and as the demand for stock sheep is on the increase, and will probably continue to increase for some years, it is unquestionable that a large part of the expected increase in eastern Oregon will quickly leave the State. So fully and reasonably were the probable results of these fluctuations of the market and their effect upon stock sheep explained to me by a prominent owner in eastern Oregon, Mr. J. N. Williamson of Prineville, that I am disposed to accept his judgment that within the next few years the number of sheep in eastern Oregon will not materially increase, but that succeeding this period of a large outside demand for stock sheep an overproduction in Oregon will take place, so that at the end of, say, four or five years a marked increase will probably have shown itself.

In this connection I may say that an increase of the available range, should the demand for range increase, seems not impracticable. Under the peculiar conditions that exist in the lodge-pole pine forests on the pumice soils of the southern portion of the sheep range (described on page —), I see no reason why under a system of intelligent and skilled forage management experiments can not be made. It seems to me probable that the forage output of Crane Prairie, for example, might be doubled, but the experiment must be conducted with great care and the effects carefully watched by measuring the run off of the main fork of the Des Chutes.

REMEDIAL MEASURES.

Two extreme remedies have been proposed for the present unstable and unsatisfactory system: On the one side the total exclusion of sheep, and on the other the abolition of the reserve.

EXCLUSION OF SHEEP FROM THE RESERVE.

Assuming that the Interior Department adopts and puts into execution the policy of exclusion, the evils incident to overgrazing would of course be prevented. But what would be the effect on the forest fires? Would they cease? If they would, and if exclusion were the only remedy that would bring this about, no question could fairly be raised against it. But from the fact that destructive fires occurred in the Cascades long before they were used as a sheep range, that destructive fires have occurred in parts of the reserve in which sheep have never grazed, and that destructive fires are to-day occurring from a variety of causes that have no connection with sheep grazing, it can not be maintained that exclusion of sheep would wholly stop the forest fires.

DIFFICULTIES BETWEEN SHEEPMEN AND RANCHERS.

One common and persistent source of opposition to the grazing of sheep in the reserve is the ranchers who live along the routes over which the sheep customarily pass as they are driven to and from the mountains. These ranchers own plats, comparatively small in most cases, of fenced arable land, taken up for the most part under the homestead act, and commonly, therefore, containing 160 acres. The fenced area is not sufficiently large in addition to the land under cultivation, to furnish pasturage for the few horses and cows required to work the ranch and supply the mild luxuries of milk and butter. Their only pasturage resource, therefore—for under the existing land laws they can neither buy nor lease any more land from the Government—is to run their stock upon the outside range. Between one rancher and another the customary range of his neighbor, though he has no title to it, is respected. But many of the sheep herders—not all—in driving their bands toward the mountains in spring, when the new grass is in excellent condition, without the slightest consideration for the rancher, and often doubtless to pay back a score of an earlier year's quarrel, will bring their sheep up to the very fences and the grass may be eaten off so close that for the remainder of the season a cow can not get a nibble. There is no law, except the questionable law of the Winchester, by which the rancher can defend his home, and he earnestly supports the demand for exclusion, believing that if the sheep are kept out of the mountains the industry would be ruined and his own little range left free. I am confident, however, that this expected result would not be effected by exclusion, but that the sheep would be crowded into the lower range and the difficulty, except in a few favorably situated places, would be increased. A remedy, and perhaps the most easily available one, has been suggested in the form of local legislation prescribing limits (say a distance of half a mile) within which a band of sheep shall not be driven toward a ranch.

DIFFICULTIES BETWEEN SHEEPMEN AND CATTLEMEN.

Under the present land laws any man has a right to graze any amount of any kind of stock on any portion of the public lands (forest, Indian and military reserves, and national parks excepted) at any time. Naturally, sheep are very close grazers and an area on which they are pastured can not be used for either cattle or horses. "They won't work together." Furthermore, sheep are herded stock, while cattle and horses are never herded. As a result, a sheep owner can drive his sheep to any portion of the public range he may select, and can therefore exercise essentially a prior right to any choice piece of grazing land and exclude all other stockmen from it. The only limit to a sheep owner's progress over the public range is, first, mutual consent between himself and his stock-grazing neighbors as to limits; second, the use of physical force. Between reasonable men mutual consent is usually effective. Between men who can not come to an agreement various discouragements are adopted, such as poisoning sheep by scattering on the ground castor-oil beans or saltpeter mixed with salt, burning up the sheep herder's camp when he is away herding his sheep, or opening fire on a band with buckshot or bullets. Occasionally these amenities end in the death of one or more men by shooting. Details of such cases need not be given here.

