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U. S. DEPARTMENT OF AGRICULTURE.

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REPORT

OF

THE FORESTER

FOR

1911.

BY

HENRY S. GRAVES.

[FROM ANNUAL REPORTS OF THE DEPARTMENT OF AGRICULTURE.]



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REPORT OF THE FORESTER.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., November 24, 1911.

SIR: I have the honor to transmit herewith a report of the work of the Forest Service for the fiscal year ended June 30, 1911, together with an outline of the plans for the work of the Service for the current fiscal year.

Respectfully,

HENRY S. GRAVES,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

CLASSIFICATION OF EXPENDITURES.

The appropriation act for the Department of Agriculture for the fiscal year 1911 and other acts made available for the Forest Service the following sums:

For salaries ¹	\$60,200.00
For general expenses.....	4,672,900.00
For improvement of the National Forests.....	275,000.00
<hr/>	
Total appropriated for Forest Service under the agricultural appropriation act.....	5,008,100.00
Available for the work of the Forest Service under other clauses of the act:	
For paper tests 1910-11.....	\$30,000.00
For naval stores industry study.....	4.55
	<hr/>
	30,004.55
Available under the deficiency act ²	900,000.00
From other sources:	
Federal cooperation (expenditures reimbursed by other Federal bureaus).....	2,189.67
Private cooperation (\$7,620.38 contributed by cooperators in 1911; \$7,295.21 brought forward from 1910; less \$311.29 returned to cooperators).....	14,604.30
	<hr/>
	16,793.97
Total from all sources.....	<hr/> 5,954,898.52

At the close of the year there were unexpended balances as follows:

From appropriation salaries and general expenses.....	\$29,615.27
From appropriation improvement of the National Forests.....	1,365.58
Unexpended cooperative funds (carried to fiscal year 1912).....	3,977.71
	<hr/>
	34,958.56
Amount expended.....	<hr/> 5,919,939.96

¹ In addition to this appropriation for salaries for specific positions, the appropriation for general expenses was available for salaries for the purposes set forth in the bill.

² This appropriation was made necessary by the heavy emergency expenditures for forest-fire fighting incurred in August and September, 1910. The extra expenditures for fighting fires totaled \$1,086,560.89.

The total expenditures from the above sources for the work of the Forest Service, including extra expenditures for fire fighting, were therefore \$5,919,939.96. The \$1,086,590.89 which, as already stated, was disbursed in fighting fires covers only the charges incurred specifically for this purpose, i. e., the hire of temporary laborers when the regular force of forest officers is too small to handle the fires, payments for transporting and provisioning these men, the purchase of tools for their use on the fire line, etc. In addition there was the cost of the regular protective force of nearly 1,500 rangers and over 500 guards, and also that of the supplies and equipment and field and station expenses for other purposes than fire fighting. These four headings of (a) extra expenditures of fighting forest fires, (b) cost of regular protective force, and (c) cost of field and station expenses, supplies, and equipment, together with (d) the cost of permanent improvements on the National Forests, make up the strictly field expenditures on the Forests; though the charge entered below under the head of (e) supervision and inspection includes both salaries and traveling expenses of supervisors and deputy supervisors on the Forests, whose duties involve to a large extent work, both office and field, which are not, strictly speaking, supervisory.

This item of supervision and inspection includes also the salaries and expenses of the supervisory men in the six district offices. The other items in the cost of National Forest administration are (f) technical assistance, which includes the services of timber and mining experts, engineers, land examiners, etc., as well as forest examiners and forest assistants, and (g) clerical, law, and accounts work. The amount of the charge for each of these items is shown below:

Expenditures for the National Forests (not including expenses at Washington):

(a) Fighting forest fires.....	\$1,086,590.89
(b) Protective force.....	1,786,548.43
(c) Field and station expenses, supplies and equipment.....	841,672.51
(d) Permanent improvements.....	273,634.42
(e) Supervision and inspection.....	580,720.07
(f) Technical assistance.....	393,922.25
(g) Clerical (including law and accounts).....	402,534.96

Total.....	5,365,623.53
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The remaining expenditures for the Forest Service are partly for the support of the Washington office, partly for the Madison laboratory. At the Madison laboratory are concentrated the technical studies having to do with forest products. The cost of the Washington office covers general supervision of the entire work of the Forest Service, including the administration of the National Forests; the cost of all scientific investigations; and also a great deal of routine work for the National Forests which can be done more economically at Washington than in the districts, either because of the advantage of concentrating the work or because of the necessity of consulting the records of the General Land Office.

Adding in the cost of the Washington office and the Madison laboratory, the total expenditures of the year become:

National Forests (not including expenses at Washington).....	\$5,365,623.53
Madison laboratory.....	158,710.69
Washington office.....	395,605.74
Total.....	5,919,939.96

There were also made under the direction of the Forest Service the following miscellaneous expenditures:

Examination of lands, titles, etc., under the Weeks Act.....	\$18,076.07
National Bison Range, Mont.....	2,381.61
Refunds to depositors, excess deposits (34 Stat., 1270).....	57,912.73
Payments to States, 25 per cent of receipts from National Forest resources for fiscal year 1910.....	506,194.83
Cooperative funds returned to contributors.....	311.29
Total.....	584,876.53

In addition a liability of \$224,000 was incurred through a contract entered into for the purchase of lands under the Weeks Act, and expenses of the National Forest Reservation Commission, amounting to \$178.57, were defrayed.

The following statement shows the amounts paid to States and Territories, to be expended for roads and schools, from the National Forest receipts of the fiscal year 1910, and the amounts that will be paid from the receipts for the fiscal year 1911:

State or Territory.	Amount paid fiscal year 1910.	Amount payable fiscal year 1911.	State or Territory.	Amount paid fiscal year 1910.	Amount payable fiscal year 1911.
Arizona.....	\$51,229.38	\$55,385.45	Nevada.....	\$16,314.33	\$12,198.38
Arkansas.....	2,904.44	3,487.04	New Mexico.....	28,529.53	32,541.50
California.....	60,752.91	53,717.42	North Dakota.....	63.64	71.41
Colorado.....	50,306.19	52,372.28	Oklahoma.....	626.10	273.67
Florida.....	706.38	1,381.41	Oregon.....	39,635.87	35,612.29
Idaho.....	66,074.55	52,594.33	South Dakota.....	9,808.93	14,197.32
Kansas.....	1,004.67	919.10	Utah.....	32,905.49	34,869.10
Michigan.....	.....	4.25	Washington.....	23,671.89	24,111.36
Minnesota.....	457.37	1,309.55	Wyoming.....	34,704.54	30,126.52
Montana.....	\$3,678.38	74,021.04	Total.....	506,194.84	482,376.73
Nebraska.....	2,820.25	3,183.31			

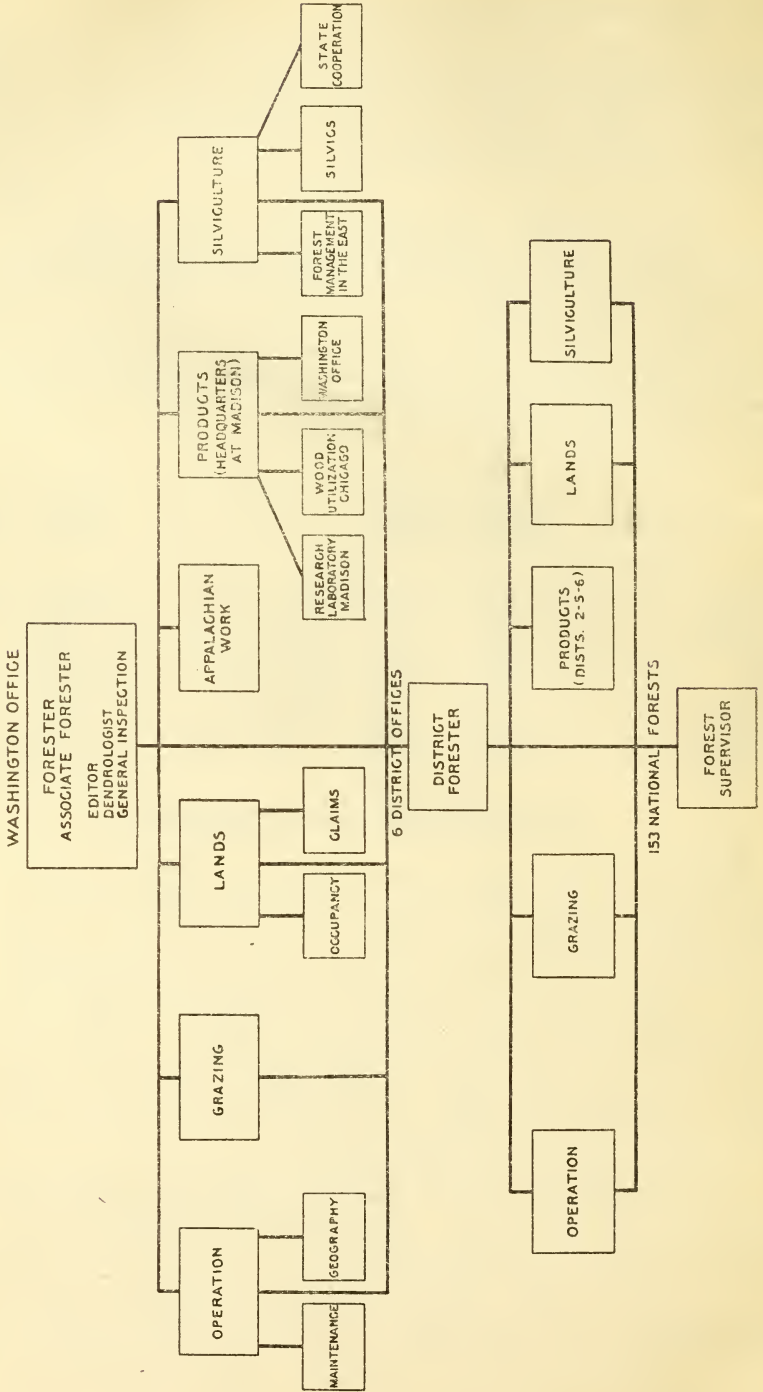
ORGANIZATION AND PERSONNEL.

The form of the organization of the Forest Service at the close of the fiscal year June 30, 1911, is shown graphically on page 6. The only important change during the year was the addition of a new unit to handle the work arising under the Weeks law in connection with the purchase of lands on the watersheds of navigable rivers. Mr. W. L. Hall, formerly in charge of the Branch of Forest Products, was assigned to the direction of this new work. A small supervisory organization is maintained at Washington, but the principal force, engaged in the examination of lands and negotiations for their purchase, is located in the field. Field headquarters were established at Asheville, N. C., and at Concord, N. H.

An important change which does not appear on the chart was a substantial reduction in the number of supervisory officers in Washington and in the districts. It has been the consistent policy of the Forest Service to conduct in the field as much of the business of the National Forests as possible. This was the purpose in establishing the six district offices. Just as fast as it was deemed wise increased responsibility was placed upon the district officers, and in turn the district foresters steadily increased the responsibilities of the supervisors as fast as they became sufficiently experienced to assume them; and again in turn the supervisors from time to time increased the

ORGANIZATION OF THE FOREST SERVICE

JUNE 30, 1911



responsibilities of the rangers. It is obvious that during the early period of building up the technical organization it was necessary to maintain a considerable force of officers charged with supervising and inspecting the work on the Forests. The gradual reduction of the supervisory force at Washington and in the districts has been carried on now for about three years, and amounts to fully 33 per cent. In the Washington office the number of men holding the title assistant forester has been reduced to four. In the districts the office of associate district forester has been dispensed with, and there has been curtailment in each district office of at least two assistant district foresters. During the past year alone the supervisory force in the districts was reduced by 19 men. The men occupying these positions were for the most part promoted to fill vacancies or for one reason or another have resigned from the Service.

In districts 5 and 6 the district foresters, Mr. F. E. Olmsted and Mr. C. S. Chapman, resigned their positions, the first to enter private business as a consulting forester, the second to accept a position with the Oregon Fire Protective Association. In these men the Forest Service lost two of its most experienced and capable officers; Mr. Olmsted was appointed in 1900 and Mr. Chapman in 1901. Their positions were filled by the promotion of District Associate Foresters Coert Du Bois and George H. Cecil. The district forester in district 1, Mr. W. B. Greeley, was transferred to Washington to assume charge of the Branch of Silviculture, vacated by Mr. W. T. Cox, who, to my keen regret, resigned from the Forest Service to become the State forester of Minnesota. In district 2 the associate district forester, Mr. Paul G. Redington, was transferred at his own request to the position of supervisor of the Sierra Forest. The associate district foresters in districts 3 and 4, Mr. Franklin W. Reed and Mr. Earle H. Clapp, were transferred to the Washington office as inspectors, the first in the Branch of Operation and the second in the Branch of Silviculture.

While a certain amount of drafting and map work is conducted in the district offices, and a small amount necessarily on the Forests, the greater part is concentrated at Washington for reasons of economy. A great deal of scientific work centered at Washington is closely related to Forest administration and is for the purpose of developing better methods of silviculture and range management. It is, however, properly carried as a separate charge. The total force at Washington has been increased in spite of the reduction in the administrative officers. This is due to the additional work required under the Weeks law, to the greater amount of work in accounts resulting from the new form of the appropriation bill, to the introduction of a more detailed system of cost accounting, and to expansion in certain phases of research work, notably range investigations, dendrology, and forest products.

In the districts the administrative force has now been cut to the district forester and four assistant district foresters. In addition, there are specialists who assist in certain lines of work, as, for instance, the district engineer, expert lumbermen, assistants in planting, mineral examiners, etc.

The policy of reducing the overhead charges to a minimum and expending the available money on operating expenses has been carefully applied also on the Forests themselves. In general, the

organization of a Forest consists of a supervisor, a deputy supervisor, a forest clerk, and a group of rangers. The need of the deputy supervisor is to enable constant field supervision of the rangers and of their work. An efficient clerk is frequently able to handle the bulk of the routine office business, so that often the supervisor and deputy supervisor can be in the field at the same time. The effort is to reduce to a minimum the office routine which must be handled by the forest officers themselves in order that their time may be spent in directing the details of the business of the Forest. Where the work requires it, a forest assistant is assigned to the supervisor's office to assist him in miscellaneous lines of technical work and in such experimental and scientific studies as may be conducted on the Forest. In general, there is a group of permanent rangers on each Forest employed during the entire year. The force of rangers is kept down to the smallest number compatible with a permanent organization. During the summer additional rangers are appointed for from three to six months of service. The latter are recruited from the civil-service register, as in the case of the permanent rangers. Temporary forest guards are also appointed during the summer for fire patrol, the construction of trails, and other temporary work.

A systematic plan has been introduced to bring about the most effective distribution of the rangers' time. A detailed cost-keeping plan has been put into effect, and the forest officers are developing plans on each Forest to make the rangers' work more effective. Already excellent results are being obtained, for the rangers as well as the higher officers have undertaken the problem with enthusiasm.

The following table shows the classification of the Forest force, including field men temporarily assigned to the district offices, on June 30, 1911:

Supervisors.....	151
Deputy supervisors.....	100
Rangers.....	1, 424
Guards.....	526
Forest examiners and forest assistants.....	129
Timber and mining experts, engineers, land examiners, hunters, etc.....	112
Clerks.....	182
Total.....	2, 624

To facilitate administration a number of Forests were divided into smaller units. Four new units were created by the partition of existing Forests upon which the amount of business has increased to such an extent as to necessitate a reduction in the area, with small additions of territory which has been found to be more valuable for forest purposes than for other use. These new units are the Tusayan, in Arizona, which comprises a portion of the Coconino Forest and 74,356 acres of newly added territory; the Kern, in California, which is made up of a portion of the Sequoia Forest and 12,663 acres of new territory; the Eldorado, in California and Nevada, which comprises a portion of the Tahoe Forest, together with 31,710 acres of new territory; and the Palisade, in Idaho and Wyoming, formerly a part of the Targhee Forest. The San Luis Forest, in California, was merged with the Santa Barbara Forest, following a large elimination which reduced its area to such an extent as not to warrant separate administration. The San Juan Forest, in Colorado, the Black Hills Forest, in South Dakota, and the Chelan Forest, in Washington, were administered in two separate

units, owing to an increased volume of business in these Forests. On the other hand, on account of the undeveloped character of the Forest areas, the Choctawhatchee and Ocala Forests, in Florida, and the Michigan and Marquette Forests, in Michigan, were administered as single units. The Luquillo Forest, in Porto Rico, is not under administration, because of the large amount of alienated land and of land the title to which is in question within its boundaries. A new Forest, called the Santa Rosa National Forest, was created from public lands in Nevada not hitherto within Forest boundaries. The net result is that 153 units were under administration within the limits of the United States, as against 147 at the end of the last fiscal year, and the average Forest area was reduced from 1,129,957 acres to 1,070,545 acres.

THE NATIONAL FORESTS.

AREA AND BOUNDARIES.

The total area within the boundaries of the National Forests was decreased during the year by presidential proclamations which eliminated 4,598,705 acres and added 2,806,267 acres. These additions and eliminations were made as a partial result of the field examinations carried on during the past two years. Additional changes, not shown in the area table on page 10, became effective on July 1, 1911, adding 364,480 acres and eliminating 84,969 acres. Further additions and eliminations, amounting to approximately 619,000 acres and 1,128,000 acres, respectively, are still pending.

The policy which has governed recommendations for additions and eliminations, as agreed upon by the Secretary of Agriculture and the Secretary of the Interior February 7, 1910, and later approved by the President, is as follows:

(1) Lands wholly or in part covered with brush or other undergrowth which protects streamflow or checks erosion on the watershed of any stream important to irrigation or to the water supply of any city, town, or community, or open lands on which trees may be grown, should be retained within the National Forests unless their permanent value under cultivation is greater than their value as a protective forest.

(2) Lands wholly or in part covered with timber or undergrowth, or cut-over lands which are more valuable for the production of trees than for agricultural crops, and lands densely stocked with young trees having a prospective value greater than the value of the land for agricultural purposes, should be retained within the National Forests.

(3) Lands not either wholly or in part covered with timber or undergrowth, which are located above timber line within the Forest boundary or in small bodies scattered through the Forest, making elimination impracticable, or limited areas which are necessarily included for a proper administrative boundary line, should be retained within the National Forests.

(4) Lands not wholly or in part covered with timber or undergrowth, except as provided for in the preceding paragraphs, upon which it is not expected to grow trees, should be eliminated from the National Forests.

While it will doubtless be necessary in the future to make small additions and eliminations from time to time as conditions change, it is believed that the boundaries as now established or planned may be regarded as fairly stable.

As the National Forests consist largely of unsurveyed lands the gross area figures are subject to corrections. A revised estimate adopted January 1, 1911, reduced the apparent area of the Forests 530,516 acres, as shown by States in the following table. The changes of area due to additions and eliminations, the amount of alienated lands within the Forests, and the net area—that is, after deduction is made of the lands eliminated—are also shown. Lands covered by patents issued or pending are classed as alienated. They include as their principal items the following: Railroad selection lists pending, 1,273,360 acres; homestead entries, original, 1,138,550 acres; State selections, including school, 670,086 acres.

National Forest areas, in acres, by States.

State or Territory.	Gross area June 30, 1910.	Addi- tions.	Elimina- tions.	Correc- tions Jan. 1, 1911. ¹	Gross area June 30, 1911.	Alienated area.	Net area June 30, 1911.
Arizona.....	15,214,745	512,065	915,665	+ 86,855	14,898,000	1,014,548	13,883,452
Arkansas.....	3,189,781	40	964,242	+ 311	2,225,890	1,041,878	1,184,012
California.....	27,968,510	732,378	883,400	- 82,033	27,735,455	6,631,386	21,104,069
Colorado.....	15,491,791	.....	641,967	- 87,924	14,761,900	1,353,762	13,408,138
Florida.....	674,891	.....	.....	+ 79	674,970	356,010	318,960
Idaho.....	19,963,171	5,695	72,842	-252,669	19,643,355	1,503,920	18,139,435
Kansas.....	302,387	.....	.....	+ 1,550	303,937	147,561	156,376
Michigan.....	163,373	.....	.....	+ 398	163,771	79,760	84,011
Minnesota.....	1,204,486	.....	.....	+ 264	1,204,750	360,277	844,473
Montana.....	19,474,696	.....	114,575	- 55,021	19,305,100	3,112,596	16,192,504
Nebraska.....	556,072	.....	.....	+ 628	556,700	35,635	521,065
Nevada.....	5,109,415	647,838	97,823	- 9,083	5,650,347	226,093	5,424,254
New Mexico.....	11,140,123	608,884	742,776	+105,069	11,111,300	1,300,778	9,810,522
North Dakota.....	13,940	.....	.....	- 20	13,920	7,696	6,224
Oklahoma.....	60,800	1,204	360	+ 4	61,640	612	61,028
Oregon.....	15,920,822	.....	.....	+228,078	16,148,900	2,408,761	13,740,139
South Dakota.....	1,294,440	.....	.....	- 6,740	1,287,700	213,940	1,073,760
Utah.....	7,411,157	298,163	78,318	+ 36,553	7,667,585	465,890	7,201,695
Washington.....	12,007,340	.....	17,610	-305,050	11,684,080	1,770,366	9,914,314
Wyoming.....	8,941,681	.....	56,327	-191,811	8,693,543	273,046	8,420,497
Total in United States.....	166,103,621	2,806,267	4,585,905	-530,540	163,793,443	22,304,515	141,488,928
Alaska.....	26,761,626	.....	12,800	+ 24	26,748,850	105,590	26,643,260
Porto Rico.....	65,950	.....	.....	.....	65,950	32,975	32,975
Grand total.....	192,931,197	2,806,267	4,598,705	-530,516	190,608,243	22,443,080	168,165,163

¹ Due to new computations of acreage, as explained in the text above.

CLAIMS AND SETTLEMENT.

Still further alienations will, of course, take place. Many claims which antedate the creation of the Forests remain to be perfected; claims may still be initiated under the mining laws, and listing of areas for settlement continues wherever the land is found to be more valuable for agriculture than for forest purposes.

While the Forest Service does not obstruct or desire to prevent the patenting of any valid claim, it cooperates with the General Land Office to protect the Government against illegal claims by making field examinations on notification that patent is sought. This cooperation has worked well. The procedure in claims cases was greatly simplified and delays were obviated by the adoption in November, 1910, of the method set forth under "Work for the ensuing year" in

last year's report, whereby reports on claims are submitted by the district foresters directly to chiefs of field division of the General Land Office. When it appears necessary to contest a claim, the district assistant to the Solicitor of the Department of Agriculture considers the evidence submitted by the Forest Service field examiner, and the law involved; and, if satisfied that a contest should be initiated, frames the charges to be recommended to the chief of field division. The latter decides whether or not a hearing shall be ordered.

In examining mineral claims the procedure followed is so planned as not to interfere with legitimate mineral development. Reports on mining claims are made to the General Land Office only when patent is applied for, or when the land is held for purposes other than mining and the claim is interfering with the administration of the Forest. On notification that patent to National Forest land is sought under the mining laws a forest officer makes an examination and, if he finds that the claim is apparently held in good faith for mining purposes and its location is such that the issuance of patent will not prejudice National Forest interests, his recommendation is favorable. When he finds that the claim is located on land valuable for its timber, or which has a high value for purposes other than mining, an examination is made by a mining expert to determine whether the mineral law has been fully complied with. Adverse recommendations are never made to the General Land Office except upon the report of such mineral experts.

To supply the Forest Service with a sufficient force of properly qualified men the Civil Service Commission held an examination and established a register of eligibles designated as mineral examiners.

Field examinations of claims furnished a basis for reports to the General Land Office as follows:

Reports to the General Land Office on unpatented claims.

