ORT OF THE FORESTER.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., October 8, 1919.

SIR: I have the honor to transmit herewith a report of the work in the Forest Service for the fiscal year ended June 30, 1919.

HENRY S. GRAVES,
Forester.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

THE EXTENSION OF FORESTRY PRACTICE.

The year covered by this report was signalized by a new movement for extending the practice of forestry. More than 20 years ago the Division of Forestry offered to give advice and assistance to private timber owners who might wish to consider applying forest management. The offer received a remarkable response and formed a real turning point in the forestry movement. For the first time forestry in the United States became something which a business man could grasp and weigh on its merits as a definite business proposal. This aided powerfully in bringing the whole question of forestry, public as well as private, before the country. But it did not result in any widespread acceptance of the practice of forestry by timberland owners.

The failure of this early movement to get private forests extensively under management was, however, not immediate. The Division of Forestry made its offer of cooperation early in the fiscal year 1898. By the close of the fiscal year 1905 requests had been received for the examination of private holdings, large and small, comprising all told more than 10,900,000 acres of land. Many requests were from lumber companies and other owners of extensive timber tracts. On the strength of the showing made by the preliminary examinations, a number of these large owners entered into cooperative agreements for the preparation of working plans. The interest of the lumbermen was much increased by the fact that the young foresters were able to show them that they were losing money by certain wasteful practices. Closer utilization spread rapidly through the industry. Public interest in forestry and an intelligent idea of what it meant became general. In the early years of the present century it really looked as though the management of forests as permanent productive properties might be voluntarily undertaken by private owners on a very large scale. Although many obstacles were presented by the internal conditions of the lumber industry, progressive lumbermen were giving much serious attention to the possibility of engaging in the practice of forestry. The chief stimulus was furnished by the rising value of stumpage.

The panic of 1907 radically changed the situation. The lumber industry entered a period of protracted depression. From that time on private forestry made relatively little progress in the United States, except on farm woodlands. While public forestry has made vast strides, the forests of the country that are in private hands are being depleted with very great rapidity, and almost everywhere without effort to renew them. A grave situation is becoming manifest in various ways. This is why the Forest Service is now putting forth a new and energetic effort to call public attention to the facts and to propose a program that will afford relief.

The problem presented is one that can be solved only by public action. The general practice of forestry on privately owned lands in the United States will not take place through unstimulated private initiative.

The magnitude of the National Forest enterprise and the prominence given to its accomplishments have given the impression to some that the problem of forestry is under way of solution. In point of fact, this is by no means the case, for the National Forests represent in area only about a quarter of the forest area of the country and less than that proportion of the actual standing timber. Private owners therefore hold more than three-fourths of the present timber supplies of the United States. The amount of materia which is actually placed on the market from the National Forests amounts to only about 3 per cent of the entire consumption of the country. The rest comes from private lands. While the proportion will be altered, the country must still look to private lands for a large part of its forest supplies.

The rate of depletion of our forest resources is more than twice, probably three times, what is actually being produced by growth in a form which will be servicable for products other than firewood. High prices of lumber are not wholly due to the increased cost of labor and materials. A part is due to the ever-retreating sources of timber supply. Already the supplies of all our eastern great centers of production are approaching exhaustion with the exception of the South, and even there most of the mills have not over 10 to 15 years' supply left of virgin timber. Already the southern pine is being withdrawn from many points as a competitive factor and its place taken by western timbers, with consequent freight charges which the consumer must pay. Communities needing to build roads and other public works which involve increased taxation are often having brought sharply to their attention the economic consequences of stripping off the forests and leaving in their stead unproductive wastes of low taxable value now or in the future. These facts are recalling public attention to the effects of uneconomic and wasteful exploitation of our forests in the past and to the need of steps which will put a stop to the destructive processes and replace them with methods which will build up rather than injure the country.

The situation necessitates a broad policy of forestry for the whole Nation which will include both an enlarged program of public acquisition of forests by the Government, the States, and municipalities and protection and perpetuation of forest growths on all privately owned lands which may not better be used for agriculture and settlement.

The proposed plan for realizing these objectives contemplates cooperation between the Federal Government and the States. The Government and the States must join hands in working out a program that will bring into correlation the various public and private efforts for the protection and right handling of forests. The function of the Federal Government, in addition to handling the National Forests, would be to stimulate, guide, and coordinate State action and conduct necessary investigations regarding the best methods of forestry, to assist the States in classification of land, and to harmonize action as between the different States. The States would also have a function in handling public property owned by them, and they would have a further direct responsibility in connection with the protection and perpetuation of private forest lands.

In the matter of private forestry the Government would work primarily through State agencies. To initiate the proposed policy there should be a Federal law authorizing the Government to cooperate with the States in bringing about the protection and right handling of forest lands within their borders, and providing means for such cooperation.

The net result of the steps already taken to inaugurate and organize the new movement for forestry has been to attract renewed and widespread attention to the fact that a real forest problem must be reckoned with, and is of national concern; to establish a conviction in the minds of many who have first-hand knowledge of the facts that definite action to protect the public interests involved and safeguard a resource essential for economic and industrial stability is now required; and to secure what is believed to be a feasible program, of a character to command general acceptance as it becomes fully understood.

PERSONNEL CHANGES IN THE FOREST SERVICE.