It is an interesting and important fact, however, that whatever the

difficulties between cattlemen and sheepmen regarding winter ranges in the plains, they are agreed in desiring the summer-range privilege for sheep in the mountains, the sheepmen, of course, from its distinct addition to their grazing opportunities, the cattlemen because the temporary removal of sheep from the plains leaves a larger amount of summer forage there for their own stock, particularly in the canyons and moist bottom lands.

OTHER DIFFICULTIES.

According to the statistics given earlier in the report, 101,960 sheep were grazed last year in the Three Sisters and the Upper Deschutes range districts. It appears from examination of the original data that of these sheep only 8,660 were owned in Crook County, all the others being owned in the counties of Wasco and Sherman. Now, as the only routes to the Three Sisters and the Upper Deschutes districts are through Crook County, it follows that 93,300 sheep not owned in Crook County and paying no taxes there were driven across that county, eating up a large amount of forage that otherwise would have been available for the stock raisers of the county and causing damage to the roads, which must be repaired at the expense of the taxpayers of the county. The most practicable and direct remedy for this, it appears to me, lies not in excluding sheep from the reserve, but in levying on the transient sheep owners a county toll tax, offsetting the amount of damage sustained by the county. This has been done in Inyo County, Cal., and doubtless elsewhere. The legislative functions of the counties of Oregon are extremely limited constitutionally, but the State could undoubtedly make the necessary enactment to remedy both this and the preceding difficulties.

Reference has already been made to a general opposition to sheep grazing in the reserve on the part of those who look upon the reserve as a park, to be withheld from the general use of the public, instead of a reservation of natural resources to be maintained in a state of the highest continued production. Congress by its legislation has repudiated this park idea of the forest reserves as a whole, but has made it possible to provide for the maintenance as parks of such portions as are admittedly suitable for this purpose and are demanded as such by the local or general public.

IMPORTANCE OF SHEEP GRAZING TO THE COMMUNITY.

It is important to consider what would be the effect of exclusion on the trade relations and commercial welfare of the State of Oregon. Of the wool clip (that is the wool product) of 1897, there had been sold up to September, at The Dalles alone, the principal shipping point for eastern Oregon, about 8,000,000 pounds, at an average of 11 cents per pound, amounting to \$880,000. To this must be added the sale of mutton and stock sheep, the statistics of which are not available. Of the three principal products of eastern Oregon—wool, beef, and wheat—it is a matter of common belief, frequently expressed, that the money that comes into the hands of wool growers is the most important as ready cash in the community; that the nature of the business is such as to make it a quick distributor of money, and to add in a very material way to the general prosperity. According to the State census of Oregon for 1895, the wool clip of Crook County, for example, in that year was 1,983,325 pounds. Taking 15 cents as an average price, this amounts to \$297,498.75. When it is considered that the population of

Crook County, according to the census of 1895, was only 3,212, and that therefore the wool clip alone brings into the county an average of about \$92.62 per capita each year, the importance of the wool growing business as a supporter of local prosperity is at once evident. As a specific illustration of the significance of these figures I cite from the Massachusetts State census and statistics of manufactures for 1895 as follows: Population of Massachusetts, 2,500,183; manufactures of cotton goods, \$86,689,082; of boots and shoes, \$76,882,713; food preparations, \$43,984,375; machines and machinery, \$23,785,409. The total product of these manufacturing industries, the largest in the State of Massachusetts, is \$231,341,579, an average of \$92.53 per capita. In brief, the wool clip alone of Crook County is of as much commercial importance to its people as the five largest manufacturing industries of Massachusetts combined are to the people of that State. Crook County is, for its population, a large purchaser of general merchandise, most of which is either produced in the Willamette Valley or is shipped from outside the State through Portland. The prosperity of Crook County, therefore, is of importance to the prosperity of the whole State. Similar trade relations, varying in each case, exist in most of the thirteen other counties of eastern Oregon. Both the men who make laws and the men who administer them must weigh carefully the effect of their action before striking a blow at one of the leading industries of a region such as would be struck in the present case by excluding sheep from the reserve. Many ranchers and other men who have a dislike of sheep, of the methods of some sheep owners, and of the devastating effect of overgrazing, nevertheless stated that, in their opinion, the exclusion of sheep from the reserve was against the best commercial interests of their communities.

ABOLITION OF THE RESERVE.