Character of action.	Home- stead entry.	Desert land entry.	Timber and stone entry.	Mineral entry.	Coal entry.	Miscella- neous.	Total.
Favorable.....	1,418	31	220	1,049	207	22	2,947
Unfavorable.....	395	18	32	157	18	6	626
Total.....	1,813	49	252	1,206	225	28	3,573

Action upon claims to National Forest land before the Department of the Interior resulted as follows:

Claims to National Forest land disposed of by the Department of the Interior.

Character of report.	Home- stead entry.	Desert land entry.	Timber and stone entry.	Mineral entry.	Coal entry.	Miscella- neous.	Total.
Patent issued.....	935	21	325	700	19	7	2,007
Canceled.....	626	17	15	183	53	4	898
Total.....	1,561	38	340	883	72	11	2,905

The applications for and listing of National Forest lands for homestead entry under the act of June 11, 1906, are shown in the following table. The total acreage listed since the passage of the law was at the close of the year 943,718 acres, as against 632,412¹ acres at the close of the previous year. Since the fiscal year ends in the midst of the field season, and since there is always an accumulation of applications during the winter months when field examinations are in most regions impossible, the number of applications awaiting final action is not typical of the actual state of the work. By the close of the field season the work will be practically up to date.

Applications and listings for Forest homestead entry.

Fiscal year—	Number of applications during year.	Awaiting final action at close of year.	Number of tracts listed during year.	Acreage listed during year.
1911.....	5,349	2,984	2,962	311,306
1910.....	5,216	4,193	1,751	188,751

¹ Corrected figures. The total given in the report for 1910 failed to include 5,106 acres listed on the Wichita Forest and 434 acres on Forests in Colorado and Wyoming. The total area listed to June 30 1910, was 632,412 acres instead of the 626,872 acres reported a year ago.

The above table shows that the number of tracts listed last year was about 70 per cent greater than in 1910. At the present time the areas listed for settlement under the Forest homestead act exceed a total of 1,000,000 acres, undoubtedly the cream of the land suitable for agriculture. Over 8,000 settlers have thus been provided for.

COST AND USE.

The following tables show the gross cost of administration and protection, expenditures for permanent improvements, and receipts from the several sources, both in totals and per acre, during the year, as compared with those for the fiscal year 1910. The per-acre expenditures and receipts are computed on the basis of the gross area of all National Forests under administration at the close of the year, since the cost of administration is not materially lowered by private holdings within the Forests.

Expenditures for administration and protection and permanent improvements during the fiscal year 1911, compared with 1910.

	Administration and protection.		Permanent improvements.	
	Total.	Per acre.	Total.	Per acre.
1911.....	\$5,335,886.97	\$0.02766	\$273,634.42	\$0.00142
1910.....	3,752,316.91	.01894	598,835.64	.00310

¹ Corrected figures. See note under table.

Comparison of receipts from the several sources for fiscal years 1911 and 1910.

Fiscal year—	Timber.		Grazing.		Special uses.		All sources.	
	Total.	Per acre.	Total.	Per acre.	Total.	Per acre.	Total.	Per acre.
1911.....	\$1,014,769.84	\$0.00526	\$935,490.38	\$0.00491	\$76,645.93	\$0.00040	\$2,026,906.15	\$0.01065
1910.....	1,043,428.20	.00541	986,909.38	.00512	59,810.50	.00031	2,090,148.08	.01084

Refunds of excess deposits (as, for example, deposits made by buyers of timber in advance of cutting) have not been deducted from the receipts given above. The refunds of timber receipts in 1911 amounted to \$48,176.43 and of all receipts to \$57,912.73. A deduction of the refunds would leave the total of receipts for 1911 \$1,968,993.42, as against \$2,041,181.22 for 1910. These figures show a decline in total receipts of \$72,187.80. The decline in receipts from timber, after deducting refunds, was \$45,249.97, and from grazing \$42,004.45, while from special uses there was a gain over the previous year of \$15,066.62.

The reasons for the decreased receipts from timber and grazing are explained in detail under the heads of "Forest management" and "Range management." The salient facts are: (1) That in both timber sales and grazing use fluctuations of the receipts take place in response to business conditions affecting the lumber and live-stock industries; (2) that the National Forest range is now utilized, in most regions, substantially up to its capacity and no considerable increase in receipts from grazing is to be anticipated while the charge for the grazing privilege remains on the present basis; and (3) that only a very small part of the merchantable timber on the National Forests has as yet come into demand, and increase in the income from the sales of timber depends primarily on the rate at which the upbuilding of the West develops better markets and transportation facilities.

The lumber industry has never made full recovery from the depression which followed the panic of 1907. The improvement manifest in the period covered by the fiscal year 1910, and reflected in increased receipts from National Forest timber sales in that year, was checked early in the fiscal year 1911; and to the unfavorable effects of a general business policy of retrenchment and economy was added the depressing influence of overproduction of lumber in the Northwest. Nevertheless, receipts from timber sales in 1911 were within 3 per cent of what they were in 1910, while contracts of sale for timber to be cut in the near future disposed of 45 per cent more timber than was sold in 1910. Sales under existing contracts practically assure a substantial gain in receipts for 1912.

The fact that for a year in which receipts from the Forests declined about 3 per cent, the gross expenditures for administration, protection, and improvement showed an increase over the previous year, raises the question whether this accords with good business policy, and also the question whether the net cost of the Forests to the Government year by year ought not to be growing less.

The cost of the National Forest work may be analyzed into: (1) Expenditures necessary to provide for present use; (2) expenditures in connection with claims and the listing of land for settlement; (3) expenditures to protect the standing timber, young growth, and

water-holding power of the Forests from harm; (4) expenditures to equip the Forests with the things required to facilitate use and protection; and (5) expenditures for investigations, designed to promote better use.

Of these only the expenditures of the first class are to be regarded as the cost of doing current business; and since a part of current business is free use, the cost of doing the business which yields receipts is less even than the total expenditures in this class. By stopping all work other than that involved in making and supervising timber sales, regulating grazing, and handling special uses for which payment is made, the Forests could easily be made to show a net profit to the Government, even with the charge for grazing left, as at present, far below the commercial value of the privilege. Such a policy would, however, lessen the public benefits which the Forests are yielding at the present time; it would entirely fail to provide for the best use of all kinds of land; it would expose to destruction by fire public property of enormous money value and incalculable future importance; it would fail to provide the means for making the natural resources of the Forests most serviceable. In other words, it would be a reversal of the entire policy which has underlain both legislation concerning the National Forests and the present administrative system. It would also be a serious business mistake.

The major part of what is spent on the Forests each year is an investment. Permanent improvements are like betterments made by a railroad to enable it to handle business at a lower cost. In the absence of proper equipment, operating expenses are increased. This is forcibly illustrated in the case of fire protection. Last year nearly \$1,100,000 was spent in wages for temporary employees hired to fight fires and for transporting, provisioning, and equipping them. While the natural conditions this season are very different from those faced last year, so that a close comparison of results is impossible, the extra expenses incurred in fire fighting will not exceed \$190,000; yet much better protection has been given. Every step forward in developing a good system of permanent improvements means a lower annual cost for fire protection. It is already evident that the increase in the permanent improvement fund expendable in 1912 will materially reduce the expenditures for fire fighting. Fires can now be discovered and reached more promptly, and consequently put out at less cost, than ever before. The total expenditures for all purposes in 1912 will probably fall slightly below the total for 1911; but because of the more highly organized and better equipped protective system the money will be spent to much better advantage.

Properly speaking, most of what is spent in protecting the Forests is also an investment. Any private owner of timber held for future sale would, as a matter of course, add his carrying charges to his original outlay as an increase in the capital tied up; and if he sees his property rising in value faster than the cost of carrying it, he knows that he is on the safe side. Since the National Forest timber is for the most part either on what may be called the fringe of present demand or quite beyond the zone of present operations, its value will for some years to come rise rapidly. The average rise in the stumpage price of timber sold by the Forest Service in the last four years has been 18 cents per thousand. An average annual increase of only 6 cents per thousand feet for the 518 billion feet of merchantable timber on the Na-

tional Forests (exclusive of Alaska) would be equivalent to \$31,000,000 added each year to the value of the present stand. There is also the increase which takes place through the growth of small timber. The Government can well afford, in consideration of the rising value of its property, to give it protection irrespective of what the Forests are now bringing in. It would be inexcusable folly to do otherwise.

If the expenditures of the Forests can not be curtailed, the natural query follows. Why can not the receipts be largely increased to meet the expenses? This could only be done by throwing large bodies of timber on the market at prices much below its real value. The market is now glutted through overproduction from private lands. To sell public timber when it is not really needed at prices below its value and under conditions which would be injurious to the Forest itself, thus sacrificing the great public reserve which will be badly needed later on, would be nothing less than a betrayal of the people's trust. The truth is that, regarded as public property, the National Forests form an aggregate so stupendous that the most conservative statements and estimates appear visionary. In consequence it is difficult to secure a consideration of questions of business policy on their actual merits where questions of value are involved. It cost the Nation no outlay of capital to reserve for public use timber which it would require an outlay approximately equal to the present national debt to buy; but that does not alter the actual situation. The pressure for throwing down the barriers which now prevent this great prize from passing into private hands is a natural result of this situation.

While the gap between expenditures and receipts can not be expected to close entirely for some years unless a shortsighted and false economy is attempted, there is every prospect that the net cost to the Government will decrease yearly. In the fiscal year 1912 the gross cost will probably be slightly less and the receipts somewhat greater than in 1911, and the estimate of appropriations needed for 1913 keeps within the total for 1912.

Although the receipts for timber and grazing fell off, the number of persons who made beneficial use of the Forests was greater than in any previous year. The total number of timber sales made (5,653) was 5 per cent above the number in 1910, the pay grazing permits issued were within one-third of 1 per cent of the number in 1910, the permits for free use of timber rose from 35,364 in 1910 to 40,660 in 1911, while the free special use permits fell from 2,986 to 2,844, but the pay special use permits rose from 2,222 to 2,301.

The most important development in the field of special uses was in connection with applications for the use of land for water-power purposes. The new form of permit and stipulation described in last year's report was approved on December 28, 1910. Its fairness was generally recognized, and the applications for permits which have been made show that preparations for local development of the water-power resource are now well under way. The following statement indicates the extent to which this has gone. It does not include noncommercial projects utilizing or contemplating the utilization of less than 1,000 horsepower.

Number of projects operating June 30, 1911.....	28
Number on which construction had been begun	12
Number for which permits had been issued.....	91
Number of permits issued in fiscal year 1911.....	49
Number of applications for permits received in 1911.....	75

Of the 91 permits included in this statement, 50 were for commercial use, and 61 of the applications here reported as received in 1911 were for commercial use.

It still remains true, however, that there is need for legislation to make possible the granting of term permits, revocable only for breach of the stipulations during a period of years sufficient to justify the financing of large enterprises. By direction of the President, representatives of the Agricultural and Interior Departments took up last winter the question of the legislation immediately needed to provide for the use of portions of the public lands by private companies for the generation and transmission of hydroelectric power. The Department of Agriculture was represented by the Forester, the Solicitor, and Mr. J. B. Adams, of the Forest Service. Recommendations were drawn up proposing a system of leases secured against interference through the location of claims under the public-land laws, with safeguards to protect the public against the speculative tying up of power sites, and with provision for a moderate charge based on the net horsepower capacity of the site. The report of the joint committee of the two departments was approved by their respective Secretaries and submitted to the President, who in turn gave it his approval. A bill along the line of the report was introduced into Congress by a member of the House Public Lands Committee. Other bills, advocated by representatives of some of the hydroelectric power companies, were also introduced. The latter embodied the principle of perpetual easements, without compensation proportioned to the value of the sites and without adequate safeguards of the public interest. No bill was reported to either branch of Congress at the last session.

FOREST MANAGEMENT.

STAND OF NATIONAL FOREST TIMBER.

The standing timber on the National Forests, including cordwood, is now estimated to be the equivalent of 518,000,000,000 board feet, exclusive of Alaska. In 1910 a total stand of 530,000,000,000 feet was reported. The shrinkage is due in part to the loss from forest fires in the summer of 1910 and in part to the corrected data. Reliable estimates of the timber on the National Forests in Alaska have not been obtained. A rough approximation, however, credits these Forests with a stand of 69,000,000,000 feet.

THE TIMBER SALE POLICY.

The stock taking of National Forest resources as a basis for scientific forest management, and particularly a more exact inventory of the standing timber, has progressed as rapidly as funds and men could be spared for this work. First consideration has been given to Forests where the demand for timber is greatest and overcutting most likely to occur. In 1908 a systematic plan of timber reconnaissance was adopted and put into effect on a small scale. This work has since been extended into all of the districts and is now nearly complete on a few Forests where information of this character is most critically needed. Up to the present time the reconnaissance of 8,658,983 acres on an intensive basis, including detailed timber esti-

mates and accurate maps on a large scale, has been completed. Of this amount 3,900,824 acres were covered during the last fiscal year. In addition, reconnoissance of a less detailed character, designed to determine only the broader conditions in respect to topography and the amount and character of the timber, has been conducted on 17,174,251 acres.

The reconnoissance of each Forest or portion of a Forest is designed to furnish the basis for a working plan, or systematic scheme of management, for the area covered. Such working plans include, among other facts necessary to place the administration of the Forest upon the best practicable basis, the amount and location of stands of dead or overripe timber whose immediate cutting is advisable; the annual production of wood, as indicating the amount which may safely be cut each year without impairing a sustained yield of equal amount in future years; the stand of timber on desirable logging units, together with the topographic factors affecting their exploitation and market value; and the location and extent of areas where artificial reforestation is necessary. It is the aim of the Service to place each Forest as rapidly as possible under a systematized plan of management based upon information of this character.

The single factor of greatest importance in such working plans is the determination of the amount of timber which may safely be cut from each Forest annually without exceeding the annual production of wood. This is expressed in the maximum cut prescribed by the Secretary of Agriculture for each Forest each fiscal year. Up to the present it has been necessary to determine the annual cut in the majority of cases by a rough approximation based upon the area of the Forest and its stand of merchantable timber. As intensive reconnoissance covers new areas, much more reliable data concerning the rate of growth of the various species, the areas of young timber where the production of wood is at its maximum, and the like, are being secured and applied directly in fixing the maximum cut prescribed for the Forest in question. The maximum annual cut as determined by scientific data of this character represents, therefore, the interest on the National Forest timber viewed as a public security administered so as to maintain its present value for all time; in other words, the current yield which may be safely utilized without depleting the stock of material on hand. As established for the past year, the total amount which could properly be cut annually from all Forests is 3,273,690,000 board feet.

In the timber-sale policy of the Service provision is first made for local needs, present and future, and sales of timber which will enter into the general markets are considered only when it is clear that an excess over the permanent supply required by local industries exists. The application of this policy is indicated in the following statement showing the number of sales made of various amounts during the year.

Number of timber sales classified according to amount of sale.

State or Territory.	Under \$100.	\$100 to \$500.	\$500 to \$1,000.	\$1,000 to \$5,000.	Over \$5,000.	Total number of sales.
Arizona.....	609	10	2	1	1	623
Arkansas.....	21	7	3	6	2	39
California.....	506	24	2	6	5	543
Colorado.....	782	53	13	16	4	868
Florida.....	7	.....	.....	.....	.....	7
Idaho.....	552	42	12	6	6	618
Minnesota.....	.....	3	.....	1	.....	4
Montana.....	1,137	59	15	9	3	1,223
Nevada.....	202	3	.....	.....	.....	205
New Mexico.....	241	8	3	4	5	261
North Dakota.....	2	.....	.....	.....	.....	2
Oklahoma.....	38	.....	.....	.....	.....	38
Oregon.....	210	5	2	3	3	223
South Dakota.....	159	11	1	3	1	175
Utah.....	287	10	3	4	2	306
Washington.....	49	25	6	6	6	92
Wyoming.....	132	7	2	2	2	145
Alaska.....	210	60	6	5	.....	281
Total for fiscal year 1911.....	5,144	327	70	73	39	5,653
Total for fiscal year 1910.....	4,925	269	70	96	38	5,398

It will be noted that nearly 97 per cent of the sales of the past year were under \$500 in amount, and that the increase in sales over those during the fiscal year 1910 was almost wholly confined to the smaller transactions.

Aside from provision for permanent needs of localities dependent upon National Forests for their supplies of timber, primary consideration is given to the silvicultural needs of the Forests themselves and the utilization of material whose removal will be of benefit. The sale of merchantable dead timber and stands of overripe timber in which decay equals or exceeds the growth, and the cutting of mature trees from stands where their removal will greatly increase the growth of the remaining forest, are essential to accomplish this object. This policy not only makes possible additional revenue through sales of timber for the general market, in excess of local needs, but actually increases the amount of wood being produced on the Forests, puts the productive capacity of the soil to better use, and insures larger supplies of timber for the future.

In fixing the annual cut the limit is set with reference to the amount of timber which can be secured as a sustained yield from individual Forests or groups of Forests which form well-defined economic units. In view of the general conditions in regard to timber supply in the United States and the rapid exhaustion of the stands of timber in private ownership it appears advisable to go even further than this in restricting the immediate cut from the National Forests, and to reserve additional supplies of forest products in order to assist in tiding the country over the period of economic readjustment which must inevitably ensue when the main supplies of timber outside of Government ownership are exhausted. To a certain extent no other course is open now, for only a small fraction of the total amount which is being produced annually on many of the Forests by growth can be sold under present conditions. But as a broad public policy it would seem advisable for the Government to accumulate a surplus stock against the time when the demand for forest products, in view of the rapidly diminishing supply, will be one of the most critical economic conditions confronting the country.

The application of this policy will not prevent sales of National Forest timber to an amount sufficient to make the Forests self-supporting. If only one-half of the total annual cut of 3,273,690,000 feet, which it is estimated could be removed without reducing the permanent stock on the Forests, were sold each year at the average price obtained in the sales of the past fiscal year, leaving the other half to accumulate as a reserve supply, the income from this source would exceed \$4,000,000 annually. The timber cut during the year under both timber sales and free-use permits, aggregating 498,166,000 board feet, was but a little over 15 per cent of the total annual cut established as representing the actual yield of the Forests.

The specific policy adopted, therefore, has been to increase the volume of timber sales, as business conditions permit without an undue sacrifice of stumpage value, up to an amount which will, in connection with receipts from other sources, put the National Forests upon a self-supporting basis: To go beyond this at the present time does not appear advisable in view of the need of accumulating reserve supplies of timber to draw upon when the supplies in private hands shall be largely exhausted.

That it will be practicable in pursuance of this policy to place the National Forests on a self-supporting basis is indicated by the results obtained on a number of Forests where, because of the presence of local industries which consume large amounts of timber annually or of transportation facilities which make possible the logging and manufacture of Government timber for the general market on a large scale, the sales have been much larger than on the great majority of Forests, which are still undeveloped in these respects. The following table shows the receipts and disbursements and the proportionate amount of receipts from timber sales on four such Forests where local conditions not only have made self-support possible but have resulted in a substantial net revenue after meeting the cost of administration.

Receipts and disbursements on certain Forests.

Forest.	State.	Receipts from sales of timber.	Total receipts.	Cost of administration. ¹	Net revenue.
Bitterroot.....	Montana.....	\$60,035.55	\$62,198.23	\$29,436.62	\$32,761.61
Deerlodge.....	do.....	77,672.53	85,537.68	41,864.27	43,673.41
Cocconino.....	Arizona.....	51,257.16	70,308.12	40,991.24	29,316.88
Plumas.....	California.....	31,707.23	39,401.93	37,061.11	2,340.82

¹ Exclusive of permanent improvements.

Another fundamental feature of the sale policy of the Service, which directly affects the amount of timber sold and the receipts from this source, is the maintenance of stumpage prices at figures representing the actual value of the standing timber under normal market conditions as closely as it is practicable to determine it. This value is based upon market prices of the products manufactured from the timber during normal conditions, stumpage rates being determined by deducting the cost of logging and manufacture and a reasonable percentage of profit from the sale value of the product in the form prepared for final consumption. The Service has consistently refused to make sales at a sacrifice in what is believed to be the value of its

standing timber during normal conditions and to depreciate the value of its stumpage by lowering prices to meet temporary fluctuations in the lumber market. The great body of National Forest timber is looked upon as a public security which it is the duty of the Service to maintain at par value, a value which should increase as the supply from other sources is lessened and which protects the public interests represented in these national holdings. Since 1907 a general depression, more or less acute in different portions of the West, has prevailed in the lumber market. A reduction in stumpage prices adapted to depreciated lumber prices would have materially increased National Forest sales during this period.

At the cost of a considerable sacrifice of receipts the Service has declined to make sales under such conditions, believing that the interests of the people in the National Forests, both as joint owners of the property which these Forests represent and as consumers of lumber, require the withholding of timber from the market until more favorable terms could be secured. In fact, the timber sold last year brought a higher price than during the preceding fiscal year, the average rate being \$2.56 per thousand feet in 1911, as compared with \$2.44 in 1910. The timber cut during the year paid an average stumpage price of \$2.25 per thousand feet, as compared with \$2.36 in the fiscal year 1910, this difference being due to increased operations under some of the older contracts which made lower rates.

The requirement of methods of logging which wherever possible leave the basis for a second cut of timber on the ground, and which in all cases will insure the protection of the cut-over area and its speedy restocking with forest growth, is another essential feature of the sale policy of the Forest Service which should not be sacrificed in order to sell more timber. In many instances a third of the merchantable stand is reserved, consisting of younger and thriftier timber, as a basis for a second cut within a maximum period of 50 years. In other cases where this is not practicable the restocking of the ground is insured by the reservation of a sufficient number of seed-bearing trees and careful protection of the seedling and sapling growth on the area. In all sales adequate protective measures are enforced, either by piling and burning slash resulting from cutting on the entire tract or by constructing fire breaks around the sale area and burning the slash clean within these breaks. Close utilization of all merchantable material in the trees cut is insisted upon. These measures are essential to the perpetuation of the timber supply on the Forest areas where cutting is permitted, the establishment of definite standards of conservative lumbering, and the elimination of the wasteful use of forest products. The requirements of National Forest timber contracts in these respects, while framed to meet the methods of logging necessary in each locality, should be such as will not only amply protect the future forest resources on the public holdings, but also establish standards of forestry practice which will sooner or later be applied to private timberlands.

The prevention of monopoly in the timber-sale policy of the Service has been constantly enforced. It has been found, however, that the application of this policy is not inconsistent with sales of large amounts of timber under comparatively long cutting periods in localities where there is little or no local demand and the timber must, if used at all,

be sold in the general markets of the country. A vast proportion of the National Forest timber is inaccessible to present transportation. To exploit such bodies, large investments in railroads, flumes, or other transportation facilities are needed. Such investments by business interests are not practicable unless the amount of timber covered by the contract of sale is sufficient to reduce the investment per unit of manufacture to a reasonable figure. In accordance, therefore, with the policy of increasing timber sales sufficiently to make the National Forests self-supporting, larger sales than formerly are being made of bodies of inaccessible timber not needed for local use. It may be advisable to make sales under such conditions for amounts of one-half or three-fourths of a billion feet, with cutting periods of 10 years or perhaps more, as determined by the rate at which logging operations can be practically conducted. In every sale of this character provision will be made for the periodic readjustment of stumpage prices in conformity either with stated increases specified in the contract, with prevailing prices secured for similar National Forest timber at the date of readjustment, or with the market value of the manufactured product at the date of readjustment. Because of the physical conditions which control the exploitation of the great bulk of National Forest timber, it is from sales of this character that the Service is likely to secure in the immediate future substantial increase in the total volume of its business. The fact that the construction of railroads or other transportation facilities, an essential feature of such contracts, enhances the value of other bodies of timber and develops the entire country to a marked degree is a further reason for the adoption of this policy.

SALES OF THE YEAR.

The undeveloped condition of most of the National Forests and the lack of information concerning their timber resources and the opportunities for purchases of stumpage in many of the principal lumbering centers of the country have made it advisable for the Service to take more definite and aggressive steps to bring desirable sales to the attention of possible purchasers. This is being done through the publication of descriptive material in lumber and trade journals and through the personal efforts of members of the Service. The latter method has been taken up primarily to assist in the disposal of bodies of fire-killed timber, which is in danger of becoming a total loss through rapid deterioration. It is probable that these methods will assist materially in the sale of bodies of National Forest timber whose removal is most urgent.

The more important factors influencing the sale of timber are: (1) The distance of the larger bodies of National Forest timber from markets and from existing transportation facilities, and the cost of constructing necessary improvements to exploit such bodies, usually under rugged, mountainous conditions; (2) difficulties in logging, particularly the rough surface usually encountered and the short seasons of practicable logging due to the elevation at which most of the National Forest timber occurs; (3) the condition of the lumber markets, which are usually very sensitive to general business conditions, and which in many portions of the West are in danger of constant overproduction through the manufacture of bodies of timber, developed by large investments, in excess of the current

demand; and (4) the presence of privately owned timber tributary to the same markets and usually more accessible and of better quality than the Government timber. As a rule the greater part of the privately owned timber tributary to a given market must be removed before there is any considerable demand for National Forest timber. The cost of marketing National Forest timber usually exceeds that of privately owned timber because of its inaccessibility and the rougher logging conditions.

The requirements imposed in Service contracts for the perpetuation of the Forest increase the cost of operation, as a rule, by 5 to 10 per cent as compared with similar operations upon private lands. To offset this disadvantage there are certain distinct advantages to the purchaser of Government timber. These consist in the elimination, in large part, of fire risk because of the protection furnished by the Government, the small deposits required in advance of cutting, and the elimination of taxes and other carrying charges necessary where bodies of privately owned timber are controlled for similar periods. The realization of these advantages by the lumber trade is a significant factor which in many localities will tend to increase sales of National Forest timber, even though stumpage prices may be somewhat higher than in the case of privately owned timber and the cost of operation somewhat greater.

The condition of the timber-sale business during the year is indicated by the following statement of timber sold and timber cut under sales, with the value of each, by States:

Timber sold and cut under sales on the National Forests, fiscal year 1911.

State or Territory.	Timber sold.		Timber cut under sales.	
	Amount.	Value.	Amount.	Value.
	<i>Board feet.</i>		<i>Board feet.</i>	
Arizona.....	90,876,000	\$280,028.27	37,858,000	\$102,880.54
Arkansas.....	13,458,000	29,472.71	4,817,000	10,626.97
California.....	112,438,000	295,536.22	37,899,000	80,243.65
Colorado.....	59,075,000	115,878.01	47,647,000	96,110.62
Florida.....	55,000	44.00	32,000	18.75
Idaho.....	44,576,000	94,010.62	49,597,000	118,472.26
Minnesota.....	473,000	1,313.46	647,000	2,481.82
Montana.....	144,605,000	485,758.79	57,642,000	170,276.49
Nevada.....	2,278,000	5,108.95	2,539,000	5,207.79
New Mexico.....	21,225,000	51,944.90	20,096,000	36,594.57
North Dakota.....	1,000	7.50	1,000	6.30
Oklahoma.....	37,000	79.20	37,000	79.20
Oregon.....	134,245,000	332,242.52	22,446,000	42,158.93
South Dakota.....	10,326,000	29,174.53	10,056,000	27,496.65
Utah.....	15,167,000	38,295.08	12,275,000	28,498.69
Washington.....	142,776,000	305,748.48	25,343,000	48,368.20
Wyoming.....	9,796,000	27,692.27	17,598,000	43,265.39
Alaska.....	28,897,000	30,203.54	28,148,000	30,206.07
Total fiscal year 1911.....	830,304,000	2,122,539.05	374,678,000	842,992.89
Total fiscal year 1910.....	574,555,000	1,400,992.69	379,616,000	896,308.34

The total value of the timber cut under sales as given above differs from the receipts from timber as given on page 13, both because the latter includes the receipts from timber and fire trespass and because payment for timber is required in advance of cutting.

The sale of turpentine from the Florida National Forest yielded \$8,268.68, as compared with \$4,238.50 for the preceding year.

The year was characterized by a marked depression in the lumber markets of many portions of the West, a depression resulting in several localities in prices for manufactured lumber of from \$2 to \$3 per thousand board feet less than those of 1906 and 1907. This depression was most acute on the northern Pacific coast, in the Douglas fir belt, where practically no additional sales were made and operations under several existing sales were suspended owing to the inability of the purchasers to market their product. This depression also affected seriously the demand for National Forest timber in the Douglas fir and lodgepole pine belt of the northern and central Rocky Mountains, from which considerable quantities had previously been sold for local uses, mining timbers, railroad crossties, and timbers for structural purposes. The general suspension of construction work by many railroads and the reduction in output on the part of various mining and manufacturing companies have reduced the demand for National Forest timber and even made it difficult or impossible to continue operations under some old sales.

The demand for pine timber on the National Forests of western Montana, northern Idaho, and eastern Oregon, and in the Sierra Nevada Mountains of California, Arizona, and southern Colorado, has remained fairly firm. This material has felt the general depression relatively less, because it is in good demand in the general market and has a considerable variety of uses. A number of additional sales were made on these Forests, and the bulk of the year's cut was confined to them. The operations in the pine forests mentioned, together with sales supplying primarily local industries less affected by general market conditions, kept the cut very close to that during the preceding fiscal year, the difference being less than 5,000,000 feet.

In spite of the poor market conditions an anticipated revival of more active demand resulted in a marked increase in the amount of timber sold, as compared with the preceding year, an increase amounting to 44.5 per cent in the quantity and 51.5 per cent in the value of the material disposed of. The policy adopted during the year of making sales for larger amounts and longer cutting periods where the investment necessary called for this course was an important factor in the increase in sales.

The disastrous fires of 1910 had the immediate effect of canceling two large sales in western Montana and northern Idaho, covering areas where a large portion of the timber was killed. This in itself caused a reduction in timber-sale receipts of from \$50,000 to \$100,000 during the year.

Twenty-three per cent of the timber cut and 11 per cent of the timber sold was fire-killed material. Including one sale of 100,000,000 feet, previously reported sold as green timber, but resold during the year as fire-killed, 21 per cent of the total amount sold was dead timber. The effort to dispose of the stands of fire-killed timber resulted in the sale of approximately 190,000,000 feet subsequent to the close of the fiscal year. The inaccessibility of much of the fire-killed timber will prevent its disposal before it becomes unmerchantable, but every possible effort will be made to salvage the maximum amount of this material. In some instances the efforts of the Service to dispose of the dead timber have been very successful. On the Pike National Forest in Colorado, for example, sales during the past

five years have removed over 50 per cent of the dead timber from an area of approximately 350,000 acres.

The chief obstacle to making additional sales has been the refusal of many applicants to pay the appraised value of the timber. Other sales have not been consummated because of the unwillingness of purchasers to comply with the requirements imposed by the Service for the protection and perpetuation of the forest. As indicated above, however, a more lenient policy in these respects is considered advisable in view of the duty of the Service to maintain stable values for National Forest timber and to regulate the cuttings so that the objects of the National Forests will be carried out.

TIMBER TRESPASS.

The receipts for the year included \$43,236.37, paid in settlement for timber cut in trespass, and \$14,371.16 paid in settlement of fire trespass, the greater portion of which was for the destruction of merchantable timber and young forest growth. The receipts from these sources during the year 1910 totaled \$35,755.55.

FREE USE.

The following table summarizes the free-use business of the service during the past year:

Free use of timber on National Forests, fiscal year 1911.

State or Territory.	Number of permits.	Quantity.	Value.	State or Territory.	Number of permits.	Quantity.	Value.
		<i>Bd. ft.</i>				<i>Bd. ft.</i>	
Arizona.....	1,955	4,729,000	\$12,211.92	Oklahoma.....	232	137,000	\$300.00
Arkansas.....	163	480,000	1,472.88	Oregon.....	2,383	11,331,000	15,582.78
California.....	3,085	9,197,000	17,359.02	South Dakota.....	1,401	5,855,000	7,350.57
Colorado.....	4,025	12,246,000	20,625.25	Utah.....	4,677	11,656,000	16,249.96
Florida.....	16	29,000	39.45	Washington.....	621	2,851,000	4,790.10
Idaho.....	7,150	21,523,000	31,797.32	Wyoming.....	1,652	6,852,000	8,952.79
Michigan.....	2	12,000	6.00	Alaska.....	7	100,000	108.95
Minnesota.....	7	87,000	313.65				
Montana.....	8,152	19,403,000	38,576.67	Total for fiscal year 1911.....	40,660	123,488,000	196,930.24
Nevada.....	496	1,799,000	2,950.52	Total for fiscal year 1910.....	35,364	104,796,000	176,166.51
New Mexico.....	4,442	15,149,000	18,170.71				
North Dakota.....	192	52,000	71.70				

The amount of timber cut under free-use permits was 22.8 per cent of the total cut for the year.

The policy pursued with regard to permitting the free use of National Forest timber has followed closely that of the past, this privilege being accorded residents in or near the National Forests who need material for personal use, and who can not reasonably be expected to purchase. Special consideration is given to new settlers and prospectors for minerals. Free use is also granted on a liberal scale for cooperative enterprises and public purposes. In granting free-use permits, dead timber is first disposed of wherever available and suitable for the needs of the applicant. Approximately three-fourths, or 91,956,000 feet b. m., of the material cut under free use during the past year was dead timber.

TOTAL CUT OF THE YEAR.

The total cut of National Forest timber last year, under both sales and free use, was 498,166,000 board feet, with a value of \$1,039,923.13, as against 484,412,000 board feet, with a value of \$1,072,475.25, in 1910. The falling off in value at the same time that the total quantity cut increased is due partly to the somewhat lower stumpage price obtained for the timber cut under sales, already pointed out on page 20, but more largely to the increased ratio of the cut under free use. Both because most of the free-use timber is dead and because the live free-use timber is often low-grade material desired for fuel, fencing, and similar purposes, its average stumpage value is much lower than that of the timber cut under sales. In 1911 this stumpage value was \$1.60 for the equivalent of 1,000 feet board measure, as against the \$2.25 obtained for timber cut under sale.

LOSSES BY FOREST FIRES.

THE FIRES OF 1910.

Since the fiscal year closes in the midst of what is, taking the National Forests as a whole, the fire season, the statistics of fire losses are compiled by calendar years. Seasonal variations in weather conditions produce wide differences in the risk for different years. The calendar year 1910 was exceptionally unfavorable. Throughout the West the winter snowfall and spring rains were unusually light, so that with the oncoming of summer the supply of surface moisture rapidly dried away, and an abnormal and steadily increasing number of fires followed. Through the summer the conditions of drought grew worse and worse, until in parts of the Northwest they became the most severe within the period of Weather Bureau records. Steady high winds were combined with almost complete failure of the light summer precipitation, which usually mitigates the severity of summer drought in the mountains. By the middle of August the Forest Service was straining every resource to hold in check, with a force entirely inadequate to the work, the multiplying fires.

Out of this situation there developed a national disaster. From the Pacific coast region eastward to central Montana the forests of the Northwest seemed suddenly to burst into flames. Fierce winds attained, in northern Idaho and western Montana, hurricane proportions. The scattered fires were driven together and lashed into fury, until they forced to shelter (where shelter could be found) the scattered bands of fire fighters. Within a few days' time the National Forests suffered losses which surpassed the total inflicted by all the fires of former years since Government protection of the Forests began.

The total area burned over within the National Forests was 4,134,253 acres, of which 3,078,109 acres were classified as timbered and 1,056,144 acres as open. These figures are in striking contrast with those for the calendar year 1909, in which 362,014 acres were burned over, of which 209,671 acres were timbered. The loss in 1910 in timber destroyed or damaged was 6,508,369,000 board feet, with an estimated value of \$14,889,724, as against 169,410,000 board feet, with an estimated value of \$297,275 in 1909. There was also a loss of reproduction valued at \$9,180,989 and of forage valued at \$114,382.

Including the losses on private lands within the National Forests, the total timbered area burned over was 3,805,572 acres, and the total estimated loss was \$26,597,228, as against \$456,246 in 1909. This shows the losses of the two years in a ratio of more than 50 to 1.

The total cost of fighting these fires, exclusive of the time of forest officers, was \$1,037,254.03, as against \$54,669.83 in 1909. An average of 25.87 acres per thousand acres was burned over, as against an average of 1.86 acres the previous year. The total number of fires reported was 5,201, of which 3,164 were confined to an area of 5 acres or less. Of these fires 1,704, or 32.76 per cent, were caused by railroad locomotives; 724, or 13.92 per cent, by lightning; and 668, or 13.23 per cent, by campers. Incendiarism and brush burning were each responsible for a little less than 6 per cent of the fires; sawmills and donkey engines, for a little less than 1 per cent; and other causes, classed as miscellaneous, for 4.63 per cent. Finally, 1,184 fires, or 22.77 per cent of the total, were due to unknown causes.

The percentage due to lightning was unusually high. The exposure of forests to fires caused by lightning is the result of climatic conditions peculiar to the West, and is most serious in the high mountains. In other parts of the United States a thunderstorm brings with the lightning an antidote for fire, in the rainfall which accompanies an electrical storm. Many of the western storms, however, are characterized by violent lightning with little rain, and lightning often strikes where there is no rain at all. If the woods are unusually dry, the number of fires set will be correspondingly increased. Inasmuch as the regions most exposed to this danger are those which it is most difficult to protect because of their remoteness and the absence of means of communication, the danger of fires caused by lightning must always remain formidable while large parts of the Forests remain in an undeveloped state.

It is necessary to report, with deep regret, that a heavy loss of life took place in the fight against the fires of the calendar year 1910. That the losses were not much greater is due to the coolness, woodcraft, and devotion to duty of the forest officers, usually rangers, who brought their men through safely, even at imminent risk to themselves. The work of some of these forest officers may fairly be called heroic.

The names of the temporary employees of the Forest Service whose lives were lost, so far as they are known, appear in the list given on page 27. No forest ranger or other officer in the regular employ of the Forest Service lost his life, though several were badly injured.

1. George Smith.	27. W. Polk.	53. Joe Beauchamp.
2. G. A. Blodgett.	28. William Casey.	54. Roderick Ames.
3. Oscar Weigert.	29. James Kerr.	55. Tony Butcher.
4. Harry Jackson.	30. Gus Johnson.	56. Chris Omiso.
5. L. Ustlo.	31. W. Flynn.	57. C. Buck.
6. James Donahue.	32. Sam Hull.	58. William Learmouth.
7. Frank Xanders.	33. L. Johnson.	59. Joe Fern.
8. Patrick Crogan.	34. Edward Frye.	60. Richard Woods.
9. Larry Levar.	35. John Hoss.	61. Andrew Hanson.
10. M. Phweiser.	36. Harry Smith.	62. Louis Shoman.
11. J. Ruzick.	37. Joe Denton.	63. August Berger.
12. M. Dilo.	38. J. Stevens.	64. Walter Beamair.
13. Jack Hill.	39. J. Harp.	65. E. Williams.
14. O. Bing.	40. Chris Christensen.	66. A. G. Bourette.
15. Ed Murphy.	41. Jim Denton.	67. George Strong.
16. H. Siphers.	42. Glenn Taylor.	68. George Fease.
17. Ralph Ekhoen.	43. K. Anderson.	69. J. Harris.
18. Frank Skeychell.	44. E. Smith.	70. J. Plant.
19. Ed Dunn.	45. Unidentified.	71. Val Nicholson.
20. W. E. Norton.	46. Unidentified.	72. Larry Ryson.
21. L. Schwartz.	47. Unidentified.	73. Leslie Zellers.
22. W. H. Baker.	48. Upton B. Smith.	74. S. D. Adams.
23. Frank Masterson.	49. George W. Cameron.	75. Aaron Benton.
24. George McGurk.	50. Guecomo Viettone.	76. Louis Holmes.
25. O. Ellefson.	51. Dominick Bruno.	77. Tom Welsh.
26. F. D. Swick.	52. W. J. Elliott.	78. Ernest Elgin.

There were considerable losses of horses, horse equipment, etc., which had been hired by the Forest Service for transporting provisions and tools to the fire crews. Since no funds are available, under the appropriation act, for the settlement of obligations of this kind, it was necessary to seek relief from Congress in order to meet the just claims of the owners of the property. It was also necessary to ask for a deficiency appropriation of \$935,000 to meet the expenses incurred in fire fighting. By act of Congress appropriations totaling \$902,742.90 were made for both of these needs.

Since expenses for medical attendance and hospital care of those who were injured in fighting fires, as well as the expense involved in caring for the dead, could not lawfully be met by the Government, voluntary contributions from members of the Forest Service were offered as soon as the need for help became apparent; and this was followed by an offer of assistance by the National Red Cross Society, which made it possible to meet the immediate situation adequately. Appropriations of \$20,450 made by Congress in the deficiency act, which became law on March 4, 1911, provided for the payment of medical, hospital, and burial expenses of those injured or killed, and for reimbursement to temporary employees for loss of time due to injuries sustained while fighting fires.

CONDITIONS IN THE CALENDAR YEAR 1911.

During the last six months of the fiscal year 1910-11 fires did little damage. Except in the Black Hills in the month of June, the losses were everywhere entirely insignificant. In general, the weather conditions in the spring of 1911 were, in contrast to those of 1910, highly favorable to fire protection. Throughout the West the winter of 1911 was one of abundant precipitation, and the snows stayed on the ground well into the spring. This resulted in an unusually abundant growth of vegetation, which remained green well into the summer and provided a natural protection against the spread of fire. The

summer rainfall has been, in most National Forest regions, reasonably good, and there is every indication that when the present season closes the Forests will have suffered little harm.

That fires are doing so little damage this year is, however, not solely due to improved weather conditions. A marked advance has been made in the protective system. While it would be altogether unsafe to say that, if the Forest Service were confronted again with the conditions which arose in 1910, the disastrous fires of that year would be impossible, it is certainly true that the Service is much better prepared to keep down the losses under any ordinary conditions, and that it has made appreciable progress toward the point at which the National Forests will be, humanly speaking, safe against great losses.

An analogy has often been pointed out between protecting forests and protecting cities against fire. This analogy is worth reiterating. City property can not be made reasonably safe unless there are: First, regulations to lessen the fire risk in the form of building ordinances, rules regarding combustibles, etc.; secondly, a considerable investment in signals, fire-fighting apparatus, and quarters; and thirdly, an adequate and well-organized force of disciplined men suitably located. So forests must be guarded against causes of fire and conditions favorable to its spread, must be equipped with means for discovering, reporting, and reaching fires, and must be manned with a reliable body of firefighters, stationed at the points of greatest need.

With large parts of the National Forests (and those the most rugged and mountainous parts) unoccupied and pathless wilderness, close patrol and quick access to fires by sufficient forces of fire fighters are impossible. Yet these wilderness regions contain enormous timber supplies which, though out of reach now, the Government is holding to supply future needs. A demand for this timber will come with exhaustion of the supply in regions where cutting is now active. The Government must either allow this timber to be exposed to a high fire risk or spend considerable sums yearly in protecting land now unproductive.

The development of a thoroughly efficient system of fire protection is the work of years. It calls for heavy investments in roads, trails, bridges, telephone lines, fire lines, watch towers, and ranger quarters. It calls also, obviously, for a sufficient force of men to insure early detection of fires. But it is not enough to provide merely for the quick giving of an alarm. To concentrate quickly upon a fire an experienced and properly equipped force of fire fighters, and to keep them there until the fire is under control, means careful preparation beforehand in order to meet the emergency in the right way. It can not be done on the spur of the moment.

PROGRESS IN PROTECTION.

The fires of 1910 were invaluable as a lesson. They made clear what are the most difficult problems of fire fighting under existing conditions, and showed what might be done, even under present conditions, to better the existing organization. They also aroused a much more vigorous public sentiment against fires, one effect of which has been that when fires occur the fact is widely heralded; and a higher standard of protection is now demanded than ever before.

Congress recognized the need of better protection by increasing the Forest Service appropriation for the fiscal year 1912, so as to make available an additional \$225,000 for permanent improvement work, \$135,000 for protective work and fire fighting, and in case of extraordinary emergency an additional \$1,000,000. During the winter and spring of 1911 a large part of the attention of the National Forest force was concentrated on the study of the forest-fire problem, in order that the highest possible state of preparedness might be reached and the most effective use made both of the old appropriation and of the increased appropriation available when the new year should begin.

In the permanent improvement work the development of communications was given precedence over everything else. Further, to make the work count for as much as possible, the most careful consideration was given to the relative importance of different projects. On every Forest the first question was to decide where the roads, trails, and telephones that could be built in the summer of 1911 would be of most service. There were already in existence permanent improvement plans for each Forest, prepared with a view to coordinating the work of successive years, so that all construction might take its proper place in a general scheme. The eventual equipment of the Forest with the best possible system of communications and quarters is the final object of these plans; and the fact of their existence simplified the task of deciding how to use to best advantage the increased appropriation for permanent improvements, with special reference to immediate protection against fire, but without losing sight of what will in the long run most effectively contribute to all kinds of use. The question as to what improvements are most urgently needed for fire protection was found to require, for its best answer, the preparation of special plans, with a view to coordinating on each Forest all activities which could contribute to keeping down the fire loss.

These fire protection plans were made for a large number of Forests. In another year they will have been made for all Forests. In preparing them, the first step is to locate those parts of the Forest on which fires are most likely to break out, and also those parts which are in greatest need of protection. Thus, in certain parts the danger of fires from lightning is likely to be especially great; elsewhere railroads or lumbering operations or campers may necessitate unusual vigilance; while areas on which reproduction is abundant or where much inflammable material on the ground endangers a valuable stand should be guarded more carefully than parts of the Forest where fires will do relatively little harm. After it is known how the protection should be distributed, the second step is to plan the most effective means of locating and reporting fires. This includes such matters as the location of watchtowers and lookout points, decision as to the frequency of patrol and the lines which the patrolmen should follow, provision for giving the alarm when a fire is discovered, and similar matters.

The third step covers the means of gathering help, getting them quickly to the fire, and supplying them with tools and food on the fire line. One of the great difficulties encountered in fighting the fires of 1910 was to obtain enough capable men quickly, and to provision them after they had been sent far into the woods. In making fire-protection plans all possible sources of labor supply are carefully studied, and an understanding is reached with settlers, lumber com-

panies, mine operators, and others so that fit men picked beforehand are ready to respond immediately to a call for help. Similarly, it is learned from what stores and ranches provisions and tools can be obtained, and in what quantities, and also where pack horses and other means of transportation can be hired. Finally, so far as possible, all the various contingencies likely to arise are considered and courses of action marked out beforehand, to the end that the best course may be taken at once and every one whose cooperation is needed may be ready to fall into line and perform his part without confusion or loss of time.

Where possible, lookout towers have been so placed that they command a considerable common field, within which fires can be very accurately located when their bearings are reported from both lookouts. Patrolmen on their rounds are called upon to report to the supervisor from fixed points at certain hours, while ranger headquarters are always connected by telephone with the supervisor's office and parties working on improvements or reconnoissance are within as close touch as possible.

The building of lookout towers and establishing of telephone communications has as yet been hardly more than begun, for the permanent-improvement appropriation necessitates doing the work a little at a time; yet a great advance has been made, because so much care has been used to do what could be done at the points where it would give the largest results. As a supplement to the permanent telephone lines it was found that temporary lines of insulated copper wire could be laid cheaply and rapidly. Insulated wire, weighing less than 30 pounds to the mile, can be carried on a pack horse to any point from which it is desired to extend an existing line so as to establish temporary telephone connection with a field party or lookout. The insulated wire is then laid on the ground. It has been found good for any distance within 60 miles.