The proposition, on the other extreme, to abolish the Cascade Reserve originated with the sheep owners, and doubtless did a great deal to foster the general public opinion that the sheep owners were carrying on an industry opposed to the best interests of the State. It has always been a matter of surprise to me that the sheep owners, instead of taking the almost inevitably untenable stand that the reserve be not established, did not support the movement, but demand that the right to graze be conceded to them. This is now explained. I was reliably informed by leading sheep owners that they were misled by a prominent official, who supposed, and accordingly told them, that if the reserve was created sheep would undoubtedly be excluded. Under these circumstances they took the only course open to them, namely, to maintain the then existing conditions by opposing the creation of the reserve. From my conversations with representative sheep owners I am convinced that a large majority of them, if they are given the grazing privilege on equitable terms, will cordially accept the reserve as a public benefit.

A NEW SYSTEM OF REGULATIONS.

After a thorough examination of the whole subject of sheep grazing in the Cascade Reserve, my conclusions are that the evils of the present system can be corrected neither on the one side by abolishing the reserve, nor on the other side by the exclusion of sheep, without in either case inflicting much more serious evils upon the welfare of the

State. I am confident, however, that a system can be adopted which, honestly and intelligently carried out, will stop the real evils of the present system and at the same time maintain the interests of all the communities concerned.

CLOSED AREAS.

The first step toward a satisfactory system of sheep-grazing regulations in the Cascade Reserve is to provide absolute protection for those places which the people of the State require as public resorts or for reservoir purposes. The grandeur of the natural scenery of the Cascades is coming to be better known. Even before the forest reserve was created a movement was on foot to have the Mount Hood region and the Crater Lake region set aside as national parks, and since the reserve was created the eminent desirability and propriety of the earlier movement has been clearly recognized, both in the continued efforts of the people to keep sheep from grazing in these regions and in the concession in the petition of the sheep owners that if the Cascade Reserve as a whole be abolished the Crater Lake and Mount Hood regions be maintained as smaller and separate reserves on which sheep be not allowed to graze. In the tentative regulations of the General Land Office dated June 30, 1897, the justice of these representations was officially recognized by a rule excluding sheep from grazing "upon or in the vicinity of the Bull Run Reserve (a small reservoir reserve contiguous to the Cascade Reserve at its northwestern extremity), Crater Lake, Mount Hood, Mount Rainier in another reserve in the State of Washington, or other well-known places of public resort or reservoir supply." Before this exclusion can be made effective the exact limits of the areas specified must be described by metes and bounds and the boundaries marked.

Crater Lake.—How much should be included in the closed areas at Mount Hood and Crater Lake is a question to which considerable attention has been paid in the field. After going twice carefully over the ground at Crater Lake and consulting with various men well informed on the subject, especially Capt. O. C. Applegate, of Klamath Falls, I question whether a better area can be adopted than that covered by the special Crater Lake contour map, published by the United States Geological Survey, which extends from longitude 122° to $122^{\circ} 15'$, and from latitude $42^{\circ} 50'$ to $43^{\circ} 04'$. At present no sheep are grazed in the vicinity of Crater Lake, but for a few years up to and including 1896 a small amount of summer grazing was carried on in the watershed of Anna Creek and that of the upper Rogue River.

Mount Hood.—It was my intention to submit a report on suitable boundaries for the closed area about Mount Hood, but as various petitions and memorials on the subject have been presented directly to the Secretary of the Interior and are under consideration, no recommendations are here presented. It may be well to state, however, that three principal propositions have been made as to the boundaries of the proposed closure. In the order of their size, beginning with the smallest, they are as follows: (1) Two roughly triangular blocks, one extending from the summit of Mount Hood north to the edge of the reserve, bounded on the east by the East Fork of Hood River and on the west by the Bull Run Reserve, the other extending from the summit of Mount Hood southward to the boundary between townships 3 and 4 south, bounded on the east by White River and on the west by Zigzag Creek and the line between ranges 7 and 8 east; (2) all that portion of the reserve north of the Barlow road and west of the summit of the

divide east of the East Fork of Hood River; (3) all that portion of the reserve north of an east-and-west line drawn through the northern boundary of the Warm Springs Indian Reservation.