One of the most serious of the fire risks to which the National Forests are exposed is that created by railroads. Of the known causes of fires in 1910, 32 per cent were due to sparks from railroad locomotives. There are approximately 2,000 miles of track within the National Forests, besides logging railroads. The most careful attention has been given to devising and putting into effect measures for preventing fires along railroad lines, and for the prompt discovery and extinguishment of fires which may be started. These measures include the clearing away of inflammable material along the tracks, the cutting of fire lines, provision for patrol, the assistance of railroad employees, both in giving the alarm when fires are discovered near the railroads and in putting out the fires, and the prevention of the dropping of live coals and the throwing out of cinders. Safety against the starting of fires from the throwing out of cinders, especially on heavy grades, calls for the equipment of locomotives with efficient spark arresters or the use of oil for fuel.

There is an increasing willingness on the part of railroads to cooperate with the Forest Service in diminishing the fire risk along their lines. It is obviously to the interests of the railroads themselves to prevent fires, both because serious fires may inflict heavy losses on the railroads in the destruction of property, the interruption of traffic, and the loss of tonnage which results when timber is consumed, and because the courts are now holding railroads liable for damages

resulting from fires which the railroads cause. In a number of cases damages were paid last year by railroads on account of fires on National Forests for which they were responsible. With the principle established, as it now is, that the loss of reproduction constitutes a legitimate and tangible claim for damages, the interest of railroads in preventing fires from spreading has become much greater.

Special mention should be made of the admirable spirit in which the Chicago, Milwaukee & Puget Sound Railroad has acted to reduce the fire risk along its lines. By the use of oil-burning locomotives in the Rocky and Cascade Mountain Ranges and the careful clearing of its right of way across National Forest land, the fire risk was greatly lessened. The Great Northern and Northern Pacific Railway companies also materially reduced the danger along their lines by entering into cooperative agreements with the Forest Service. These agreements were signed in the spring of 1910. They provided for the close patrol of the railroads during the fire season, for the supplying of equipment, telephone connections, tools, and other necessities for effective work in fire fighting, and for payment by the railroads of the cost of fighting fires which start within 200 feet of the track and are not proved to have been caused by some other agency than the railroads, and also of fires at a greater distance which are proved to have been caused by the railroads.

In the spring of 1911 a further advance was made by a cooperative agreement between the Forest Service and the Northern Pacific Railway for joint protection of areas on which lands of the railway are intermingled with National Forest land. Where the railway company was granted alternate sections of land by the Government, and these alternate sections lie within National Forests, neither the company nor the Forest Service can protect its holdings effectively without cooperation from the other. The agreement is an example of the cooperative agreements which have been entered into with private owners, generally organized into associations, for keeping down the fire losses where fires on private lands would endanger the National Forests. Among these associations are the Oregon Forest Fire Association and the Washington Forest Fire Association, the holdings of which include most of the heavily timbered west slopes of the Cascade Mountains; the Pend Oreille, Coeur d'Alene, Potlatch, and Clearwater Timber Protective Associations, whose holdings embrace the greater part of the white-pine belt of northern Idaho; and various smaller organizations. These agreements provide for a division of the cost of protecting specified areas where both parties to the agreement would suffer from failure of the other to protect its lands, on the basis of the relative holdings of each. The object and the result of these agreements are, so far as the Government is concerned, better protection of the National Forests at a lessened cost to the Government.

Both the desire of associations of private owners to join forces with the Forest Service in this protective work and the spirit of cooperation shown by the railroads in efforts to reduce the fire risk illustrate the growth of public sentiment generally in favor of preventing fires. The gain in public sentiment on this point during the last year has been enormous. Incidentally, this gain has put the Forest Service to a severer test than formerly to come up to the demand of the public for efficient work. Where fires were in the past regarded as inev-

itable and little attention was paid to them, immediate public attention is now focused upon them as soon as they break out, and the Forest Service is expected to bring them under control at once. This is shown in the attention which newspapers now give to forest fires—an attention which would not have been thought worth while until very recently. As a means of awakening public sentiment and creating a realization of the fire danger and the possibility of keeping it down the terrible fires of the summer of 1910 exerted an influence which it would be hard to overestimate. This increased sensitiveness of the public mind on the fire question is one of the most helpful evidences of progress. It means, of course, a diminution of carelessness, better laws, and more general efforts to combat fires everywhere. The Forest Service can well afford to have the community critical of its work for the sake of the support to the general cause of fire protection which this state of the public mind gives.

REFORESTATION.

Approximately 15,000,000 acres of National Forest lands which are capable of producing timber and valuable chiefly for that purpose have been denuded of their original tree growth. These lands are not adapted to agriculture and possess but slight value for grazing. In their present condition they are practically unproductive barrens.

It is probable that one-half of this area will reforest naturally through the reseeding of burns and the encroachment of tree growth upon natural gaps, parks, grass, and brush lands. Natural extension of the Forest on such areas is progressing at an estimated rate of 150,000 acres annually. The mere protection of this increasing acreage of young forest from fire, without other measures, will greatly increase the value of the National Forests and their future productive capacity.

The remaining half of the denuded area, 7,500,000 acres, must be reforested by artificial methods. Aside from this land, which is unquestionably adapted to growing timber and useful to the country primarily for this purpose only, there is a large aggregate area of grass lands scattered mostly in small patches throughout the Forests or above timber line, portions of which it may be found desirable and practicable to stock with trees.

Aside from the areas denuded through burns or other natural agencies, some 90,000 acres cut over annually under National Forest timber sales will reforest promptly by natural seeding through the careful selection of the trees to be cut with this end in view.

The problem in the broad is the most productive use of National Forest lands which have little or no value for other purposes, to the end that the Forests may serve most fully the objects for which they were created. It is directly related to accomplishing the largest possibilities of many Forests in their function as conservers of stable streamflow.

The duty of the Forest Service to put the denuded areas which will not be reforested naturally into a condition of productivity and usefulness is clear. Under the semiarid conditions prevailing on many National Forests this work involves uncertainties and unsolved problems. In the National Forest regions artificial reforestation was an untried field when the Forest Service entered it. It therefore had to develop its own practice in the face of a great variety of condi-

tions, largely unfavorable. The situation still calls for intensive experiments to develop the best methods, from the standpoint of both cost and results, applicable to each region. It also calls for the application on a large scale of the methods demonstrated by experiment to be successful.

Intensive experiments must come first. Business prudence requires the development of methods in detail, and reasonable certainty as to their results, before large sums are expended upon field operations. In the least favorable regions, like the semiarid portions of the Southwest, the work must be restricted for the present to small, carefully conducted experiments, the result sought being reliable information on how to proceed rather than the reforestation of many acres. In the most favorable regions, as on the west slopes of the Rocky Mountain and Cascade Ranges in the Northwest, the results already obtained justify operations upon a larger scale simultaneously with continued intensive investigations.

Broadly speaking, all of the reforestation work of the Service is experimental in character. Even in the most favorable localities further experience is needed to perfect the details of the methods now employed and, in fact, to select the general method to be used in the ultimate prosecution of the work from the standpoint of maximum return for each dollar expended. The difference in the policy followed as between favorable and unfavorable regions is primarily as to the scale of work. The better opportunities for success in the latter case justify heavier expenditures in order to make a start upon the enormous acreage of denuded land confronting us. The main volume of work upon which available funds will be chiefly spent must therefore be restricted to areas having the best soil and moisture conditions, where assurances of success are most certain. As the work is extended into each new region or Forest, following experimental results which are sufficiently conclusive, the most favorable sites available will first be chosen. After the possibilities and limitations of each method have been ascertained by experience under the best conditions in each locality, the work can be either intelligently extended or restricted.

Within the conditions outlined watersheds used for municipal supply or irrigation should continue to receive first consideration. Large sums can not, however, be spent on such watersheds under any considerable uncertainty as to the outcome; that is, before successful methods have been perfected by experiment. It will be advisable, furthermore, to conduct reforestation work simultaneously for the primary object of producing timber where climatic and other factors are particularly favorable. As far as possible such areas are being selected with reference to (1) low cost of the work, (2) natural conditions which insure rapid tree growth, and (3) urgent local need for additional supplies of forest products.

Prior to the fiscal year 1911 approximately 13,775 acres of National Forest land were reforested by various methods. This work was almost wholly of an intensive experimental character, conducted under a great variety of conditions and including typical forest areas in practically all of the Western States. Many of these experiments accomplished little so far as the actual stocking of denuded areas is concerned, but they were all of the utmost value in furnishing a basis for future work.

During the past year, in accordance with the policy of the Department, the work was materially expanded. Reforestation of large National Forest areas was entered upon, along with continued investigations. In all 25,230.51 acres were covered at a cost for seed, nursery stock, equipment, and labor of \$133,802.01. Additional expenditures for the maintenance of nurseries, the production of nursery stock to be used in subsequent years, and the collection of seed to be sown in the fall of 1911 and the spring of 1912 aggregated \$69,400.

To place the reforestation work on a thoroughly sound basis it will be essential to continue intensive experiments for many years. The latter should be supplemented, however, by the application of the most successful methods, as they are developed, to large areas where the best natural conditions are found. It will be practicable for the Service, as now organized and equipped, to reforest 30,000 acres annually. Any greater acreage should, in justice to the other responsibilities of the Service, and particularly in justice to the maintenance of efficient fire protection, be provided for by increases in the specific appropriation for this work.

The acreage reforested annually should be mainly in the four northern districts, where natural conditions are most favorable and the best results have been obtained. In districts 3 and 5, embracing Arizona, New Mexico, and California, immediate work should be restricted to intensive experiments on a small scale. Extended operations are not justified in these districts until successful methods of meeting their adverse local conditions have been perfected.

Two general methods of reforestation have been developed by the experimental work conducted in the past:

(1) Direct seeding, under which tree seed is sown upon the ground with or without simple forms of cultivation.

(2) The growing of seedlings in nurseries under ideal conditions as to soil, light, and moisture, to be transplanted into the field when of suitable size.

Direct seeding is the cheaper and more rapid method, but is necessarily limited to sites whose soil and moisture conditions are exceptionally favorable to tree growth. The inability of the freshly germinated seedling to establish itself except in comparatively moist soil makes the success of this method on the semiarid Forests, subject to prolonged dry seasons, very problematical. In such localities its use must be restricted to experiments designed to determine the exact range of conditions under which it is feasible. The main effort of the Service has been given to direct seeding on areas where reasonable success appeared to be assured.

The planting of 2 or 3 year old seedlings largely overcomes the adverse soil and moisture factors which appear to have made direct seeding unsuccessful in many localities. This method, the general practice in European forestry, must probably be employed to reforest a considerable portion of the denuded lands. The growing and planting of nursery stock is carried on simultaneously with direct seeding, but on a much smaller scale. Its object is to ascertain the comparative results of the two methods, the sites on which the greater success will be obtained from each, and the proper relation of the two methods in the future development of reforestation work. Conclusive data on the comparative cost of seeding and planting have not yet

been secured. The cost of both in last year's work, planting particularly, was high because of (1) the inclusion of a large number of small experimental areas at a high unit cost and (2) the necessity of doing a portion of the work with high-priced ranger labor after the funds specifically appropriated for reforestation had been exhausted. It is probable that the cost of the two methods, seeding and planting, under similar conditions as to labor and scale of work is in the ratio of 1 to 2½ or 3.

The following table summarizes the seeding and planting operations of the year by States:

State or Territory.	Area seeded.	Area planted.	State or Territory.	Area seeded.	Area planted.
	<i>Acres.</i>	<i>Acres.</i>		<i>Acres.</i>	<i>Acres.</i>
Arizona.....	792.02	6.95	Nevada.....		12.01
Arkansas.....	45.52	28.88	New Mexico.....	342.94	56.57
California.....	2,659.17	169.17	North Dakota.....	159.00	28.00
Colorado.....	3,228.76	82.70	Oklahoma.....		4.00
Florida.....	169.90	2.20	Oregon.....	6,485.61	6.43
Idaho.....	624.41	328.27	South Dakota.....	2,322.00	
Kansas.....		58.54	Utah.....	64.82	511.22
Michigan.....	221.28	27.74	Washington.....	3,249.00	91.50
Minnesota.....	133.69		Wyoming.....	900.30	
Montana.....	1,831.02	521.17			
Nebraska.....	5.00	60.12	Total.....	23,235.04	1,995.47

THE DIRECT SEEDING WORK AND PROBLEMS.

Three distinct problems are confronted in the prosecution of direct seeding: Seed supply, rodent injury, and cheap cultivation.

The problem of seed supply has been met by organized seed collecting and extracting operations conducted by the Service directly, by purchases from local dealers or under special contract, and by purchases of European seed of species apparently suited to the conditions on certain Forests. During the year, 52,798.45 pounds of seed of coniferous species were collected by the Forest Service at an average cost of \$1.24 per pound, and 10,632 pounds of seed of hardwood species at an average cost of 11.6 cents per pound; while 26,734 pounds of conifer seed were purchased at an average cost of 78 cents per pound, and 28,162.5 pounds of hardwood seed at an average cost of 3.6 cents. The total amount of seed secured during the fiscal year was 118,326.95 pounds, at a cost of \$88,616.60.

The cheapest method of collection, and the one most extensively employed, is by the purchase of cones at advertised rates upon delivery at ranger stations or points of shipment to extracting plants. In favorable seed years cones of the more common western trees can usually be obtained at prices ranging from 25 to 75 cents per bushel. Where this method can not be used either because there is no one to undertake the work or because there are no funds available for the purchase of cones, seed is collected by forest officers by stripping cones directly from standing trees or from those felled in logging operations, or by gathering from the vast stores assembled by squirrels.

Seed extraction can usually be done most economically by experienced forest officers. It requires drying by exposure to natural or artificial heat, to open the cones; threshing, to separate the seed from the scales and woody portions of the cone; and cleaning or fanning, to remove chaff and dirt. Much of the extraction has hitherto been

done in small quantities, at a large number of stations, with very simple appliances. In view of the amount of seed which must be handled each year, the cost of extraction can be materially reduced and seed of higher average fertility obtained by concentrating the major part of this work at central plants equipped with improved machinery. Three extracting plants of this character are in process of construction, on the Oregon National Forest, in Oregon, the Medicine Bow National Forest, in Wyoming, and the Harney National Forest, in South Dakota.

The seed collected by the Forest Service shows a wide variation in cost. This is due primarily to great differences in the seed crops from year to year. The cost of yellow pine seed collected in Montana has ranged from 61 cents per pound in favorable years to \$2.01 in seasons of deficient seed crops, and the cost of Douglas fir seed from 84 cents to \$2.58. Since direct seeding, particularly under the broadcast method, requires relatively large quantities of seed, the initial cost of the seed bears a very important relation to the total cost per acre of the completed work.

A problem of still greater importance from the standpoint of final results is that of having seed available at the season of the year when needed for most effective use. Past experiments have demonstrated that fall sowing is essential to success in most of the localities where extensive seeding projects will be conducted. Experience has also shown that seed on a large scale can not be extracted in time for use the same season.

The purchase of clean seed from local collectors is often advisable in localities where this industry has been developed and the quality of the seed is assured. Such purchases must usually be made, however, at prices above the cost involved when cones can be obtained by contract or hired labor. Nor do such purchases meet either the problem of excessive cost in seasons of short crops or that of inability to secure the seed from year to year at the right time for successful sowing.

European seed is exceptionally cheap. It does not vary greatly in cost and can usually be obtained in the quantities and at the seasons desired. In order to sow the acreage desired last year the collection of native seed was supplemented by extensive purchases of Scotch and Austrian pine at 43 cents per pound, Norway spruce at 32 cents, and European larch at 76 cents. The low average cost of the seed purchased as compared with that collected is due primarily to the inclusion of these foreign orders.

The results obtained in a large majority of the experiments conducted up to the present, however, do not warrant further extensive purchases of European seed. The adaptability of these foreign species to soil and climatic conditions in the western United States is too questionable to justify their further use on a large scale until success with them is assured by conclusive experiments. In the present stage of this work it will be far preferable to rely mainly upon the valuable native trees produced naturally under the very conditions with which we are dealing, and to limit the use of exotics to small experiments designed to show how far they may wisely be employed.

Experience has demonstrated also that the quality of purchased seed, both domestic and foreign, is much less dependable and subject to control than that of seed collected by the Forest Service. This

affects both the percentage of fertile seed and the time required for germination, two factors vital to success.

The problem of seed supply can be most effectively met by concentrating upon collection of local purchases in years when seed crops are abundant and the cost therefore relatively low. The practicability of storing seed for at least one year, with slight loss in fertility, has been demonstrated. In seasons of abundant crops it will be advisable to collect two or even more years' supply of seed. In such seasons it may be necessary to concentrate the efforts and funds of the Service primarily upon this feature of the work, with a proportionate reduction in the acreage sown. Extensive collection should not be attempted in years when the cost of seed will, on account of poor crops, be excessive or when seed of the species required for the more favorable sites can not be obtained. In such seasons the organization and funds will be concentrated mainly upon sowing in so far as it is found practicable to carry reserve supplies of seed ahead. This method will maintain the balance of the various parts of the work and accomplish the reforestation of the areas desired by periods of years. The reduced cost of seed and its availability at the right time for sowing should materially increase the area which it is possible to reforest successfully with given funds.

Seed tests were continued during the year as an essential factor in the solution of the general problem of seed supply. The tests covered (1) the fertility of over 150 samples of seed collected on the National Forests, (2) the relative merits of various containers of seed, and (3) the results of various methods of storing seed. Tests of different methods of germination were discontinued, all germination tests being conducted by the soil method.

The tests of fertility of samples of collected seed were used directly in determining the amount of seed to be used in both field sowing and nursery operations. The storage tests showed the sealed glass jar to be the best container, and that seed must be stored either in air-tight receptacles or at low temperatures to be kept for any considerable period without loss of fertility.

The destruction of sown seed by rodents has been one of the greatest obstacles encountered in reforestation. The failure of many of the earlier seeding projects was due primarily to loss from this cause. It has occurred on areas of practically every character, regardless of the time of year when the seed was sown, except in cases where recent burns had largely eliminated the animals either by outright destruction or by loss of food supply. Special effort has been given to the solution of this problem during the last year, with the efficient assistance of the Biological Survey, and a large number of methods of destroying destructive species were tested in the field. The coating of seed with poisonous substances has not proved effective. On many areas, however, free use of poisoned grain has reduced the loss from rodents sufficiently to secure satisfactory germination. The successful elimination of such injury appears to lie in the thorough poisoning by this method of areas to be seeded, once or oftener in advance of sowing.

With successful germination assured, the great problem lies in cheap methods of cultivation and sowing, which will enable the young seedling to develop its root system early enough and rapidly enough to withstand the first annual drought, the dominant climatic feature

of all of the western National Forests. During the year over 700 separate tests were made, on 114 National Forests. Twenty-four native conifers, 12 native hardwoods, and 12 foreign species were tried. Seed was sown at the beginning of midsummer rains in the Southwest, in the fall, in midwinter, and at various periods in the spring up to June 1.

Three general methods were employed:

(1) Broadcast sowing in the fall and spring and upon snow in winter, both on unprepared ground and on soil which had been scarified by rough brush drags, harrowing, disking, and partial or complete plowing.

(2) Seed-spot sowing, in which the seed is planted at regular intervals in small spots where the soil is cleared of vegetation and worked loose to a depth of 5 or 6 inches.

(3) Corn planting, or dibbling, in which the seed is thrust into the soil by a hand corn planter, or, in the case of large nuts, pressed into holes made with pointed sticks. This method was combined on a number of areas with the preparation of seed spots or the plowing of single furrows in order to plant the seed in loose soil free from vegetation.

On a large majority of the Forests broadcast seeding on unprepared ground has not succeeded. As a rule, satisfactory stands have been secured from broadcasting only after an expenditure for preliminary cultivation which would be impracticable in extended operations and which exceeds the cost of planting with nursery stock. Seeding in spots or by corn planters, or by a combination of these methods, has in the main proved far more successful. This method is also most economical, since it requires a minimum amount of seed—approximately one-fourth of that used in broadcasting. Winter and spring seeding has brought poorer results as a rule than fall seeding. Fall-sown seed germinates from four to six weeks earlier than that sown in the spring, and with many species germination is far more uniform and complete. These factors are of vital importance in carrying a satisfactory stand of seedlings through the first dry season, the most critical period of their entire life.

Fall seeding, with the spot method of cultivation, is the general method of future work indicated by the experience of the past year. Another essential feature of future work, forcibly demonstrated by the results of the past year, is concentration of seeding upon comparatively few Forests in the four northern districts. Large areas where the most favorable soil and moisture conditions exist will be carefully selected, mapped, and studied in detail with reference to all factors affecting success. Such areas will be systematically poisoned and protective measures against grazing and other possible injury taken if necessary. Seeding operations will be concentrated upon these areas, year after year, until the entire tract is successfully reforested. Through such concentrated operations on a large scale the best expert supervision can be given at minimum cost per acre, while results obtained under different methods and seasonal conditions and with different species can be closely compared.

The largest areas were seeded in the main commercial timber belts of the central West, Northwest, and Pacific slope: 2,578.38 acres with Austrian and yellow pine in the National Forests of the western Dakotas and eastern Montana; 5,972.95 acres with yellow pine,

Engelmann spruce, Douglas fir, and lodgepole pine in the central and northern Rocky Mountain Forests; 8,062.47 acres with Douglas fir, Sitka spruce, yellow pine, hardwoods, and various European species in western Washington and Oregon; and 1,883.48 acres with sugar, yellow, and Jeffrey pine, incense cedar, and Douglas fir in the Sierra Nevada Mountains and northern ranges of California. Successful reforestation was accomplished on some areas in every locality, usually those where thorough poisoning has been combined with fall sowing in seed spots or with other simple methods of cultivation. It is probable that a satisfactory stand of young trees will be secured on at least a third of the entire acreage sown. The results as a whole indicate that reasonable success may be anticipated with native species under the policy of concentration upon the most favorable sites, with the work restricted mainly to fall sowing in prepared soil.

Small experiments in seeding with Norway pine the sandy barrens composing the National Forests of Michigan were begun. The development of successful methods on these Forests will be of exceptional value because of the enormous area of waste lands in northern Michigan to which they can be applied. Another promising line of experiments which has been successful is the extension of the valuable hardwoods of the Southeast by seeding on the National Forests of Arkansas. On the Ozark Forest 38.15 acres were sown with black walnut, hickory, and white and red oak, and 5.26 acres with black locust. This work will be materially increased during the ensuing year.

The introduction of valuable exotics on portions of the Florida National Forest, on inferior soils where natural reproduction is scattered or wanting, has formed another set of experiments which may have results of great economic importance. Three acres were sown with the cork oak of the Mediterranean, and 157 acres with maritime pine, the tree which supports the naval-stores industry of France. These experiments will be continued until conclusive results are obtained.

The average cost of the areas seeded, including seed, was \$4.08 per acre. The cost in the respective districts varied from \$2.35 per acre to \$6.95, the chief factors being (1) cost of seed and (2) the size of the areas seeded. The cheapest work was done in the large projects of western Oregon, where solid blocks of several hundred acres each were sown by organized crews of temporary laborers. Under the policy adopted of concentrated seeding on large areas and the collection of large amounts of seed in years of favorable crops, it is probable that future seeding can be done uniformly at a cost of \$3.50 to \$4 per acre.

PLANTING AND NURSERY WORK.

With the major emphasis directed to seeding, it is the policy of the Service to continue the production and planting of nursery stock upon a limited scale; to develop its nursery practice to the highest efficiency; to secure a series of comparative tests of planted stock with direct seeding; and to extend experimental plantations into the less favorable sites until the limitations upon this method are determined. Its nursery and planting operations will be gradually extended, as may be necessary for these purposes or to secure greater

economy in the production of seedlings, but not so as materially to increase the cost of this part of the work.

The experimental character of the nursery work and the fact that much of it is done under the administrative appropriations of the respective Forests has required the establishment of a relatively large number of nurseries, mostly of small capacity and maintained by rangers in connection with other duties. The following is a complete list, with the annual capacity of each nursery as developed up to the present and the estimated stock of all ages on hand at the end of the fiscal year:

Nursery.	Forest.	Annual capacity.	Present stock.	
			Seedlings.	Transplants.
Boulder.....	Helena.....	3,000,000	6,427,300	1,231,300
Savenac.....	Lolo.....	1,500,000	3,721,400	278,800
St. Regis.....	do.....	(1)	104,517	.....
Trapper Creek.....	Bitterroot.....	50,000	291,000	38,000
Dakota.....	Dakota.....	200,000	145,000	.....
Cass Lake.....	Minnesota.....	100,000	225,000	.....
Monument.....	Pike.....	700,000	1,257,000	602,800
Halsey.....	Nebraska.....	2,000,000	2,215,410	378,290
Garden City.....	Kansas.....	300,000	318,200	20,410
Animas.....	San Juan.....	10,000	20,270	.....
Hyannis.....	Nebraska.....	10,000	.....	5,930
Fort Bayard.....	Gila.....	150,000	196,300	51,000
Gallinas.....	Pecos.....	100,000	183,400	82,000
Frye Canyon.....	Crook.....	40,000	130,400	.....
Cocconino Experiment Station.....	Cocconino.....	10,000	41,000	14,000
Rocky Bayou.....	Choctawhatchee.....	2,500	2,500	.....
Uinta.....	Uinta.....	4,000,000	4,306,000	2,100
Wasatch.....	Wasatch.....	5,000,000	5,285,000	634,500
Pocatello.....	Pocatello.....	3,000,000	3,285,000	33,300
Cottonwood.....	Boise.....	50,000	100,000	.....
Long Gulch.....	do.....	100,000	102,400	.....
Pine.....	do.....	50,000	16,000	.....
Flowers.....	Sawtooth.....	100,000	130,000	.....
Upper Jose.....	Manti.....	50,000	65,000	13,700
Poorman.....	Payette.....	10,000	15,000	.....
Pilgrim Creek.....	Shasta.....	500,000	388,000	54,900
Converse Flats.....	Angels.....	200,000	159,000	27,000
Los Prietos.....	Santa Barbara.....	(1)	8,300	49,000
Wind River.....	Columbia.....	1,000,000	591,000	1,075,700
Silverton.....	Snoqualmie.....	500,000	410,000	5,500
Page Creek.....	Siskiyou.....	50,000	44,200	45,118
Total.....	.....	22,702,500	30,208,597	4,643,348

¹ To be discontinued.

Since two years is the minimum age at which nursery-grown seedlings can ordinarily be planted in the field, the stock now on hand, aggregating 34,851,945 plants, represents about three-fourths of the capacity of the present nurseries. The enlargement of the Halsey nursery, Nebraska, to a capacity of 2,000,000 plants seemed advisable in order (1) to secure a greater return from the investment in nursery equipment and from the services of the experts employed at the station, without increasing the running expenses; (2) to begin the production of Norway pine stock, a species which appears peculiarly adapted to the western Nebraska sandhills; and (3) to provide for the distribution of seedlings to settlers in accordance with the act of March 4, 1911, known as the Kinkaid Act. The latter is a significant step in Federal policy. The distribution of free stock to homesteaders in small quantities will begin in the spring of 1912, when approximately 50,000 plants will be available. The annual produc-

tion of seedlings for this purpose will be gradually increased up to half or three-fourths of a million, as the demand warrants. The plantations established with this stock will be systematically inspected to insure proper methods in planting the trees and the restriction of their distribution to settlers who make effective use of the seedlings.

The Dakota National Forest was created in response to the request of many citizens of North Dakota, primarily as a demonstration station in methods of reforestation. The establishment of a small nursery seemed necessary to accomplish this purpose. On many portions of the Dakota natural conditions are so adverse that the use of nursery stock will undoubtedly be required for successful reforestation. Yellow pine and native hardwoods, particularly elm, box elder, and green ash, will be the species used.

The Los Prietos nursery on the Santa Barbara and three nurseries in the foothills of the Angeles will be discontinued with the planting or transfer of all remaining stock. Natural conditions in the foothill belt of southern California, a belt naturally treeless and exposed to an exceptionally long season of drought combined with high temperature, are so difficult to overcome that it has seemed wise to cease further attempts at afforestation. This decision was based upon the negative results of a large number of plantations made during the past seven years, and upon the conviction that the stream-conserving function of these watersheds will be better met by their native cover of chaparral than by any growth of trees which it is possible to establish. Reforestation work in southern California has therefore been transferred to the timber belt, above 5,000 feet, where success is far more assured and where the planting of large areas will be exceedingly desirable, both for the further protection of headwaters of irrigation systems and for the production of commercial timber. In accordance with this policy the Converse Flats nursery has been established on the Angeles National Forest at an elevation of 5,500 feet. This nursery will be kept on a small, intensive basis, its function being to conduct experimental tests of a wide range of methods.

An advance in the development of methods adapted to semiarid conditions was made by tests at the California nurseries and the Coconino Experiment Station of transplanting young seedlings to individual pots of pasteboard or tarred paper, and of growing them in pots from the start. When ready for the field, the entire pot is set out without disturbing the root system of the young plant. This method has been extensively used in India and South Africa, and promises greater success in carrying seedlings through the first dry season than is possible under the loose-root or European system.

In general nursery practice the chief efforts of the Service during the year have been directed to (1) reducing the cost of growing stock, and (2) continuing exhaustive experiments to determine the best nursery rotation for each of the principal species. The cost of the stock previously grown by the Service has been excessive on account of the relatively small size of the nurseries, the heavy initial investments required for equipment, and losses in the first-year seed beds and in transplanting. These elements of cost have been materially reduced through the completion of the equipment of the nurseries, improved organization in the matter of scale of production and proportionate overhead expenses, and study of the causes of loss in the seedlings and means of preventing it. Much has been accom-

plished to eliminate injury from "damping off" fungi in the first-year seed beds and to perfect methods of transplanting which reduce the loss from that process.

Substantial progress has been made in reducing the cost of nursery-grown stock. Two-year-old yellow pine seedlings were grown at the Montana nurseries at costs ranging from \$1.44 to \$2.46 per thousand plants, and 2-year-old Douglas fir seedlings at a cost of \$2.22 per thousand. One-year seedlings were grown at the Wind River nursery, Washington, at a cost of 37½ cents per thousand, exclusive of the cost of nursery improvements and equipment. This stock can be carried a second year in transplant beds at a total cost when ready for the field of \$1.75 per thousand plants. With the present organization of the Utah and Idaho nurseries it seems probable that 2-year-old seedlings can soon be produced at 75 cents per thousand plants, and 2-year stock once transplanted at \$1.75 per thousand. A large portion of the stock planted during the year cost from \$8 to \$12 per thousand seedlings, this item being the principal factor in the high average cost of the plantations established. The foregoing figures, however, indicate the possibilities of greatly reducing this cost through experience and better organization of the nursery work.

For the greater part of the planting now being done by the Service a nursery rotation of two years, one year in seed beds and one year in transplant beds, produces stock of adequate root and crown development. One transplanting during this period is ordinarily necessary to harden the root system and promote the growth of lateral roots. With some species, particularly the hardier pines, it seems probable that the cost of transplanting in the nursery can be eliminated by using 2-year-old seedlings in planting on favorable sites. In fact, some tests with yearling seedlings of yellow pine on good soil have been successful, owing to the very rapid root development of this species in the early stages of its growth.

With this possible exception, experience has eliminated the use of stock under 2 years old in planting with the loose-root system. In potting transplants for arid districts it may prove practicable, under the protection thus afforded the young roots, to use stock but 1 year old by transferring the seedlings to pots within a few weeks of germination. For the less favorable localities, as in portions of the Southwest, tests with older stock will be continued until comparative results are reached which are conclusive. These will include 3 and even 4 year old stock twice transplanted in the nurseries in some instances in order to form hardier and brushier root systems.

The greater part of the areas planted were in the central and northern Rocky Mountains, using the native species—yellow pine, Douglas fir, Engelmann spruce, and lodgepole pine. Tests with Scotch and Austrian pine, two exotics of great drought-resisting power, were continued, together with small experiments with valuable eastern hardwoods.

The work in California included 77.87 acres of eucalyptus and hardwoods. The susceptibility of eucalyptus to frost and its exacting soil requirements apparently restrict the acreage of National Forest land to which it is adapted to a very small amount. The importance of the eucalyptus to California, however, makes it desirable for the Service to continue experimental tests with a view to building up our knowledge of the silviculture of the various species, very few of

which have been thoroughly tested in North America. The plantations of the two preceding years have proved successful on the relatively good soils and with intensive cultivation. The main emphasis is now being given to pit planting on the rougher ground where cultivation is not practicable. Experiments were conducted during the last year with 14 species on the Angeles and Santa Barbara Forests, and will be continued during the coming year on the same scale. Small eucalyptus experiments were also begun on the Florida National Forest.

The experimental planting of maritime pine on sand dunes along the Pacific Ocean in the Siuslaw National Forest, Oreg., was inaugurated. Aside from the utilization of waste land it is important to determine the possibilities of establishing forest cover on such areas as a means of controlling shifting sand, which is a serious menace to many Pacific coast harbors.

Up to the present time the results on a large majority of the plantations are satisfactory, with upward of 60 per cent of the plants in a thrifty condition. On a large number of tracts over 90 per cent of the seedlings have survived the first dry season and made satisfactory growth. With the experience acquired it seems practicable to obtain uniformly a stand of at least 80 per cent by this method on all but the distinctly unfavorable sites.

The cost of planting varied greatly with the size of the areas planted, the cost of the stock, and the more or less intensive character of the work. Small tracts were planted with jack pine in Kansas and with white pine in Arkansas at a total cost of \$4.75 and \$5 per acre, respectively. Sixty acres were planted with Sitka spruce, yellow pine, and white pine in the Snoqualmie Forest, Wash., at a total cost of \$6.72 per acre. The average cost of this year's planting was \$19.56 per acre. The unit cost of this work must necessarily remain high as long as it is conducted on a small scale, and largely with a view to obtaining better knowledge through experiments rather than primarily for the sake of the improvement of the specific area planted. The cost will be materially decreased, however, as reductions are made in the cost of growing nursery stock. On a reasonable scale of operations it should be feasible for the Service to do much of its planting at a cost of \$8 per acre, and to bring the average below \$12 per acre.

FOREST INVESTIGATIONS.

Both experimental and general studies were conducted to obtain a better scientific basis for National Forest management. These studies also develop the knowledge needed for the practice of forestry generally on western timberlands.

Experimental studies of an intensive character were conducted almost exclusively at the Fremont, Wagon Wheel Gap, and Fort Valley Experiment Stations. Because of the importance of the reforestation work of the Service, the experiments were directed chiefly to this problem. Aside from tests of a wide range of methods in seed extraction, direct seeding, nursery work, and field planting, studies in tree breeding and the factors governing production and fertility of tree seed have been inaugurated. These cover the effects of altitude, precipitation, and soil upon seed, and the adaptability of seed to different conditions from those under which it was pro-

duced. The classes of trees which produce the most vigorous seedlings and the transmission of defects in seed-bearing trees to the seedlings form a second group of valuable studies. Tentative results obtained at the Coconino Experiment Station indicate that yellow-pine trees under 250 years of age produce seed of 8 per cent higher fertility than that from trees of a greater age; and that trees affected by mistletoe or infested with bark beetles produce seed of a much lower germination per cent than healthy trees. Records have been established at this station of about 100 trees in various stages of decadence to determine how long they will continue to bear seed.

Studies in natural reforestation have been begun on a number of National Forests, the primary object being to determine methods of cutting and brush disposal in timber sales which will secure the best reproduction of desirable species. These experiments include Douglas-fir stands in the Cascade Mountains, lodgepole-pine and Engelmann-spruce stands in the Rocky Mountains, and yellow-pine stands in Arizona. On the Coconino Forest, experiments begun in 1908 to determine the effect of scattering brush upon reproduction indicate that while brush protects young seedlings against drought and frost it is not sufficient to carry them through protracted periods of rigorous climatic conditions. The presence of scattered brush was found detrimental in keeping seeds from reaching the mineral soil and shading the young plants excessively at certain periods.

Observations on the effects of different methods of brush disposal on the Minidoka, Sawtooth, Cache, and Targhee Forests, in both old and recent cuttings, indicate that lopping and scattering will apply to nearly all types in Utah, Nevada, and northern Arizona. This method increases the fire danger and will not be advisable near settlements and lines of travel.

Studies of the effects of grazing upon natural reproduction were conducted in Arizona, with a view to devising a system of range control which would minimize such injury without requiring the total exclusion of stock from the range. Serious damage was found to have occurred to seedlings under 4 feet in height, during the dry season, on areas containing poor forage, or which had been overgrazed, or where there is little or no underbrush. It was found that sheep do twice as much damage as cattle. The revegetation of overgrazed areas, reductions in the amount of stock in some cases, provisions for better distribution of stock by regulation of watering places, and the exclusion of sheep from cut-over areas on which reproduction is deficient until the seedlings reach a sufficient height are among the measures to be tested for lessening this injury.

Experiments were also conducted to determine the practicability of opening dense stands of chaparral in northern California by regulated goat grazing, in order to make possible the extension of forest growth into the enormous brush fields of that locality. Definite results have not yet been reached.

Aside from investigations related to reforestation, the work of the year included experimental studies of forest influences, the climatic requirements of forest types, growth and yield studies, sample plot studies, and insect and fungus investigations.

That the forest exercises a decided moderating influence upon temperature extremes, wind motion, and evaporation was shown by experimental observations which have been conducted at the Fort

Valley Experiment Station since January 1, 1908. These conclusions, which are based upon a comparison of records in a large open park and within a virgin forest, may be used to good advantage in selecting the most favorable sites for reforestation.

One of the conclusions drawn from the observations is that the presence of a forest cover retards the melting of snow in the spring. Both this question and the influence of the forest upon the accumulation of snow will be studied further through a special investigation in the yellow-pine type of Arizona and the Douglas-fir and Engelmann-spruce types of Colorado.

At the Wagon Wheel Gap Station records of great interest are being obtained from the principal experiment, which is to determine the effects of forest upon streamflow. The entire purpose of the study during the first two or three years is to determine the character of the two streams which are to be measured. The forest cover on the two watersheds is practically the same. The results so far obtained indicate that the influence upon streamflow must be about the same in both cases, and, consequently, a comparison of these streams after the denudation of one watershed will be a very fair test of the influence of the forest cover upon the relative height of the flood stage and low-water stage, the amount of erosion, and the rate of melting of the snow.

In August, 1909, the town of Ephraim, on the Manti Forest, Utah, experienced a disastrous flood from Ephraim Canyon, which was attributed in part to the overgrazed conditions on the watershed. An examination made in the spring of 1910 clearly demonstrated that the severity of the flood was a direct result of deterioration of forest, brush, and grass cover due to prolonged overgrazing. The canyon was therefore closed to grazing as an immediate protective measure, and it is planned to restore the forest cover on Ephraim Canyon by sowing and planting.

The climatic requirements of forest types has been studied at the Fremont Experiment Station since January 1, 1910, through experimental observations. The first step is to obtain a complete meteorological record as a basis for determining what climatic conditions are most important in limiting the natural range of the yellow pine, Douglas fir, and Engelmann spruce. The first year's study shows that soil moisture and soil temperature are the controlling factors in determining the existence of the three different types, and gives knowledge as to what climatic conditions each of the three species must have in order to succeed.

Reliable growth and yield data for different species and types are necessary to properly handle timber sales as well as for forest management. They are also essential for determining damages caused by fires, trespass, etc. During the year there were secured a large number of volume tables on the Custer and volume and yield tables on the Deerlodge and Kaniksu Forests for lodgepole pine, western yellow pine, and Douglas fir. Considerable progress has been made on growth studies for yellow pine, sugar pine, and incense cedar on the Stanislaus National Forest.

Sample plots have been established on a number of large timber-sale areas in important forest types. On each plot of 6 or more acres every tree is carefully measured and recorded. Similar measurements will be made at regular intervals to determine the increase

in volume and the production of wood, following the cutting, among the trees left of each age and species. Close observations of the reproduction which takes place, brush and other forms of cover which may establish itself, and changes in soil conditions will be recorded. The studies will help to determine the cutting methods which will bring the best results in new forest growth and maximum production of wood.

In cooperation with the Bureaus of Plant Industry and Entomology studies have been conducted on a number of Forests in tree diseases and insect infestations and methods of controlling them. Special effort was made to combat the most serious recent insect infestation, of *Dendroctonus monticola*, in yellow and lodgepole pine timber on the Whitman National Forest, Oreg. Nearly \$25,000 was expended on this Forest in cutting, piling, and burning recently infested trees. It is hoped that this work, together with logging under pending timber sales on this Forest, will at least materially check the damage threatened by this attack.

In connection with studies of the more serious fungi attacking white fir in the western Sierra Forests of California it has been found practicable in recent timber-sale contracts to require the removal of all infested trees of this species. In this manner it will be possible greatly to reduce the extent of the disease and to protect the new growth of timber from its attack.

Besides these experimental studies there were completed commercial tree studies of western yellow pine in the Southwest, Douglas fir in the Northwest, Utah one-seeded juniper, and Rocky Mountain juniper. Similar studies of western yellow pine in Oregon, western red cedar, western white pine, and lodgepole pine were begun.

RANGE MANAGEMENT.

The abnormal weather conditions which prevailed during the summer and fall of 1910 brought out strongly the practical value of the methods of range control used on the National Forests. Arrested growth and early maturity of forage, scarcity of water, and all the other disastrous effects of a prolonged drought were apparent on the Forest ranges, but their condition was immeasurably superior to that of contiguous ranges not under regulation. Despite the adverse season few losses of live stock occurred. The control of stock upon the ranges, the enforcement of Federal and State quarantine regulations, the destruction of predaceous animals with consequent lessening of stock losses, the restoration of depleted ranges, the utilization of new ranges made possible by the construction of trails and the development of new sources of water supply, all progress uninterruptedly, and, contributing materially to the amelioration of discouraging conditions, strengthened the realization of an identity of interests between the stockmen and the Forest Service to the end that the range resource may yield the largest benefit possible without sacrifice of other interests. There has been a pronounced gain in good will, approval, and cooperation everywhere.

GRAZING CAPACITY OF NATIONAL FORESTS.

Of the 150 National Forests within the United States, exclusive of Alaska, on June 30, 1911, 144 were under grazing administration. On the Santa Rosa National Forest, which was created after the beginning of the grazing season, grazing was allowed free of charge and without permit for the remainder of the 1911 season. The five other Forests are either inaccessible or lacking in forage growths, and are therefore not occupied by domestic animals.

The area under grazing administration at the close of the year was less by 2,300,000 acres than at the close of the preceding year. This represents a reduction of 1.39 per cent in area, but in grazing capacity this percentage would be largely exceeded, as the lands eliminated were chiefly lowlands of high grazing capacity and heavily stocked, principally with cattle and horses. To this fact is largely due the decrease in the amount of revenue derived from grazing privileges.

Energetic efforts on the part of the district officers in districts 1 and 6 to promote a full utilization of the surplus forage on the Forests of northern Idaho, Montana, and Washington were only partially successful, and enormous quantities of feed went to waste, adding greatly to the fire danger. More or less inaccessible and remote from spring, fall, and winter ranges and railroad shipping points, these ranges can at present be utilized by sheep only, and flockmasters, discouraged by the depression in market prices, did not care to avail themselves of the inducements offered by the Forest Service or the concessions granted by the railroads in the form of reduced feed-in-transit rates.

The effort to stock these ranges will not be relaxed, and it is anticipated that eventually the surplus forage will be fully utilized. While the demand for sheep range in some localities in district 5 is greater than the supply, in general the National Forest ranges in that district are not stocked to their full capacity. Some inaccessible ranges on the northern Forests will be used as soon as transportation becomes easier or the live-stock market improves. With these exceptions the National Forests were stocked during the first half of the year to approximately their full normal grazing capacity, and it was necessary to deny many applications for grazing privileges.

During the last half of the year, the beginning of the grazing season of 1911, an entirely different condition existed upon all but a few of the most heavily stocked Forests. For a variety of reasons wool-growers regarded the prospects immediately ahead as unfavorable, and heavy shipments to market took place during the fall of 1910. Everything for sale in the cattle line had been bought up during the fall by buyers anxious to fill contracts, and cattle not sold were held at prohibitive prices. In consequence, the numbers of stock held in feed lots and on winter range were far below normal; and this, in turn, resulted in a great reduction in the numbers of stock to be grazed within the National Forests. With an unusually abundant growth of forage available, a surplus of feed upon many Forests hitherto fully stocked or even overstocked was certain.

During the season of 1911 reductions in numbers of stock as measures of Forest or watershed protection were required on only seven Forests. The reductions made were: On the Manti, 2,000 head

of cattle and horses, 27,000 head of sheep; on the Caribou, 7,000 head of cattle and horses, 50,000 head of sheep; on the Cache, 10,000 head of sheep; on the Hayden, 12,500 head of sheep; on the Lincoln, 12,400 head of sheep and goats; on the La Sal, 4,100 head of sheep; and on the Wenatchee, 1,500 cattle and horses and 25,000 sheep. On the Manti the stock were allowed by special agreement to remain upon the Forest until the close of the season. The Caribou reduction, while partially attributable to eliminations, was mainly to promote the natural reforestation of burned-over areas; the actual reductions made in the permits of old users amounted to but a few hundred head of cattle and horses and approximately 20,000 head of sheep. The reductions in the Wenatchee were due to the passing to private ownership and utilization of large areas of land previously occupied by stock grazed under permit. The other reductions were wholly to prevent overgrazing. On the other hand, there were numerous increases in the numbers of stock authorized to graze upon other Forests, these increases in the aggregate exceeding the reductions above specified to such an extent that the total allowances for the year were greater than those for the year preceding. The collective grazing capacity of the National Forests has increased, and the reduced numbers of stock covered by permit this year are due wholly to the specific reductions mentioned above, to eliminations from the Forests, and to voluntary reductions by permittees in the numbers of stock placed upon the Forests.

There are a few Forests upon which the full reduction necessary to bring about recuperation of the range has not yet been made because such action would have caused serious disturbance of local grazing conditions. Except for these few unusual cases it is believed that the National Forest range has been brought to the point at which further reductions to stop damage from overgrazing are not likely to be called for.

RANGE CONDITIONS.

Probably at no time since the creation of the National Forests has the range been put to as severe a test as during the season of 1910. Within the National Forests the forage crop was estimated to be from 25 to 33 per cent below normal, and even upon the higher ranges it matured shortly after July 1. The range was taxed to its utmost to carry the number of stock authorized. In some sections light rains fell early in September, but these afforded only local and temporary relief. On some Forests it became necessary to remove the stock before the permit periods expired, but on others room was found for outside stock which had to be removed from the open range. In the majority of cases readjustment of ranges by the local forest officers made it possible for the permittees to obtain feed through the season. Upon only two groups of Forests were the actual losses from drought serious enough to merit special attention.

After the 1st of August the bulk of the stock sold had to be marketed as feeders, but while it was not in the best of flesh and finish as compared to preceding years, conditions generally were better than the stock growers had anticipated. Cattle from Forest ranges brought very good prices because of a strong market. The market for sheep, however, was not so strong as in preceding years, and a big drop in

values became noticeable about October. Sheep owners were anticipating another severe winter season; the drought had greatly reduced the supplies of feed on the winter ranges; the surplus stocks of hay had been exhausted during the previous winter; the season's hay crop was being held for higher prices; and the outlook was not an encouraging one. In consequence many transfers of sheep were made at prices far below those of preceding years.