Huckleberry patches.—In this connection one of Oregon's peculiar institutions should not be lost sight of. I refer to the practice common to the ranchers and townspeople who live near the Cascade Mountains of resorting to the mountains in summer to pick huckleberries. There are areas in the mountains which, from late August to October, produce annually an enormous amount of wild huckleberries (chiefly the kind known to botanists as *Vaccinium membranaceum*), and the present inhabitants, following an aboriginal custom of the Indians, go into the mountains, usually a whole family together, often driving 100 miles, and camp out for a few weeks, hunting, fishing, and picking huckleberries. One such area known as Huckleberry Mountain lies about 12 miles southwest of Crater Lake, immediately south and east of Union Creek, an affluent of Rogue River. It is not included within the boundaries of the proposed closed area at Crater Lake, described above, and should be made an additional closed area. Immense huckleberry patches are situated on and immediately south of Mount Hood and should be taken into consideration in defining the closed area of that vicinity. Another favorite huckleberry patch lies on the west slope of the Cascades, south of the Santiam-Prineville road; but it was not visited by us nor was its exact location ascertained.

Finally, with reference to closed areas, as the population of Oregon increases the recreation of the people will require the setting aside of additional areas of resort, from which sheep must be excluded. No place will be attractive as a public resort if the vegetation is eaten off every year by sheep, nor can camping parties under such circumstances find suitable pasturage for their horses.

GRAZING PERMITS.

The system of regulations I have to propose, which may be called the "special tract permit system," is, in brief, the granting of the grazing privilege to sheep owners in return for the protection of the reserve from forest fires and overgrazing. It is proposed to grant to each owner a permit to graze on a specified territory a certain number of sheep, such as that area can support without detriment, to give him the exclusive right to graze on that area, and to protect him in that right, at the same time requiring on his part that he confine himself to that area, fulfill all the terms of his agreement with the Government, and especially that he keep the area free, so far as lies within his power, from forest fires.

As an illustration I may cite the Fish Lake range, in the Three Sisters range district. This range is divided into five smaller ranges, known as The Parks, Bald Mountain, Iron Mountain, Browder Ridge, and the Blue River range. These, altogether, will support, without overgrazing, six bands averaging 2,000 each, one band upon each of the first four, two bands upon the last. In 1896 there were eight bands on the Fish Lake range—two of them on The Parks, one on Bald Mountain, one on Iron Mountain, the other four on Browder Ridge and the Blue River range, alternating one or two on the former and three or two on the latter. This was a larger number of sheep than the Fish Lake range could support properly, and as a result the sheep did not come out in good condition and there was general dissatisfaction among the owners. By the adoption of the system here proposed the number

of sheep allowed on the Fish Lake range would be limited to 12,000. No other sheep would be permitted to go into the Fish Lake range. Each owner would be assigned that subdivision of the range on which he had been accustomed to run his sheep, and would be supported and defended in his exclusive right to graze there. In return it would be the duty of the owner occupying Browder Ridge to see that no forest fires be allowed to occur on that area, either those set carelessly and intentionally by his own herder or packer, or those set by any hunter, camper, or other person who might be on that territory. If forest fires did occur on Browder Ridge, and the Interior Department was satisfied that the owner or his employees had not made every reasonable effort to prevent them or to extinguish them when once started, his permit would be terminated forthwith, and if evidence of collusion in setting the fires were shown one or all of the persons concerned would still be liable to prosecution under the forest-fire laws.

ADVANTAGES TO THE GOVERNMENT AND THE SHEEP OWNER.

To the Government the chief advantage of such a system would be to prevent a very large proportion of the fires that occur in the sheep-grazing area. The enormous annual loss in burned timber would at once be checked. By the granting of a permit for a particular area the responsibility of the owner is direct and his sense of that responsibility is keen. Under the old system an owner may range anywhere, with any number of sheep, and the Government knows neither where he is nor what he is doing.

The advantages to the sheep owner are several and important. The adage, "Every man for himself and the devil take the hindmost," was never more justly applicable to any business than to this one of grazing sheep on the public lands. It is to the interest of each owner to get his sheep sheared as early in the season as possible, even before the cold weather is gone, in order to get them off to the mountains before his neighbor. Then he must make long drives so as to keep ahead, and if his range lies on the west slope of the Cascades he will drive across the summit while it is yet covered with snow, the sheep passing sometimes two and even three days on the snow drifts without a nibble of grass. Then he has reached his range first and is reasonably secure for the season. But the ground is still soft, the spring rains may still be falling, and the sprouting grass has not yet reached the development necessary to make good feed. He may be crowded off during the summer, though usually it does not pay a later arrival to push in on a range already occupied. Whatever happens it is usually to the owner's interest to get all the grass possible without reference to the next year's crop, for he is never certain that he will be able to occupy the same range again. Where the competition is close the difficulty of insufficient forage is increased by the haste of a herder in forcing his sheep too rapidly over a grazing plot, the result being that they trample more feed than they eat. So year after year each band skins the range.