The winter of 1910-11 was in most localities a very favorable one, and all classes of stock wintered well except in southern Oregon, where heavy losses were sustained because of a shortage of feed upon the desert ranges and unfavorable weather conditions. The spring of 1911 opened early in districts 2 and 3, and late in the remaining districts. Where it was early the foothill ranges showed some signs of drying out, but timely spring and summer rains have put all of the Forest ranges in excellent condition. Where the spring was late some of the sheepmen were unable to use their customary lambing grounds and were somewhat inconvenienced because of this fact, but no serious losses resulted. The range conditions at the close of the fiscal year were generally the best since the ranges came under the control of the Forest Service. The results of the effort expended in past years to secure a proper distribution of stock, to open up new grazing lands, to provide new sources of water supply, and in every way to increase both the production and the utilization of forage are now becoming manifest. In the grazing seasons of 1909 and 1910 the weather conditions were so adverse as to obscure the gain achieved. It is now plain, however, that range regulation is actually giving the stock growers more and better feed for their stock as well as security in the use of the range and consequent stability to their industry.

IMPORTANT CHANGES IN LIVE-STOCK INDUSTRY.

Prior to the year 1911 an annually increasing number of stock growers requested the privilege of substituting sheep for cattle upon the National Forest ranges, but this year there has been a noticeable reaction in favor of cattle, in all but the most northern States. Many Forest users who stocked their ranges with sheep instead of cattle a few years ago now desire to engage in cattle raising. This is wholly attributable to the fact that low prices for wool and mutton products, combined with the occupation by new settlers of many choice lambing grounds and winter ranges, have robbed the sheep industry of many of the attractions which it formerly held for small operators, while a strong demand at exceptionally good prices for all classes of cattle has made that industry more profitable than it has been for many years. The demand for sheep grazing privileges necessitated the opening to that kind of stock of many ranges better suited to the grazing of cattle, and the change which is apparently taking place will prove beneficial to the extent that it will result in the restocking of this class of range with the kind of stock best adapted to it. In the Northwestern States the tendency is still from cattle growing to sheep growing.

GRAZING TRESPASS.

The legality of the regulations promulgated by the Secretary of Agriculture for the control of the National Forests was definitely and conclusively established by two decisions rendered by the Supreme Court of the United States on May 1, 1911, and the uncertainty and unrest caused by the widespread impression that the regulations were not enforceable ceased immediately. Before these decisions were given out there was a frequent tendency to graze stock on the Forests without permit, which in some Forests took the definite form of willful trespass. The most noteworthy instance was that of the Alamo National Forest in New Mexico, where 33 cases of grazing trespass were reported during the fiscal year. Criminal prosecutions were deferred pending the decision of the Supreme Court, but favorable action was secured in many suits for injunction or for the collection of civil damages. In the future, cases of willful grazing trespass are likely to be infrequent and exceptional; when they occur, no question of the legality of the regulations can be raised to complicate their prosecution, nor can there be any further reason for leniency in instituting criminal action against persons who willfully violate the regulations. Experience has demonstrated that civil action is not always adequate to safeguard the Forests from further invasion, so that resort to criminal prosecution of persons who willfully and defiantly trespass upon them is necessary to give them adequate protection.

There occurred during the year 192 cases of grazing trespass, which is 43.86 per cent less than in 1910. The number of cases pending at the beginning of the year was 125, which included 9 cases not previously reported. Of the 317 cases, 101 were dismissed by the Forest Service, 9 were prosecuted, 99 were adjusted upon the payment of damages, judgment being secured by civil suit in a number of cases willful in character, and 108 were pending at the close of the year.

ADVISORY BOARDS.

Continued encouragement was given to the formation of local organizations of stock growers, and 12 new advisory boards representing organizations of this character were recognized during the year. A total of 68 advisory boards are now recognized, and cooperating effectively with the Forest Service in the settlement of grazing problems. The disinterested aid of the highly efficient representatives selected by the stock growers has been of great value.

One circumstance with which the district foresters have had to contend in their efforts to secure the organization of the stock growers has been the relaxation of interest on the part of the permittees as the gradual adjustment of grazing problems has removed the causes of dissatisfaction. Many fail to realize that organizations to promote their interests are as valuable as organizations to protect them, and where there is every prospect of the continued enjoyment of the present grazing privileges it is difficult to maintain active organizations; many associations have, in fact, practically disbanded. The Forest Service is at present entering new fields of scientific range management and is engaged upon problems of vital importance to the stock growers, who may, if they will, render cooperative assist-

ance which will gain for them benefits of far greater value than those hitherto secured. Continued cooperative assistance is therefore very desirable.

PERMITS.

Paid grazing permits were issued as follows:

State or Territory.	Cattle, horses, and hogs.			Sheep and goats.			
	Permits issued.	Cattle.	Horses.	Hogs.	Permits issued.	Sheep.	Goats.
Arizona.....	1,658	221,128	10,020	228	170	421,529	7,186
Arkansas.....	10	403		20			
California.....	2,382	151,582	9,824	3,867	298	368,781	13,464
Colorado.....	2,718	229,125	8,205		432	663,502	2,697
Florida.....	26	545		121	5	435	
Idaho.....	1,771	100,464	8,539	20	835	1,641,581	
Kansas.....	91	10,945	173			300	
Montana.....	1,948	128,478	16,114		348	640,362	1,100
Nebraska.....	92	42,648	1,625				
Nevada.....	344	45,120	4,780		78	433,467	1,200
New Mexico.....	1,881	99,177	6,715	184	663	445,916	51,641
North Dakota.....	13	415	120				
Oklahoma.....	39	4,701	229				
Oregon.....	1,225	94,803	9,049	60	538	875,524	365
South Dakota.....	472	14,322	2,276				
Utah.....	4,739	119,738	7,748		1,327	899,466	10
Washington.....	292	10,983	1,279		114	190,562	
Wyoming.....	798	77,345	4,820		296	790,322	
Total.....	20,499	1,351,922	91,516	4,500	5,105	7,371,747	77,668

The reductions from last year's totals amount to 57,951 cattle, 186,903 sheep, and 12,632 goats. The increases amount to 6,964 horses and 1,355 swine. The net reduction in the total number of animals grazed under permit was 2.72 per cent. These reductions in the number of stock grazed were due to two principal causes. One was the restoration to the unreserved public domain of 2,300,000 acres of land which, because of its relatively low altitude, accessibility, and high grazing capacity, comprised much of the best range. The other was the pronounced shortage, already mentioned, of all kinds of stock at the beginning of the season of 1911. Although the number of cattle and horse permittees is only 193 less than in 1910, a loss of less than 1 per cent, and the number of sheep and goat permittees is 110 greater than in 1910, a gain of 2.2 per cent, the average number of cattle and horses per permit is only 70.6 and of sheep and goats 1,459, as against 72 cattle and horses and 1,531 sheep and goats in 1910. In other words, the number of permittees remained practically the same as in 1910. The decrease in the amount of permitted stock caused by the eliminations and by voluntary reductions was largely in excess of the net reductions reported, but was offset by large increases in a number of States, made possible by the development of new ranges and by increases in the carrying capacity of ranges long occupied. The States in which increased numbers of stock were grazed and the increases made are as follows:

States.	Cattle.	Sheep.	States.	Cattle.	Sheep.
Colorado.....		68,500	Washington.....	1,500	25,500
Montana.....		63,400	Wyoming.....	4,300	
Nebraska.....	4,000		Total.....	16,600	161,400
South Dakota.....	2,400				
Utah.....	4,400	4,000			

The following is a report of permits issued, by grades, in 1911 and 1910:

CATTLE AND HORSE PERMITS.

	1911		1910	
	Number.	Per cent.	Number.	Per cent.
Grade 1—1 to 40 head.....	13,419	65.46	13,336	64.46
Grade 2—41 to 100 head.....	3,910	19.08	4,128	19.95
Grade 3—101 to 200 head.....	1,735	8.46	1,776	8.58
Grade 4—Over 200 head.....	1,435	7.00	1,452	7.02
Total.....		100.00		100.00

SHEEP AND GOAT PERMITS.

Grade 1—1 to 1,000 head.....	2,521	49.38	2,426	48.37
Grade 2—1,001 to 2,500 head.....	1,923	37.67	1,837	36.77
Grade 3—2,501 to 4,000 head.....	367	7.19	418	8.37
Grade 4—Over 4,000 head.....	294	3.76	314	6.29
Total.....		100.00		100.00

These statistics, like those given above, show a steady decrease in average holdings. This is partially the result of the recognition of numerous new owners, settlers within and adjacent to the Forests, effected by reductions made in the renewal of permits to purchasers of permitted stock and in a few cases by sliding-scale reductions upon all permits above certain limits; but to some extent voluntary reductions by permittees have swelled the lower and reduced the higher grades.

The percentage of approved applicants who failed to pay the grazing fees and utilize the privileges allotted to them was 7.8 per cent, exactly the same as during the preceding year.

The percentage of reduction in grazing receipts largely exceeds that in the number of stock grazed. This is undoubtedly attributable to the fact that most of the lands eliminated were available for grazing purposes during the major portion of the year, and consequently produced more than the average revenue. In other cases the eliminations divided individual ranges in such a way that the numbers of stock grazed under permit were not materially lessened, but the permits were issued for shorter periods, for which much lower charges were made. The receipts for grazing privileges during the year are stated on page 13. They show a decrease of \$51,419.

The plan to allot grazing privileges for periods of five years was effective upon 40 Forests at the close of the year, the system having been inaugurated upon 5 additional Forests. Its success in accomplishing the purpose for which it was designed—to give stability and permanency in the use of the range—has been complete, but the plan has been losing in popularity among the stock growers. Grazing conditions have become so well settled upon the large majority of the Forests that term applications are not essential to certainty of tenure, and the permittees realize this fact. As the term application prescribes a minimum as well as a maximum use of the range by the permittee, stock growers have in many instances considered it advantageous to relinquish their term permits in favor of annual

permits, holding that the greater freedom of operation allowed by the latter class more than offsets the greater degree of exemption from reduction afforded by the term permit.

Crossing permits to the number of 2,711 were issued free of charge to the applicants. These permits allowed 80,423 head of cattle and horses and 4,939,589 head of sheep and goats to be driven to private lands within the Forests or across the Forest lands to outside ranges or shipping points. While the number of permits increased by 3.7 per cent, the difference in the number of stock covered by them was negligible. Permits are not required where small bands of stock are driven along public highways or where the stock is not grazed upon Forest lands en route. Considering the large number of stock involved, there has been surprisingly little abuse of the crossing privilege and no injury to Forest interests has resulted. Stock growers suffered no embarrassment because of the requirements of these permits, and the free movement of stock was not hampered.

In some of the districts, notably districts 2 and 6, considerable attention was given to the division of the ranges by drift fences erected in cooperation with the stock growers, the Forest Service contributing the timber needed for the construction of the fences and in some cases the wire and staples. In other districts satisfactory cooperation could not be secured, and as there was pressing need for all available funds to prosecute other lines of work very few range improvements were constructed. At the close of the year preparations were being made for the removal of the sanitary drift fence, located on the western boundary of New Mexico, to the western boundary of the Peloncillo division of the Chiricahua Forest, where it will serve the double purpose of controlling the drift of cattle upon the Forest and of preventing the spread of Texas fever from the adjacent quarantine area. The most important drift fence erected was the Rabbit Ear fence, 15 miles long, located in the Routt Forest and constructed in cooperation with the North Park Stockmen's Association. A number of important fences were erected in the Deschutes Forest. The boundary drift fences upon the Alamo Forest, which by eliminations from that Forest were left upon the unreserved public domain, were condemned, sold, and removed during the year. The future expenditure of funds for range improvements will, except in extraordinary cases, be made where improvements are needed in order to carry out the grazing working plans which are being formulated for various Forests as detailed range reconnoissances furnish the necessary basis for systematic and scientific development of the range resource.

USE OF PRIVATE LANDS.

As in previous years, the owners or lessees of unfenced private land had the privilege of waiving the right of exclusive use of such lands and securing in return a free permit for the number of stock which the private lands would support under the regulations of the Secretary. By exercising this privilege such owners or lessees were relieved of the necessity for securing a free crossing permit, where the stock were to be grazed on the Forest en route, and of so handling their stock that it would not encroach upon Forest lands; consequently they could utilize their holdings at a minimum of expense. In addition

other permittees were freed from claims for damages, which in many States might follow the intrusion upon the private lands of stock grazed under Forest Service permits. Thus the plan resulted in the fullest and most economical use of the entire range. The permits of this class numbered 1,205, and allowed the grazing of 57,594 head of cattle and horses, 989 swine, and 392,592 head of sheep and goats. The owners of this stock waived the right of exclusive use of 2,418,202 acres of private land. The number of permits issued fell off 8.43 per cent, the number of cattle and horses increased 5.74 per cent, sheep and goats 4.89 per cent, and the number of acres of land increased 12 per cent.

Under the cooperative agreement previously in force with the Atchison, Topeka & Santa Fe Railroad Co. the Forest Service continued to advise the company as to the number of stock which may safely be grazed on its lands within the Zuni National Forest. An agreement is also in force with the Northern Idaho Forestry Association, composed of representatives of the State of Idaho and private owners of 94,000 acres of patented land in the Palouse division of the Coeur d'Alene Forest, under which persons grazing stock upon the Palouse division pay a part of the grazing fee to the Northern Idaho Forestry Association and a part to the Forest Service in proportion to the respective holdings of the association and the Service. The Weyerhaeuser Land Co. and the Northern Pacific Railroad Co. continued their informal cooperation with the Forest Service. While under no agreement to do so, both of these companies in leasing their lands within the National Forests give preference to Forest Service permittees who will waive the right of exclusive use in exchange for a permit under Regulation G-19. The Northern Pacific Co. also makes a practice of referring all applications for the lease of lands within National Forests to the district forester to learn whether the proposed lease will be detrimental to Forest interests.

PROTECTION AGAINST DISEASE.

Permittees who grazed their stock during a part of the year on outside ranges where communicable diseases injurious to live stock were known to exist were required to submit the stock to rigid inspection by representatives of the Bureau of Animal Industry, and to present certificates showing freedom from disease before placing the stock upon the Forest ranges. This requirement has been in effect for a number of years and as a result all but three of the National Forests are free from most forms of communicable diseases fatal to live stock. The principal inspection required during the year was to prevent the grazing of sheep infected with scabies upon certain Forests in Arizona, California, Colorado, Nevada, New Mexico, and Utah, practically the same area as that where inspection was required during the preceding year. By close attention to prevent the spread of lip and leg ulceration among the sheep occupying the National Forests in the State of Wyoming, it was brought about that no sheep left the Forests in the fall of 1910 affected with this disease. The discovery that cattle to be grazed upon the Routt Forest in Colorado and the Deschutes and Fremont Forests in Oregon were infected with cattle scabies necessitated an inspection of stock entering these Forests and the enforcement of dipping requirements prescribed by the

Bureau of Animal Industry. Reports of the existence of glanders among range horses, of the spread of anthrax among cattle, etc., were investigated by members of the Bureau of Animal Industry at the request of forest officers.

During the year the Forest Service assisted the Bureau of Animal Industry to construct a quarantine drift fence along the international boundary in California, the greater part of the fence being within the Cleveland National Forest. Its purpose is to prevent the intrusion from Mexico of cattle infested with the Texas fever tick.

The Wichita Forest in Oklahoma, being south of the quarantine line, has since its creation been so infested with Texas fever ticks that heavy losses have occurred among domestic animals introduced from other States, and the welfare of the game animals within the game refuge, particularly the buffalo and elk, has been seriously threatened, three head of buffalo having died of the disease shortly after arrival at the refuge several years ago, and losses among the remaining buffalo being prevented only by constant attention and the spraying of the animals at frequent intervals. Plans were therefore made, in cooperation with the Bureau of Animal Industry, to free the forest from ticks. The permittees provided five dipping plants and adequate facilities for the dipping of all cattle within the Forest, and the Forest Service provided all material needed for the construction of the fences required to divide the ranges and control the stock. The dipping of the cattle was under the direction of the Bureau of Animal Industry, and at the close of the year arrangements for the dipping of all stock were well under way.

The Arkansas and Ozark National Forests are both situated south of the quarantine line and well within the Texas fever zone; stock holdings are small and scattered; and the work of tick eradication within the Forests difficult and costly. For these reasons, there has been no effort made to free these Forests from ticks. The forest officers and members of the Bureau of Animal Industry have, however, succeeded largely in counteracting the local belief that the tick can be controlled by burning over the lands each year, and the number of fires set for that purpose has been materially reduced.

The relations between the Forest Service and the stock sanitary boards of the different States were entirely harmonious, and the Service cooperated fully in the enforcement of State sanitary regulations. Cooperation with the Colorado State Board of Health consisted in posting State sanitary notices throughout the National Forests of the State and bringing to the notice of all Forest users the requirements of the State sanitary laws.

PROTECTION AGAINST WILD ANIMALS.

Forest officers killed the following animals harmful to live stock and to game animals:

Predatory animals destroyed.

States or Territories.	Bears.		Mountain lions.		Wolves.		Wolf pups.		Coyotes.		Wild cats.		Lynxes.		Total.	
	1910	1911	1910	1911	1910	1911	1910	1911	1910	1911	1910	1911	1910	1911	1910	1911
Arizona.....	16	15	41	33	12	16	.....	.....	273	288	114	110	56	10	512	472
California.....	73	37	23	5	2	3	.....	2	903	743	309	193	37	15	1,347	1,998
Colorado.....	12	11	3	8	6	31	11	25	613	1,008	88	70	3	2	736	1,155
Idaho.....	31	25	10	1	30	21	.....	1,177	1,328	90	52	3	3	1,341	1,430	
Minnesota.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	1
Montana.....	35	20	7	1	38	12	105	5	459	183	33	15	10	3	687	239
Nebraska.....	.....	.....	.....	.....	.....	.....	.....	.....	30	49	.....	.....	.....	.....	30	49
Nevada.....	.....	.....	.....	.....	.....	.....	.....	.....	39	137	3	5	2	.....	44	143
New Mexico.....	9	33	6	28	24	67	.....	11	1,238	250	104	77	6	23	1,387	489
Oklahoma.....	.....	.....	.....	.....	.....	.....	.....	.....	27	45	14	58	.....	.....	41	103
Oregon.....	47	23	1	4	6	3	6	.....	960	743	64	108	.....	.....	4,108	885
South Dakota.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	33	.....	.....	.....	.....	.....	33
Utah.....	.....	2	1	2	2	11	.....	.....	1,185	1,289	292	125	.....	.....	3,145	1,432
Washington.....	38	40	6	3	1	.....	.....	6	11	83	35	19	12	4	103	155
Wyoming.....	8	6	.....	2	8	8	26	20	242	308	23	38	2	5	309	387
Total.....	271	213	98	88	129	172	148	69	7,157	6,487	1,169	870	131	72	9,103	7,971

¹ Also 2 wolverines and 6 foxes, or total of 1,006 animals for California.

The total number killed was 12.5 per cent less than in 1910. There was a falling off of 21 per cent in the number of bears, 10 per cent in the number of mountain lions, 53.5 per cent in the number of wolf pups, 11 per cent in the number of coyotes, 25 per cent in the number of wild cats, and 45 per cent in the number of lynxes. There was, however, an increase of 25 per cent in the number of grown wolves killed. These reductions are probably due to a general reduction in the number of predatory animals infesting the National Forests and adjacent ranges. The work has served as an example and a stimulus to the settlers within and adjacent to the Forests, who have themselves killed many thousands of animals. On the Wallowa National Forest, in Oregon, the spread of rabies among the coyotes during the summer of 1910 caused widespread apprehension and resulted in serious losses of live stock. At the request of the settlers, the district forester assigned several of the best qualified forest officers in the State to the work of destroying the coyotes. They were so successful that this spring some of the permittees allowed their lambing bands to graze unattended throughout an entire day without suffering any loss whatever from wild animals, a condition practically without precedent in the history of the country.

The work of clearing the ranges of prairie dogs continued until the latter part of the year, when arrangements were made with the Biological Survey to take over the work. The natural distribution of the dogs is mainly within districts 2 and 3, and most of the work performed was within these two districts. The treated areas have not been entirely freed from rodents, but the prairie dogs have been so reduced in number that they can no longer completely denude the lands occupied.

PROTECTION AGAINST POISONOUS PLANTS.

Practically no reports of losses of live stock because of poisonous plants were received, although in previous years reports of this character were numerous. The cooperative work conducted by the Forest Service and the Bureau of Plant Industry has resulted in the determination of the plants which have hitherto caused the greatest losses of live stock and the location of the most important areas within which they occur. As the poison areas are located, they are marked with warning notices. One member of the Bureau of Plant Industry has been steadily engaged in making investigations of ranges reputed to contain poisonous plants.

FORAGE AND RANGE INVESTIGATIONS.

During the year the technical and scientific features of the grazing work were greatly enlarged in scope and 5 new members were added to the force employed. The field for study and improvement is a wide one, each year's experience demonstrating more convincingly that the prevailing methods of handling live stock upon the Forest ranges are economically wasteful and needlessly destructive. It is apparent, too, that the public welfare is best subserved by the determination of means of correction and cure, rather than by the exclusion of the stock from the Forests. The problem in general presents three phases: (1) The restoration of depleted ranges to a normal condition of productivity; (2) the development of unused resources, and (3) the conservation and economical utilization of all resources.

To secure an adequate basis for the immediate and future utilization of the forage products of the Forests along lines most productive to stock growers and least injurious to other interests, there is need for a careful and thorough reconnoissance of each Forest under the direction of men technically trained, experienced in methods of handling stock upon open ranges, and thoroughly qualified to determine all factors influencing range management, either favorably or adversely. This work is well under way. It will aim to determine the character of all land within the Forests, the kind of stock to which each natural grazing unit is best adapted, the natural periods of use for grazing purposes, the undergrazed, fully grazed, and overstocked ranges, the areas upon which poisonous plants abound, and the areas infested with range-destroying rodents. Grazing working plans will be prepared from the data secured by these reconnoissances. They will serve as a guide in the allotment of grazing privileges, the determination of improved methods of range control, and the improvement of the ranges. Already the grazing management of several Forests has been materially improved as a result of these studies. Detailed reconnoissances were inaugurated on the Coconino, Deerlodge, Medicine Bow, and Targhee Forests.

The series of experiments to determine the feasibility of lambing sheep in small inclosures, which was initiated upon the Cochetopa Forest in Colorado during the spring of 1910, was continued throughout the year, fairly conclusive results being secured. It was demonstrated that under conditions comparable to those governing the experiments, the pastures would effect a saving of lambs and labor, which during the life of the improvements would more than offset

the cost of construction and maintenance, and would largely obviate the losses often sustained through inability to secure the necessary labor at lambing time. The areas upon which sheep may be successfully lambed are limited and in great demand. Under existing methods lambing on the range is unusually injurious to the areas used, losses are large, and the operation is expensive; consequently, the determination of a method by which sheep may be lambed upon small areas with a maximum percentage of increase, a minimum cost, and a minimum of damage to the Forest lands, will be of large importance.

The coyote-proof pasture experiment, which for four years past has been conducted upon the Wallowa National Forest, was continued during the year. The sheep were handled by a regular herder without assistance by the Forest Service, and the results show the same reductions in expense, in amount of range required, and in percentage of natural loss, and the same increase in weight of the lambs, as was secured in preceding years.

The experiments in reseeding the ranges with introduced grasses were widened. Over 300 experimental sowings were made in the calendar year 1910. The drought which prevailed throughout the Western States militated against successful results. The season of 1911 will afford a better test of what can be done.

In connection with the study of the mountain bunch grass range types, preparations were made for the application of the rotation or deferred grazing system upon 10 overgrazed sheep allotments, investigations having demonstrated conclusively that by proper rotation in the use of grazing lands it is possible to secure a thorough natural reseeding of certain classes of land at intervals without any serious decrease in the amount of forage available for use. Experiments to discover ways by which a natural reseeding of native plants upon other depleted ranges could be secured were initiated upon several Forests by the local officers. Upon the Hayden Forest the experiments included studies of the effect of alternate grazing, limited grazing, and total exclusion of stock.

Closely allied with the preceding study is that of the effect of soil acidity or alkalinity upon the growth of forage plants. Both laboratory and field investigations were initiated during the year.

An important study was undertaken at the Coconino Experiment Station of the effects of stock grazing upon forest reproduction. This study has now been extended to the Shasta Forest, and valuable results are anticipated.

GAME PRESERVES.

The status of the Wichita and Grand Canyon National Game Refuges remained unchanged during the year. The efforts to protect the wild game from slaughter and molestation within their natural breeding grounds were wholly successful, and through the extermination of their natural enemies, proper restriction of grazing, and enforcement of the law through the maintenance of an active and thorough patrol, all species of game animals and birds multiplied encouragingly.

The buffalo herd on the Wichita Game Refuge now numbers 30 head—double the original number. Through the courtesy of the Boone and Crockett Club a shipment of antelope was received, of which 7 head survived and are in thriving condition, 1 fawn having

been born since the arrival of the antelope. During the spring 5 head of elk were received from Wyoming, making a total of 6 head now within the game refuge.

In addition to the national game refuges a number of State game preserves are included within the National Forests. By State law the Minnesota and Superior Forests are State game preserves, the killing of all classes of game being prohibited. The last session of the Montana Legislature established a State game preserve at the head of the Gallatin River in the Gallatin National Forest. Other areas where the killing of game animals is prohibited by State law are: One within the Bighorn National Forest; one within the Teton and Targhee National Forests; one within the Boise National Forest; and one within the Monterey National Forest. In practically all of the Forests containing State game preserves, the forest officers hold commissions as deputy State game wardens and play an important part in the enforcement of the State laws.

PERMANENT IMPROVEMENTS.

The purpose of the construction of permanent improvements on the National Forests is to facilitate (1) protection from fire, (2) the administration of the business of the Forests, and (3) the development of their resources. A complete system of communication by trail and telephone, tying together all parts of a National Forest, is as essential for its protection as an adequate patrol force. The administration of the Forests requires the construction of quarters for field officers and facilities needed in the regulation of the use of forest resources, such as drift fences and sheep-counting corrals. The development of the resources of the National Forests demands, in addition to the primary system of communication, the construction of roads and of stock-watering facilities and similar appliances, often needed to make forage and other latent resources available for use. Such improvements, while developing and increasing the value of the National Forests as public property, are made primarily with reference to the immediate needs of the local public in their use.

The completion of the primary system of communication, a fundamental factor in fire protection, has been and must for many years be the chief effort of the Service in the construction of improvements. All other ends sought must be subordinated to this.

A limited amount of improvement work can be done with the labor of regular employees during short periods when their administrative and protective duties will permit. The spare time of the present force, however, is hardly sufficient to maintain existing improvements in serviceable condition. It has been necessary, therefore, to meet the cost of nearly all of the new construction work on National Forests from the specific appropriations for this purpose.

The improvement appropriation for the fiscal year 1911 was \$275,000, as against \$600,000 for the preceding year. It amounted to but \$1.08 per square mile on the total acreage of National Forest land. Over one-fifth of the amount appropriated was required for needed repairs and the remaining funds were but two-fifths of the amount available for new construction in the preceding fiscal year.

Only the most urgent projects could be taken up. Most of the work related directly to improved fire protection. With 60 per cent

less money available for new work, the mileage of telephone lines constructed was but 24 per cent less than in 1910 and that of trails and fire lines 36 per cent. Special allotments to the Forests swept by the disastrous fires of 1910 were necessary to provide for the reconstruction of ranger stations, bridges, and fences.

The work done during the year comprised 1,383 miles of trails, 125 miles of roads, 1,427 miles of telephone lines, 163 miles of fire lines, 376 miles of fences, 372 cabins and barns, 50 bridges, and 47 corrals. The reduced appropriation and the necessity of concentrating upon protection facilities diminished the amount of work done in cooperation with States, communities, and private associations or individuals. Such cooperation was practically limited to means of communication. As in previous years, the contributions made by the Service to cooperative projects formed but a small proportion of their total cost. Sixty miles of telephone line were completed on the Targhee National Forest, in cooperation with the Yellowstone Power & Telephone Co., at a cost to the Service of \$867.97. This line will be maintained by the cooperating company for 5 years. Eleven miles of telephone line were constructed cooperatively on the Cache National Forest, and 20 miles on the La Sal National Forest, at costs of \$164.60 and \$50, respectively. Eight miles of telephone line were similarly built on the Manzano at a cost of \$106.19, and 6½ miles on the Klamath National Forest at a cost of \$51.30. Eight miles of road on the Monterey Forest were constructed at a cost to the Service of \$82.69. In but few cases of the most urgent character were cooperative projects undertaken which involved work for purely administrative uses. The Service was forced to reject a large number of offers of cooperation in the construction of roads and other improvements of great benefit to the National Forests, because of the necessity of limiting expenditures strictly to improvements most needed in bettering protection from fire.

With relatively small appropriations available from year to year it is difficult to avoid an uneconomical, piece-meal system of repairs and construction, taking up the most urgent work here and there without correlating the work completed and proposed. Special effort has been made to avoid this danger. A systematic plan exists for the complete equipment of each National Forest with communications and administrative facilities. As far as practicable each new piece of work authorized is in line with the approved plan; but in each case the work to be given first preference will be that directly contributing to fire protection. A comprehensive scheme of main and secondary trails and telephone lines, a system of lookout points or watch towers covering all of the areas where this method of fire control is feasible, fire lines at strategic points, such as wooded passes which form breaks in natural barriers and along the edges of dangerous slashings, and tool caches distributed throughout inaccessible areas are the most essential features of the improvement plan. Attention will next be given to structures required for the accommodation of forest officers and for the proper control of present uses of the Forests. Improvements designed to meet the third general purpose, viz, the development of the resources of the National Forests, must necessarily progress very slowly, in view of the greater urgency of the other work.

The adequate development of the enormous latent resources of the National Forests, particularly the construction of roads and other means of transportation which will be needed to overcome their inaccessibility, will require ultimately very large expenditures. In many localities there is an insistent demand for such improvements at the present time. It will be impossible for the Service to comply with this demand until the equipment needed in its protective and administrative work is completed. The undertaking of construction work designed to open up the inaccessible resources of the National Forests will depend furthermore upon the future policy adopted as to the extent to which such development should be a matter of public as against private enterprise.

Including the last fiscal year, the permanent improvements constructed on the National Forests since they were placed under administration aggregate 1,325 miles of road, 9,163 miles of trail, 7,381 miles of telephone line, 350 miles of fire line, 2,327 miles of fence, 1,338 houses, 775 barns, 280 corrals, and 271 bridges. With 256,000 square miles of National Forest land under administration, exclusive of Alaska and Porto Rico, the facilities for communication completed up to the present time amount to 0.19 mile of road, 1.29 miles of trail, and 1.04 miles of telephone line per township of 36 square miles. The funds available during the past year made possible the construction of 0.018 mile of road, 0.19 mile of trail, and 0.2 mile of telephone line per township. The inadequacy of these improvements for the protection of the National Forests is apparent. At least 10 miles of trail and 6 miles of telephone line per township are necessary to place the protection of the National Forests upon a sure footing. The current appropriation (fiscal year 1912) may permit, by practically eliminating the construction of other forms of improvements, the building of a maximum of 0.6 mile of trail and 0.3 mile of telephone line per township, besides necessary expenditures for the maintenance of existing structures. At this rate 15 years will be required to complete the fundamental communication facilities needed for an efficient protective organization.

EXAMINATION OF LANDS UNDER THE WEEKS LAW

The act of March 1, 1911, commonly known as the Weeks law, provided for the acquisition of forest lands on the watersheds of navigable streams in order to promote and protect their navigability through forest preservation. The act imposes upon the Forest Service new duties in the selection of the general areas for purchase, in the examination and valuation of the lands and forest growth to be acquired, and in conducting the negotiations for purchase. The work being different from any before done by the Forest Service, it became necessary for its handling to create a new unit of organization. The immediate control of the work was placed in charge of an assistant forester and an organization was effected for making the necessary examinations and reports. Since \$2,000,000 were made available for the fiscal year 1911, an attempt was made to examine as much land as possible with a view to its purchase before the end of the year.

From the information which had been gathered during the past 10 years it was possible for the Forest Service to designate at once

several areas within which to invite offers of land. A circular describing these areas, announcing the procedure to be followed, and inviting proposals for the sale of lands to the Government was issued on March 27.

From April 1 to June 30 proposals were received covering 1,250,641 acres, of which 832,464 acres were within the general areas which had been selected for purchase. The examinations of the Forest Service prior to June 30, 1911, covered 140,787 acres.

At the beginning of the year 1912 the Service has a force of 35 examiners working, and will undoubtedly be able to complete reports and recommend purchase of lands to the full amount of the \$2,000,000 available.

STATE AND PRIVATE COOPERATION.

The work of the past year in cooperation with States and private timberland owners consisted of (1) cooperative field investigations with State organizations; (2) cooperation with States in the protection of watersheds of navigable streams from forest fires, under the Weeks law; and (3) a limited number of examinations of individual timber tracts for the purpose of advising their owners as to better methods of management.

The cooperative field investigations were for the most part in Southern States and in continuance of projects started in 1909 and 1910. They included studies of the forest resources of South Carolina, Mississippi, Louisiana, Florida, Tennessee, North Carolina, Virginia, and Illinois. These investigations were made primarily in order to provide a basis for the development of a practicable and enlightened forest policy by each State.

In October, 1910, at the request of the flood commission of Pittsburg, the Service undertook, in cooperation with the Pennsylvania department of forestry, a detailed examination of the forest conditions on the Allegheny and Monongahela watersheds. The area covered approximates 18,000 square miles. The object of the study was to ascertain how far erosion and floods are due to forest conditions on these watersheds, and what measures for their improvement would be practicable. The report and map will be published by the flood commission.

In cooperation with the State forester of Connecticut, a study of second-growth hardwood stands, which comprise the major portion of the woodland of that State, was made during the summer of 1910. The objects of this study were to obtain reliable information on the yield of stands of this character in different periods, to determine prevailing market conditions in the State which govern the value of such timbers, to ascertain the effect of thinnings upon the rate of growth, and to recommend practicable measures in the management of second-growth woodlands to increase their productive capacity and the value of the product.

The most important work of the year was in pursuance of section 2 of the Weeks law, which appropriated \$200,000 for cooperation with the States in protecting the forested watersheds of navigable streams from fire. Such cooperation is extended only to States which have provided by law for forest-fire protection and have appropriated funds for that purpose. The amount expended by each State must at least equal that spent by the Federal Govern-

ment. Prior to July 1 agreements were entered into by the Secretary of Agriculture, specifying as the maximum amounts to be spent by the Government during the remainder of the calendar year, if needed, the following: In New Hampshire, \$7,200; in Minnesota, \$10,000; in New Jersey, \$1,000; in Wisconsin, \$5,000; in Maine, \$10,000; and in Vermont, \$2,000.

After the close of the fiscal year similar agreements were concluded providing for a maximum expenditure of \$1,000 in Connecticut, \$5,000 in Oregon, \$600 in Maryland, \$1,800 in Massachusetts, and \$2,000 in New York.

The Federal funds were to be expended in each instance for the salaries of patrolmen exclusively. Cooperative agreements were entered into only after the State had submitted a fire plan and a map showing in detail the number and location of the protective force to be employed, the location of telephone lines, lookout towers, and other structures forming a part of the protective system, the amount of State funds to be expended for various features of the protective system, and how the Federal moneys allotted to the State would be used to supplement State expenditures. The agreements provide for inspection, by officers of the Service, of the operation and efficiency of the cooperative protective system.

Past experience in examining woodlots and privately owned timber tracts has shown that the methods of forestry recommended are actually put into effect in far too small a percentage of cases. While the educational value of the cases where forestry is practiced is very great, it is important to increase their number. An attempt to do this is now made by giving greater attention, in the investigation made and reports submitted to owners, to the pecuniary advantages of good over poor methods of management, and by studies of market conditions in order to show owners how best to dispose of the products of their woodlands. Primary consideration is given to the applications and needs of small owners, since they are more disposed as a rule to put the methods recommended into operation.

As the number of State and private foresters increases, cooperation with private owners is being gradually restricted. The needs of applicants from States in which it is still difficult to secure expert information and advice are, however, so far as possible, provided for. Examinations of a single woodlot in a locality are not ordinarily made. Instead the interest of several owners in a community is sought by informing applicants that a field examination will be made upon a joint application signed by a number of owners in the same locality. The cost of such examinations is shared by the owners, on an acreage basis. In connection with such examinations studies are usually made of market or other conditions which apply to the community as a whole, and of the possibility of cooperative shipments of forest products. Public meetings with discussions of local forestry problems, the distribution of publications, the formation of local forestry clubs if advisable, and the collection of additional data needed for Service publications are valuable features of this work.

As a result of many field examinations and general studies it is often possible to furnish the advice and assistance needed by an individual owner by letter. This policy is especially applicable in cases of requests for advice on tree planting, a field well covered by

the data formerly collected and by publications. Field examinations where planting is intended are made only in exceptional cases, where the work can be cheaply done in connection with woodlot examinations or where data of distinct value to the service can be secured.

OTHER INVESTIGATIONS.

SILVICULTURAL AND DENDROLOGICAL STUDIES.

During the year commercial tree studies of eastern white pine, aspen, balsam fir, red spruce, Norway pine, and yellow poplar were completed. The results of these studies will appear as monographs dealing with the range, silvicultural characteristics, growth, yield, and management of each tree. Thus the study of the aspen, already published, brings together for those interested in aspen lands the most important facts regarding aspens, including the industrial uses of the wood, the conditions under which the tree succeeds, the rate of growth in different situations, the most suitable methods of management to secure increased returns, etc. Tables showing the volumes of aspen trees of different sizes, in cubic feet and in cords, and the number of trees required to make a cord are also given.

An economic study was made of the species of wattles, or acacia, most valuable for tanbark and timber. Many species have been successfully cultivated in California from 20 to 50 years, none of which, however, have been planted on the commercial scale which their intrinsic value and their adaptation to large areas justify.

The investigations in basket-willow culture were developed considerably. Willows can best be grown as a secondary crop. The land suited to them usually occurs as small areas, which are very commonly parts of farms valuable in the main for the production of other crops. Yet though a very insignificant fraction of the total farm area may be suited to willow culture, its use for this purpose is likely to mean a crop of high acreage value, obtained from land which otherwise might yield almost no return. For this reason it is well worth bringing to the attention of farmers. For a number of years the Forest Service has been distributing willow cuttings to applicants, with advice concerning the best cultural methods.

From 100 to 200 cuttings of the standard varieties are given each applicant. They are grown at the Arlington farm of the Department of Agriculture, from imported stock; for hitherto European varieties have furnished the material for fine basket making in the United States. But to secure varieties suited to different regions in this country it is desirable to discover or breed species or varieties not now in use. With this object in view cuttings of practically all of the native species of willow, and of a number of exotic species, are being propagated at Arlington to obtain rods for a test of their suitability for basket making. If necessary, the development by hybridization of new strains, better suited to American conditions than the European varieties, will be undertaken.

The cuttings distributed in 1911 totaled 84,800, of which 20,000 went to 40 agricultural experiment stations, 13,000 to forest schools, 30,000 for use in connection with cooperative work with the State of New Jersey, 20,000 to individuals, and 1,800 to botanical gardens. The distribution included 46 States and Territories. The Forest Serv-

ice is cooperating in willow culture with the Maryland and Virginia Agricultural Experiment Stations and with the State of New Jersey.

Fundamental facts and principles of value to the profession and the science of forestry were yielded by a study, completed and published during the year, which brings together all the facts known with regard to the part which light plays in the life of the forest. This includes the results of investigations at the Forest Service experiment stations. An investigation of the forest regions of the United States, with special reference to the laws of distribution and the fundamental laws of tree growth, was started.

The preparation of silvical leaflets was continued. Material for 42 leaflets was prepared. These leaflets both give forest officers in concise form much valuable silvical information and form the only, and an invaluable, source of information for students in forest schools on the silvicultural requirements of western species.

Dendrological studies of the structural characteristics of woods furnished material for publications dealing with fustic dyewood and its substitutes and adulterants and with "Colombian mahogany." Both the subject of dyewoods and that of the many woods now sold as mahogany, with the result that no standard exists beyond an arbitrary judgment as to whether or not mahogany has actually been furnished the purchaser, were investigated further. These investigations are minor examples of a line of work which aims to obtain the means of identifying all important woods in their commercial forms.

The distinguishing characteristics of North American gum woods and of the important North American oaks were dealt with in two bulletins published after the close of the fiscal year, and various other publications are under way or planned. Information on this subject was furnished by letter in response to many inquiries; over 500 wood samples were thus identified for manufacturers and other wood users. Studies in the geographical distribution of American forest trees were continued. Some of the data gathered and previously on hand furnished the basis for 501 folio record maps, which were prepared with reference especially to the needs of forest officers, and 17 folio maps were prepared for the use of the Forest Products Laboratory to show the range of certain eastern forest trees. One such map was prepared for publication by the Bureau of Plant Industry. The first of a series of forest geographical atlases, which when finished will form a complete atlas of North American trees, was prepared; the range of our native pines was presented on quarto size maps. The second volume in the series dealing regionally with the forest trees of the United States, which will be entitled "Forest Trees of the Rocky Mountains," was brought to an advanced stage of preparation.

STUDIES OF FOREST PRODUCTS.

The work in forest products was put on a new and greatly improved basis through a complete reorganization, planned with a view to utilizing to best advantage the new facilities afforded by the Forest Products Laboratory. This laboratory made possible the concentration of work previously scattered, with a corresponding gain in efficiency. The new laboratory was opened at Madison, Wis., in

June, 1910. Furnished with the most complete modern equipment and with a well-organized staff of experts, the Service is now able to conduct its research work in forest products with an effectiveness impossible under the old conditions.

The work as now organized comprises studies in the physical properties of wood, the drying of wood, strength tests, wood preservation, wood distillation, wood pulp and paper, naval stores, and wood utilization.

THE PHYSICAL PROPERTIES OF WOOD.

The laboratory aims not only to obtain facts regarding the qualities of wood and their behavior under different conditions, but in all cases to find the underlying causes. Structural characteristics explain the peculiar mechanical properties of a given wood. Explanation of the fact that different species require very different preservative treatment is found in differences in their physical qualities, as shown by the microscope. A study of the structural qualities of the various woods, therefore, is carried on side by side with the strength tests, the preservative tests, and the other investigations.

As a means of carrying out these studies there were prepared during the year about 1,000 microscopic slides, representing 74 different species.

To determine the ability of wood to withstand the strain of continuous loads to which its use in structural work subjects it, a series of dead-load tests was made, supplementing similar tests previously made on long-leaf pine. A series of determinations of the specific gravity of the solid matter in different woods is under way. The density of wood, which determines many of its physical and mechanical properties, depends upon the relative amounts of solid matter and open spaces; knowing the specific gravity of the former, the amount of the open spaces may be calculated.

Very little is known concerning the behavior of wood when subjected to high pressures and high temperatures or to various other conditions of the surrounding medium. Preliminary tests indicate that the strength, density, and hardness as well as the hygroscopicity of wood may be greatly affected by such conditions. They also indicate that by a proper manipulation of the treatment it is possible to entirely penetrate with preservative fluids spruce, hickory, and other woods which in their natural state are relatively impervious to injection.

The hygroscopicity of woods is of prime importance, both in connection with kiln-drying and in all cases where shrinking and swelling, or "working," of the wood after manufacture enters into the problem of its use. This subject was studied in preliminary tests. The specific heat of wood was studied in a series of careful experiments. This is the first time that this subject has been investigated in a comprehensive manner. The results show that the specific heat of all woods is approximately the same irrespective of species, the mean value between 0° C. and 106° C. being 0.327. These results are of considerable scientific importance and will prove of value in the experiments being conducted on the kiln-drying and preservative treatment of timber products.

DRYING OF WOOD.

In continuation of past studies of air seasoning, experiments were made with eucalyptus. The data obtained show the rate of seasoning and the extent of checking in trees cut in different localities and at different times of the year. The primary object sought is to learn how to get the best results when eucalyptus is to be cut for poles and piling.

Because of the time required to air-season wood artificial methods of drying are almost universal, especially for high grade lumber. All such methods have proved more or less imperfect, and it is conservatively estimated that 10 per cent of the material dried in kilns is ruined or greatly lowered in value by excessive checking and warping. To study the fundamental principles of drying in kilns operated at atmospheric pressure an experimental kiln was erected, so designed as to secure control of the temperature, air circulation, and humidity, the three elements upon which the drying of lumber depends. A small commercial kiln embodying the same principles of construction, erected by a private company at Oakland, Cal., will make possible experiments to determine the best methods of kiln-drying different species of eucalyptus.

Arrangements were also made for a series of experiments to perfect methods of kiln-drying hickory stock used by the vehicle and implement industries. At present it is necessary to air-season most of the hickory stock used by these industries, with considerable loss from the attacks of wood borers and with added expense for handling.

STRENGTH TESTS.

The timber test investigations of the year may be divided into three general classes:

(1) Standard tests upon the commercial timbers of the United States to determine their relative strength, stiffness, toughness, hardness, cleavability, and other mechanical properties. The knowledge thus gained enables manufacturers and other users to employ the different woods most advantageously, and often to substitute less well known woods for woods which are becoming scarce. The tests in this class are made on clear specimens of comparatively small size.

(2) Tests on structural forms and sizes of timber, to furnish engineers and architects with data on the strength and other mechanical properties of woods used in construction, particularly as regards species and classes of wood which are not fully utilized.

(3) Tests to determine the influence of preservative treatments, methods of seasoning, and other processes on the mechanical properties of wood.

A plan for the comprehensive study of the commercial timbers of the United States provides for the securing of data which not only will show the relative mechanical properties of the different species studied but also will be of great value in determining under what conditions of growth the best wood is produced in a given species. Tests were made upon white oak, red oak, and white ash from Louisiana; black spruce, white spruce, red spruce, and balsam fir from New Hampshire; and red oak, white ash, rock elm, and hard maple

from Wisconsin. Specimens of other species for future tests were secured from the Ohio River Valley and the Rocky Mountain region.

Tests to determine the strength of bridge stringers and car sills, and to determine the effect of knots and checking on the strength of such timbers, were completed during the year. Tests were also made of Douglas fir stringers and joists cut from fire-killed timber, of which enormous quantities are going to waste in the West. The tests show conclusively that fire-killed fir, if manufactured into lumber before it is attacked by insects and decay, is practically as good for structural purposes as material secured from the living tree.

Much of the timber growing at high altitudes in the Rocky Mountain region is too small for the manufacture of lumber and other saw-mill products, but is used in mining and miscellaneous construction work. The supply of Douglas fir, until recent years almost entirely depended upon throughout Colorado and Wyoming for mine timbers, is now growing scarce in the vicinity of most of the mining camps, and other species must be used. To aid in meeting this situation, tests were made to find out whether fire-killed timber could be advantageously used, and to determine how lodgepole pine, Engelmann spruce, bristle-cone pine, western yellow pine, and Alpine fir compare in strength with Douglas fir. The results will shortly be available. Tests made primarily to ascertain the value of lodgepole pine and Engelmann spruce, as compared with red cedar, for telephone and telegraph poles showed that lodgepole pine was approximately 80 per cent as strong as red cedar and that Engelmann spruce may therefore frequently be used to advantage in lighter construction work.