Under the proposed permit system, however, the owner, knowing that his range is assured, will shear his sheep at the time best suited to the local climatic conditions for that purpose, and will start for the mountains at a reasonable time. This is a matter of especial importance to those owners who live on the higher elevations of the plain, 3,000 feet or more above the sea, and who, in order to be in the race with those living at an elevation of 1,000 feet or less, must ordinarily, under exist-

ing conditions, leave their home range two weeks too early, at a time when it still bears a profusion of fresh nutritious grass. Reaching the grazing areas in the mountains when the grass has grown to a fair degree of maturity, a larger amount of better forage awaits the herder, and with a definite knowledge that he will use the same area in the following year he so handles his sheep as not to permanently injure the grass. Indeed, he may find it profitable to improve it by seeding with good varieties of clover and grass. One owner stated that several years ago he had sowed one summer \$20 worth of clover and grass seed, but that never having been able to secure the same range again he got no benefit from his expenditure, and had discontinued all efforts in that direction. With an assured title for a period of years an owner can also put up substantial shelters for his men and their provisions. A further advantage of great importance to sheep owners is the circumstance that, lying within a forest reserve, the grazing lands are not subject to homestead entry, and no one, therefore, by securing a title to the land can prevent its use as a sheep range. By a judicious use of the privilege granted under the proposed system the grazing lands of the reserve become a perpetual sheep range. To both the State itself and to the general body of sheep owners the proposed system is an advantage from the evident fact that if the forest grazing privilege is valuable at all it is most valuable when the amount of forage it furnishes is maintained at its highest limit of continued production, as would be the case under the proposed system, instead of being maintained at its lowest limit of production, as would finally be the case under the present system.

There is a popular but erroneous idea that the responsibility for the present system of grazing in eastern Oregon rests with the sheep owners. It is found, however, on conversation with a large number of them, that they are opposed to the present method and would welcome a change in Government policy which would give them a financial interest in the maintenance of good pasturage. If they could secure for a reasonable period of years a title to the grazing product, they believe it would be one of the greatest benefits possible to the industry.

OBJECTIONS TO THE PROPOSED SYSTEM.

In discussing the proposed plan with stock men I found, somewhat unexpectedly, that all those to whom I had the opportunity of explaining it fully without exception approved it, but often with the proviso, "If it could be carried out." Their primary doubt was that though a majority of the owners would gladly adopt the system there would always be a few who would refuse to agree to any regulations or would be unscrupulous enough to transgress them when they found it to their own interest to do so. It appears that the eminent desirability of adopting some scheme of parcelling out the range had long been recognized and in an informal way had been attempted in various localities, but that invariably some unscrupulous owner, by crowding in upon another's range, had broken up the system. Upon being reminded that a new set of laws had been enacted under which the Interior Department had full authority to make regulations covering the land within the forest reserves and full power to enforce them, and that while the Government undoubtedly wished to handle the subject with the velvet hand of equity there lay beneath it the iron claw of stern authority, they readily appreciated that recalcitrant owners would not be as serious an obstacle to the Interior Department as they had been to their own unauthorized system.

A second objection, and one at first difficult to meet, was that the Interior Department would be unable to divide the range equitably; that certain owners, particularly large owners, would secure the best ranges, and that continued dissatisfaction would result. The objection clearly was well made. I myself had been keeping a list of all the ranges, with the number of sheep each would support, and I knew how extremely difficult it would be for any one man to do full justice to each individual owner, especially in the face of the conflicting representations with which he would be met. The Northern Pacific Railroad and other corporations having grazing privileges to dispose of can and do deal directly with individual applicants, without necessarily consulting others, but this method is not open to the Government. The most natural way to decide between two or more persons competing for the same right is to grant it to the highest bidder. My own doubts of the suitability of this method were confirmed by conversations with sheep men.

The unanimous verdict was that such a proceeding would tend to put the grazing lands in the hands of a small number of large owners who could afford to pay a higher price than owners of single bands.

As a result of careful consideration, the plan of permitting the sheep owners themselves to parcel out the range suggested itself. It was found that in each of the three counties concerned—Crook, Wasco, and Sherman—there exists a woolgrowers' or stockmen's association, the original object of which, it appeared, was chiefly mutual protection of their sheep against coyotes and other wild animals through the payment of bounties raised by subscription or tax among the members of the association. A committee or commission of three, each representing one of these county associations, would be thoroughly competent to divide the range and could do it both more equitably and with less objection from dissatisfied owners than could any officer or officers of the Government. This commission could meet at a time and place duly advertised, receive the written applications for ranges, adjudicate conflicting applications, and make recommendations accordingly to the Interior Department. This plan answered the last objection brought forward against the system.