The increasing use of bridge timbers treated with coal-tar creosote has made the question of the influence of such treatments on the strength of the stringers one of considerable importance to bridge engineers. A series of tests to determine the effect of preservative treatments with creosote on the strength of yellow pine and Douglas fir stringers, started in 1908, is now nearing completion.

Much damage is caused annually by the staining of yellow-pine lumber. Various chemicals, principally bicarbonate of soda, are used to prevent such stain. There were many objections to the use of material treated in this manner, because it was claimed that the treatment affected the mechanical properties of the wood. A series of tests made in cooperation with the Yellow Pine Manufacturers' Association to ascertain whether or not this contention was justified showed that the treatment has no appreciable effect upon the properties of yellow-pine wood.

WOOD PRESERVATION.

In 1910 the amount of wood treated in the United States exceeded 100,000,000 cubic feet; this was over 500 per cent more than that treated in 1904. The rapid extension of wood preservation into new fields and the treatment of new woods have developed many practical problems concerning which little or nothing is known; in fact, the whole industry is of such recent development that the knowledge of the fundamental principles upon which it is based is very meager. The wood-preservation investigations of the Forest Service may be divided into the following classes:

(1) The study of different preservatives in order to determine their toxic properties and their relative value for the preservative treatment of wood under different conditions of use.

(2) Studies of methods of impregnating wood in order to determine the best mechanical method of injecting the required amount of various preservatives into different species of wood.

(3) The application of wood preservation to permanent improvement work on the National Forests, and assistance to outside parties in applying the principles to the commercial treatment of timber.

(4) The inspection of treated test timbers set to determine their durability under different conditions of use when treated with various chemicals and by different methods of treatment. While logically this would be included under class 1, the amount of time put upon this work and the importance of the results secured make it worthy of special mention.

In studying preservatives, their chemical and physical properties, the ease with which each kind can be forced into the wood, its toxic properties, its effect upon the strength and other mechanical properties of wood, and its effect upon the inflammability of wood are learned. Very little systematic work of this kind has ever been done, and the results now being obtained are proving of great service in determining the relative value of different preservatives for the treatment of wood under different conditions of use. Several pieces of special apparatus have been developed for conducting these tests, the most important of which are the fungus pit and apparatus for studying the manner in which preservative fluids penetrate the wood. The fungus pit is a concrete chamber beneath the floor of the laboratory, 10 feet by 20 feet in size. This chamber is divided into compartments, in which the temperature and humidity of the atmosphere can be regulated. In the compartments specimens of various kinds are subjected to attack by vigorous growths of wood-destroying fungi. By means of the fungus pit it is possible to secure records of the durability of treated and untreated woods in much less time than under natural conditions. Thirty of the most promising wood preservatives, including practically all those commercially important at the present time, are now being studied.

To determine how piling may best be protected against the attack of marine organisms, sections of piles treated with different preservatives and protected in various mechanical ways, set in San Francisco Bay and in San Diego Bay, are being examined periodically and notes taken on their condition. These experiments, which must continue through at least two or three years, and possibly longer, will be of great assistance to engineers and others concerned with construction work in waters affected by the teredo and limnoria.

An important investigation has been undertaken to determine the relative efficiency of different fractions of creosote. Commercial creosote is a mixture of a number of different oils, varying widely in their chemical and physical properties, and it is important to know what constituents are most effective in protecting woods from decay and other destructive agencies. A representative commercial creosote was distilled into a number of fractions so as to separate the different classes of oils of which it is composed, and specimens of loblolly pine were treated with different quantities of each. Some of the treated specimens are exposed to the attack of marine organisms,

others to wood-destroying fungi. These test specimens are being inspected in the same way as the treated piles already described.

Experiments under way in cooperation with the agricultural department of the University of Wisconsin, to ascertain whether or not treated wood in silos would affect the quality of the silage, indicated a probability that treatment can be used to lengthen the life of the wood and to permit cheaper woods to take the place of the expensive woods now employed.

The structure of different species of wood varies widely, some having so many open ducts that it is possible to force fluids into them with great ease, while other species are very resistant to the fluids. A correlation of the structure of woods with the best methods of treating them with different fluids was sought through tests which should also be of value in connection with the wood-pulp investigations.

Experiments in the open-tank treatment of paving blocks were made in cooperation with the University of Washington. Wood paving blocks when properly treated make an excellent pavement for streets. If blocks can be treated by the inexpensive open-tank method, their use for paving might be widely extended, especially in small municipalities distant from commercial treating plants but at the same time having an adequate supply of cheap wood.

Demonstration work is carried on by the Service to verify experimental results on a commercial scale or to assist in the practical application of processes with which the laboratory is thoroughly familiar. It is frequently possible to secure in this way important new data. Usually this work is carried on in cooperation with railroads or other companies which place their facilities at the disposal of the Service for the experiments and demonstration. Such projects include the treatment of ties in cooperation with the Chicago, Milwaukee & St. Paul Railroad Co., the application of principles of wood preservation to mining timbers in cooperation with the Anaconda Copper Mining Co., and the installation of 39 sets of test timbers of various kinds, including crossties, piles, poles, paving blocks, and fence posts in cooperation with companies and individuals interested in the problem of wood preservation.

WOOD DISTILLATION.

The wood-distillation studies of the year were confined to problems bearing on the distillation of resinous woods, especially southern yellow pine and Douglas fir. Distillation processes successfully applied to these woods would have great economic importance in the utilization of forest and mill waste. The wood-distillation industry has been placed upon a good business basis in the Southeastern States, and to a lesser extent in the Puget Sound region, where sufficient quantities of cheap wood, such as lightwood, pine knots, etc., are available. The application, however, to the general run of mill and forest waste depends upon the development of apparatus which will greatly cheapen the present cost of production.

Experiments in steam distillation investigated (1) the minimum amount of steam required for the extraction of the volatile oils from yellow pine and Douglas fir, (2) the size of the chips required to

secure the best results, and (3) the relation of the yield of products to the duration of the treatment.

These experiments yielded many significant results. They will be continued to learn how the process may be profitably applied to materials giving much lower yields of products than those now obtained.

Important results were obtained from a study of the subject of refining and grading the crude products of distillation. The commercial success of distillation plants often pivots on the ability of the manufacturer to produce a marketable product. The paint and varnish trades frequently object to wood turpentine, and they are marketed at a great disadvantage as compared with gum turpentine. By refining commercial samples from plants using different processes, including destructive and steam distillation and extraction processes, the results showed that, using a continuous-column still with a capacity of 25 gallons of crude oil per hour, it was possible in every case to obtain a marketable turpentine, and in most cases a product free from objectionable odors. Samples of the turpentine produced were sent to different paint and varnish manufacturers, and were tested by them. The tests showed that in general the greatest difference between gum turpentine and wood turpentine affecting the value of the latter is the odor, but that there is also a difference in the solvent power and drying properties. In some cases the wood turpentine was slightly superior to the gum turpentine with which they were compared, and in other cases not quite as good. To demonstrate the commercial practicability of the apparatus, the experimental still was set up at the plant of the Atlantic Turpentine Co., at Mount Pleasant, Ga., the cooperating company bearing the entire expense of shipping and installing the apparatus. The results showed conclusively that the still could be readily applied to the refining of wood turpentine on a commercial scale. As a result of this demonstration several distillation plants have decided to install improved apparatus for the refining of their products.

WOOD PULP AND PAPER.

The pulp and paper studies covered the mechanical grinding process, the chemical processes, and the suitability of different woods for both classes of pulp. So far as the immediate needs of the paper trade are concerned, the work with ground pulp is of greater importance. The consumption of news and cheap print papers has increased very rapidly during the past 20 years, and will doubtless continue to increase. Mechanical pulp is produced almost entirely from spruce. Hundreds of millions of dollars have been invested in mills which are depending upon this species for their raw material. On the other hand, the supply of spruce in the United States is rapidly nearing exhaustion, and it seems probable that the future of the mechanical pulp industry in the United States depends upon its ability to find a substitute. For the manufacture of chemical pulp also new raw materials are required.

One serious difficulty in the past in connection with the pulp and paper investigations of the Forest Service has been the lack of means for accurately describing the qualities or properties of a pulp. During the year much progress was made in overcoming this difficulty

through the perfection of laboratory methods and, following this, the establishment of standards for expressing the properties of wood pulps. Previously the results of the experiments could be expressed only by an empirical inspection of the samples of pulp produced, the value of the inspection depending entirely upon the judgment of the inspector. Until this difficulty was overcome it was impossible to record the results of these investigations so as to enable them to carry any assurance of the reliability of the conclusions.

Another difficulty now overcome arose from the absence of adequate apparatus. Congress provided in the sundry civil bill \$30,000 for paper-pulp investigations. With the assistance of the National Pulp & Paper Manufacturers' Association, a laboratory with the most approved types of commercial equipment was installed at Wausau, Wis., about January 1, 1911. Experiments have since been under way. They have already demonstrated the suitability of jack pine and hemlock for pulp. Samples of the pulp have been manufactured into paper under commercial conditions, and it seems very probable that the paper mills of the country may, with their present equipment, operate so as to use both hemlock and jack pine. It is proposed to continue these investigations until it has been conclusively determined what species available in the United States may be used for the production of news and cheap print papers.

Experiments were made to determine the suitability for chemical pulp of jack pine, dead and green tamarack, and other species easily accessible to the pulp mills; and also to establish the relations between different factors entering into the production of wood pulp and the quantity and quality of the pulps produced. A line of investigations of much greater economic importance studied the suitability of different forms of mill and forest waste for the manufacture of chemical fibers. A most excellent grade of Kraft pulp was produced from clean western yellow-pine mill waste. Excellent pulps were also made from southern yellow pine. These studies, however, have not progressed far enough to warrant definite conclusions.

NAVAL STORES INDUSTRY.

The production of turpentine and rosin has always been confined in this country to the longleaf pine belt. The industry has gradually moved southward from the Carolinas to Florida, and westward into Louisiana and Texas, seeking new sources of supply. The ordinary period of operation on the same trees is only three or four years. Unless improved methods are applied or new fields for operations are opened the industry faces an early exhaustion of the timber from which its raw material is derived.

Experiments conducted by the Forest Service have demonstrated conclusively that present methods of chipping are unduly severe on the vitality of the tree, and that by decreasing both the depth and the height of the chip much more gum can be secured, while the period of operating can be extended almost indefinitely; and contracts for turpentering on the Florida National Forest are being carried out with great success under the conservative methods developed by the Service. The results attained indicate that the production of naval stores can be made a part of forest management, and combined with the timber crop rotation in such a way as to provide for a sus-

tained yield both of crude turpentine and of saw timber from the same area. Further, experiments made during the year with western yellow-pine timber on National Forests in Arizona, southern Colorado, and California promise to open a vast new field of supply. It was found that during the productive season about the same yield of crude turpentine is obtainable from western yellow pine as from average stands of longleaf pine; the productive season, however, is much shorter in the West than in the South. Similar experiments, but on a smaller scale, were made with sugar pine, lodgepole pine, digger pine, and piñon. This work was supplemented by an exhaustive study of turpentines secured under different conditions, to determine to what extent the properties of gum turpentine may vary.

WOOD UTILIZATION.

An important line of work is the compilation of data for a series of publications on the properties and uses of commercial woods, each species being separately considered. The first of the series, "Cedars, Cypresses, and Sequoias," was published during the year. The completed series will include not only all the well-known commercial woods, but a number of others which are just coming into use, or whose properties fit them for use.

For a number of years the supply of southern juniper, or red cedar, has been growing scarce, until old fence rails and the floors and joists of old cabins in Southern States have been bought up for pencil wood. In cooperation with some of the leading pencil manufacturers the Forest Service has been making an effort to find substitutes. Special attention was directed toward species found in the National Forests. The woods tried were Rocky Mountain red cedar, western red cedar, western white pine, alligator juniper, one-seed juniper, redwood, bigtree, incense cedar, yellow cedar, Port Orford cedar, and western juniper. None of the woods appear to be equal to red cedar, but some are satisfactory, at least for second-class pencils.

Other studies of new uses of woods conducted during the year include practical tests of various species as substitutes for dogwood and persimmon in the manufacture of shuttles, tests of incense cedar in the manufacture of cigar boxes, and the use of cypress for plug-tobacco boxes.

Special studies of the conditions of utilization of a number of important species was made during the year. In cooperation with the National Hickory Association an investigation was made of the manufacture, marketing, and utilization of hickory. A study of the supply and use of osage orange was conducted with special reference to the requirements of wagon manufacturers. An investigation has been inaugurated to collect data on the use and markets for western red cedar used in the shingle industry.

In connection with the investigations of the by-products of wood the question of the waste at sawmills which might be available for use is important. Studies have already been conducted in Wisconsin to determine the average amount and condition of such waste and its availability for the manufacture of by-products.

The cooperative work between the Forest Service and the Bureau of the Census in collecting and compiling statistics of forest products in the United States was continued during the year. The statistics

cover lumber, lath, shingles, cross-ties, poles, pulp, tanbark, cooperage, veneers, and wood distillation.

Studies of the wood-using industries of various States were completed in Massachusetts, Maryland, North Carolina, Kentucky, Wisconsin, Oregon, Illinois, Louisiana, New Mexico, Arizona, Colorado, Utah, Wyoming, Washington, and Nevada. In a number of cases the reports have been published by the States concerned. Investigations were begun but not completed in Arkansas, Wisconsin, Michigan, Virginia, New Hampshire, and California.

The collection of wholesale lumber prices, f. o. b. market and f. o. b. mill, was continued with the assistance of 5,000 cooperating lumbermen. Early in the year the record of market prices was changed from a monthly to a quarterly basis. This compilation of statistics is expected to serve as a continuous record of prices; to show what the manufacturers of lumber receive for their product at the mill, and what the final cost of lumber is to the retailer and consumer; and, finally, to set forth the important part which freight and selling charges play in the final cost of lumber.

Substitution of other materials for wood is steadily gaining in this country. A summary of answers to inquiries sent by the Forest Service to 3,000 retail lumber dealers in 10 central agricultural States shows that substitution has occurred in certain classes of wood products to the extent indicated by the percentages following: Finish, 0.9; sheathing, 2.4; lath, 3; fence posts, 3.7; siding, 4.1; common lumber, 5.3; dimension stuff, 5.4; flooring, 6; pickets, 9; fencing, 13.7; shingles, 16.2; average, 5.4. These changes have occurred in the last three years. Iron and cement are the chief substitutes. The study of this subject is not yet complete.

MISCELLANEOUS.

Nine hundred and fifty books and pamphlets, obtained either through the department library (of which the Forest Service library is a branch) or by gifts or exchange, were added to the working library maintained in the Washington office, making a total of 14,963. By far the greater number of new books were free publications. The library receives regularly 60 forest and trade journals.

There are now small field libraries in the supervisors' offices, the district offices, the forest experiment stations, the Forest Products Laboratory, and the Office of Wood Utilization at Chicago. The district libraries average about 750 books each and the supervisors' about 88. To these field libraries there were sent out during the year 3,676 publications, of which the majority were free publications, either Government or State. The amount spent for the purchase of books for the field during the year was \$2,000.

There are now 25,098 classified and tabulated photographs in the collection, 1,846 of which were added during the year.

Over 200 microsections, covering 150 species of native hardwoods, were added to the collection which is used in the study of the structural characteristics of wood and in the identification of wood samples.

The reference collection of native and foreign woods was augmented during the year by the addition of 460 specimens. The entire collection now includes about 6,000 specimens. Approximately 3,000 forest-tree specimens were added to the forest herbarium,

which now contains 5,000 reference specimens, and over 10,000 tree-range records were added to those on file. There are now platted 525 maps showing the distribution of trees by species.

During the year the Forest Service issued 31 new publications, as against 27 the year before. The total number of Forest Service publications distributed was about 245,500, as compared with 406,000 in the previous year. During the past two years the Forest Service has greatly increased the number of its bulletins of a technical character, which are meant particularly for the advancement of scientific work.

There were 185 public addresses delivered during the year, usually in response to direct requests from organizations interested in technical forestry, from associations of lumbermen or lumber manufacturers, or from educational bodies or institutions. Exhibits were made at nine expositions, and four of them were supplemented, at the request of the exposition management, by a series of explanatory lectures. The expositions in which the Service participated were: The Appalachian Exposition, Knoxville, Tenn.; the National Corn Exposition, Pittsburgh, Pa.; Kansas State Fair, Hutchinson, Kans.; United States Land and Irrigation Exposition, Chicago, Ill.; Land and Irrigation Exposition, Worcester, Mass.; the Alabama Industrial and Agricultural Exposition, Montgomery, Ala.; Arkansas State Fair, Hot Springs, Ark.; and the International Exposition, Turin, Italy. All expenses for the transportation and installation of material and for travel and subsistence involved in making these exhibits and sending speakers were borne by the exposition authorities or privately contributed, except in the case of the Turin exposition, for which a congressional appropriation had been made. The material used was that on hand as a result either of work done for previous expositions or of the regular laboratory and collection work of the Service. In general, acceptance of requests for public addresses is made conditional on the payment of all expenses involved.

WORK FOR THE ENSUING YEAR.

In the foregoing report reference has been made to many investigations and experiments which were in progress at the close of the fiscal year. Some of these are of such a character that the information sought can be ascertained or the object accomplished within a comparatively short time. In such cases the work will be completed and terminated as rapidly as possible. In many cases, however, the work planned is so comprehensive in character that it must necessarily extend over a considerable period of time. In general, the work for the ensuing year will be along the same lines as that described for the past year. Detailed enumeration of all the investigations under way or planned would so largely traverse ground already covered that specific mention of most of them will not be made.

The work of bringing about changes in Forest boundaries for which the field investigations were begun in 1908 will be brought to completion. There are still 39 proclamations to be issued before the results of these investigations will have culminated in accordance with the policy outlined in the body of this report. The field work has been completed for nearly all the Forests still remaining, and the reports have been considered and final conclusions reached. The

proclamations putting the changes into effect will be issued in the course of the next few months.

The study of the business side of National Forest management will be continued on certain typical Forests to increase the effectiveness of the field force by cutting out lost motion and misdirected effort. It is true that the organization can not be operated precisely along the lines of a private enterprise having a strictly commercial purpose, but the proper output or the desired results in National Forest management are not wholly intangible. They include protection of the Forests, increase in their productiveness, and proper use of their resources. It can at least be determined on each Forest what is the cost of the work done and what results are produced, whether that cost is excessive, and whether the output in work or results can not be increased.

The better preparation of the rangers for their work will continue to be encouraged, both by regular courses of winter study and by the continuance of rangers' and supervisors' meetings. As the results of the work are shown by the increased effectiveness of the men, it is believed that a stimulus will be applied in the form of a steadily rising standard of qualifications necessary for forest officers. In this connection mention may be made of the very valuable work which is being done by several universities and agricultural colleges in the West, which give short ranger courses each winter. A considerable number of National Forest rangers go on furlough in order to attend these courses each year, and the Forest Service finds it well worth while to permit them to do this and to cooperate with the institutions offering the courses by sending lecturers who deal with questions of technical administration. One beneficial effect of these schools is to provide the means, which nowhere existed previously, for the training of prospective rangers.

The principal effort in connection with sales of National Forest timber will be to secure the disposal of as large a quantity as possible of the fire-killed timber still unsold. This effort will be combined with the encouragement of large sales under long-term contracts in localities where inaccessible bodies of mature timber exist for which there is no local demand and whose removal will be beneficial to the Forests. The specific objects of this policy will be to improve the Forests by the removal of deteriorating material, putting them in better condition for future production, and to increase receipts to a point which will place the Forests upon a self-supporting basis.

The systematization of the management of the respective Forests based upon working plans in which all of the data secured by the Service is assembled in ready form for administrative use will be particularly emphasized. Another important feature will be the standardization of methods of cutting in similar forest types throughout various portions of the West, in the light of careful study of the results obtained in all of the sales made up to the present time.

In continuing reforestation work an effort will be made to cover approximately 30,000 acres annually, but by periods of years rather than in individual years, the work in any one year being concentrated upon the various processes of seed collection, seeding, and the like, in accordance with the most economical and effective organization. Intensive experiments will be continued in direct seeding, nursery practice, and field planting, and with valuable exotics in restricted

localities to which they are particularly adapted in order to further build up the much-needed knowledge of methods necessary to the effective prosecution of this work.

The most significant feature of the investigative work will be the extension of the system of local experiment stations to include additional forest types and regions. Since the termination of the fiscal year such a station has been established in the exceedingly valuable belt of white-pine timber in northern Idaho. During the next year at least one additional station will be established, probably in the northern Sierra Nevada Mountains of California. Further stations are under consideration in Utah or southern Idaho and on the west slope of the Cascade Mountains in Oregon or Washington, and will be developed as soon as local administrative conditions make them practicable. The development of a chain of stations of this character for conducting intensive experiments in the various forest regions of the country will be of the greatest value in reducing our knowledge of silviculture to a more exact basis and will bring a greater return for the cost than any other investment which could be made in investigative work.

In grazing studies the grazing reconnoissance of different Forests will receive the greatest attention, and the energies of the majority of the technical men will be concentrated on this class of work. It is of principal importance, because it will establish a definite basis for all future scientific investigations connected with the grazing of live stock upon the Forest lands. While the number of technically trained men available for this class of investigations is not adequate to meet the demands being made by the different districts, it will be possible to complete reconnoissance examinations of several of the most important and typical Forests, and so to train the rangers assigned to the work that independent examinations by local forest officers will materially supplement those by the men regularly assigned to the work. While the grazing and lambing pasture experiments upon the Wallowa and Cochetopa Forests will be continued, they will only receive the attention necessary to secure accurate data showing the results secured by the permittees using them, there being no further need for detailed and continuous observations throughout the season. Continued attention will be given to the natural and artificial seeding of depleted ranges, the natural regeneration of certain important types of forage grasses, the study of the effect of grazing upon forest reproduction, and the study of the effect of soil acidity upon various species of important forage plants.

In order to coordinate the investigative work conducted throughout the Service and insure the thorough consideration of all plans of work before it is undertaken, a central investigative committee will be organized in the Washington office, consisting of the most proficient members of the Service in this line of work, whose function will be to exercise general direction and control of the various investigative projects of all kinds in the interest of thoroughness, proper correlation, and the avoidance of duplication. The central committee will be supplemented by field committees in each district exercising similar duties within the district. A series of publications dealing with the progress made in the various investigative projects, current data obtained at experiment stations, and the results of minor pieces of investigative work which do not merit separate publication will

be issued as a means of stimulating interest in this branch of the work of the Service and of keeping the investigators in touch with one another's work.

The series of sample plots on areas cut over under timber sales will be extended as a means of conducting a continuous and comprehensive study of the results of various methods of cutting on reproduction, production of wood, and general forest conditions.

Cooperation with the States in fire protection will in all probability be materially extended. The most important feature of this work will be close study of the actual protective systems put in effect by the various States, both as a means of insuring efficiency in the results obtained from Federal assistance and to standardize and unify as far as may be desirable the protective systems adopted by the various States. The investigation of forest conditions in States desiring to cooperate with the Government in this work and the compilation of State forest laws will be continued.

The most important work confronting the Forest Service in furtherance of a more general and better application of forestry in the East is the standardization of silvicultural systems applicable to the principal forest types. The data already secured will make it possible to do this with little additional field work. A series of publications covering specific areas, by States or portions of States, and containing the standard silvicultural methods for the various types as developed by the best experience and information, will go far toward making expert information available without cost to the great mass of private owners in the Eastern States.