ADDITIONAL DETAILS.

Other details of the system may be briefly mentioned. The permit should be for a definite number of years, sufficient to give the permittee an interest in maintaining the range in good productive condition from year to year, and on the other hand it should not be for so long a period as to prevent new men from coming into the business. A permit period of five years with a provision for renewal appears to be the most satisfactory.

Failure on the part of a permittee to occupy a range before the expiration of a reasonable period, say by the 1st of August in any year, without due explanation, would cause the permit to lapse and the range to be again open to application and the granting of a new permit for the remaining portion of the original term. This would prevent any owner from wasting the resources to which he might have an exclusive right.

The suggestion has been made by a citizen of Oregon that a sheep owner, as one of the requisites for obtaining a permit, should give a bond, securing the Government against destruction of the timber by fire. This provision, however, would be a hardship in many cases and should be adopted only as a last resort. Another provision, the adop-

tion of which is worth considering, is the exclusion of sheep for a period of several years, or until the seedlings are too high to be trampled, from any piece of forest land hereafter burned. The object of this would be, first, to allow the seedlings to get a good start; secondly, to remove the temptation to set a forest fire for the purpose of creating new range.

It is essential that provision should be made for these cases, in which an owner, in order to reach the tract allotted to him, must cross a tract allotted to another owner. After careful consideration the simplest and most effective method appears to be to provide for a right of transit with a minimum rate of travel per day. This rate should be between 7 and 10 miles; perhaps the most suitable rate, all things considered, being 8 miles. At the same time the owner whose tract is crossed should have received an original allotment sufficiently large to compensate him for the amount of feed that would be used by the one or more bands that have the right of transit.

If provision is made by Congress for a forest reserve patrol and an adequate system of administration, an adjustment of the officers can easily be made by which the proper carrying out of the proposed permit system may be assured, but it may not be amiss to point out that upon the integrity and ability of these officers rests in large measure the success of the system.

FEES AND COST OF ADMINISTRATION.

The Government will be subjected to some expense in the administration of the permit plan, and the cost of this administration should be borne by the sheep owners, to be paid in the form of a fee for the permit.

ABSTRACT OF PROPOSED REGULATIONS.

In order to sum up the conclusions of this investigation in a form showing concisely what action should be taken by the Interior Department to inaugurate a satisfactory system for the regulation of sheep grazing in the Cascade reserve, an abstract of the proposed plan is given below. It must not be forgotten that this report, both in the matter of the extent of damage done to the forests by sheep and in the system proposed for its regulation, applies only to sheep grazing in the Cascade Range Forest Reserve, and that very different findings of fact and propositions for regulation might have been submitted had the area in question been situated under different climatic conditions, or had contained other types of soil or other kinds of forests, or had been subject to sheep grazing for a longer period, or had other equally important conditions affected the problem.

The steps necessary to a solution of present difficulties by the Interior Department are as follows, and these steps, in order to save and perpetuate the timber supply and the water supply of middle Oregon, should be taken at once:

1. Exclude sheep from specified areas about Mount Hood and Crater Lake.

2. Limit the sheep to be grazed in the reserve to a specified number, based on the number customarily grazed there.

3. Issue five-year permits allowing an owner to graze on a specified tract, limiting the number of sheep to be grazed on that tract, and giving the owner the exclusive grazing right.

4. Require as a condition of each permit that the owner use every effort to prevent and to extinguish fires on his tract, and report in full the cause, extent, and other circumstances connected with each fire.

5. Reserve the right to terminate a permit immediately if convinced that an owner is not showing good faith in the protection of the forests.

6. In the allotment of tracts secure the cooperation of the woolgrowers' association of Crook, Sherman, and Wasco counties through a commission of three stockmen, who shall receive written applications for range, adjudicate them, and make recommendations, these recommendations to be reviewed by the forest officer and finally passed upon by the Secretary of the Interior.

7. Ask the county associations to bear the expenses of the commission.

8. Charge the cost of administration of the system to the owners in the form of fees for the permits.

9. If the woolgrowers decline to accept and to cooperate in the proposed system, exclude sheep absolutely from the reserve.

10. If after five years' trial of the system forest fires continue unchecked, exclude sheep thereafter from the reserve.