Since the signing of the armistice 419 members of the Forest Service have resigned. Of this number 118 were employed at the Forest Products Laboratory at Madison, Wis., 231 were members of the National Forest force, and 70 were employed in the District offices and at Washington.

The resignations at the Madison laboratory were mainly the result of curtailment of the activities there forced by large reductions in the funds supplied by the War and Navy Departments for lines of work which were a part of the war effort of the Nation. As set forth in last year's report, the Forest Products Laboratory had practically abandoned all other lines of work. When the armistice was signed the activities were at their peak. The field of public service of the laboratory was somewhat altered but in no way reduced by the sudden end of hostilities; but the supply of funds was progressively cut off. This was the chief cause of the reduction in force, though in a considerable number of individual instances men whom the laboratory wished to retain were lost because of the higher outside remuneration offered them.

Quite a different situation obtained with the National Forest force. Here the war had led to a curtailment of activities, the furloughing of many men who volunteered or were drafted for military service, the temporary or permanent withdrawal of other men to engage in

war work, and the carrying of heavier burdens by the men who were left. Generally speaking, the National Forest force sank personal considerations and recognized a patriotic duty to remain at their posts and exert themselves to the utmost to maintain through the period of the war indispensable activities, disregarding the opportunities very widely open to them to better themselves considerably in the matter of pay if they would accept outside employment. The National Forest organization, though subjected to a severe strain, was maintained intact because of the loyalty of its men to a high ideal of public service.

Since the conclusion of hostilities the personnel situation on the National Forests has grown very acute. The resumption of peace time activities upon the Forests threw a larger burden upon the organization before the men on military furlough had returned and before the personnel could be built up to meet the current requirements. At the same time, many men who had loyally remained with the service during the war felt that they no longer could justify to themselves the refusal of offers for outside employment at greatly increased compensation.

It was pointed out last year that the rate of pay of the National Forest force was entirely inadequate to attract and hold men of the training and experience needed to discharge the responsibilities involved. The forest officers are the guardians of the public property and the administrative managers who handle the great variety of business connected with the use of the properties. The safeguarding of the resources requires men of training in protective work that comes from long experience, and the same is true of the handling of timber sales, grazing, and other lines of business. Efficient service to the public necessitates competent forest officers. The standards of salaries paid today were set about nine years ago. These standards are not at all commensurate with the responsibilities involved, quite aside from any question of present-day cost of living.

During the past season the Forest Service has had the most serious fire situation in its history, due to the exceptionally severe and prolonged drought. In many cases the loss of experienced forest officers made it necessary to place men of relatively small training in charge of important districts. Fires grew large which would have been promptly extinguished if the men had had greater experience. The same effect appeared in the handling of various lines of business. The administration of grazing has suffered materially because of the difficulty of holding experienced men.

The salary of forest supervisors, exclusive of the bonus, now averages $1,958, that of deputy forest supervisors $1,524, and that of forest rangers $1,154. Many supervisors have charge of a million acres of public property and of resources not uncommonly valued at 15 to 20 million dollars. Often a single ranger district comprises 150,000 acres and resources of very great value, for which the ranger is directly responsible.

The position of forest supervisor and also that of forest ranger are in a very real sense technical, and the standards of remuneration should be such as to enable the Government to secure and hold trained men of the highest type and integrity. The effectiveness of the entire administrative system depends on the quality of the Forest force.

In the last few months the difficulties of maintaining an efficient organization have become increasingly aggravated. Impairment of the organization and reduction in efficiency of service are inevitable if some action can not be taken to check the flow of the experienced men who can not be retained on account of the low pay. If the present condition continues it will be necessary to build up practically a new organization, through a term of years; and in the meantime the public will suffer because of the lower efficiency of inexperienced men. In fact, through inefficient service the entire National Forest enterprise may be set back. The situation is one that should receive careful consideration in the interest of the public. Already protest has begun to be made by users against the effect of the changes of personnel, while internal evidences of poorer efficiency and increasing strain imposed on the organization are becoming manifest.

THE NATIONAL FORESTS.

RECEIPTS AND OPERATING EXPENSES.

The receipts from the National Forests in the fiscal year 1919 were greater by $783,484.79 than in the previous year. This is the largest increase ever made in a single year. The receipts totaled $4,358,414.86.

To this total the grazing business contributed $2,609,169.85, the timber business $1,540,099.96, special uses (i. e., the occupancy of lands for miscellaneous purposes), $136,822.99, and use for water-power development, $72,322.06. The receipts from grazing exceeded those of 1918 by $883,347.91, while the receipts from timber declined $93,549.46. Special uses showed a gain of $15,616.05, and water power a falling off of $21,654.29.

The falling off in the receipts from timber was not due to any material reduction in the current timber sale business but is explained chiefly by the fact that in 1918 settlement was secured under a court judgment of a claim against one of the transcontinental railroad companies amounting, with interest, to $89,264.

The increase in the receipts from grazing was due to the fact that last year the final step was taken in carrying through the advance in the grazing fees, proposed in 1916 and inaugurated in 1917.

With the stockmen paying more than two and one-half million dollars annually into the public treasury for use of the National Forest ranges, there is strong reason for their urging that the Government expenditures aimed at making the range more useful should be increased. Unquestionably the value of the range, to the live-stock producers and to the country, can be developed to a higher point by constructing more improvements and pushing further the investigations which make possible the most efficient and complete utilization of the forage crop and the most highly perfected methods of live-stock management. Since the Government receives a return on what may be called development expenditures, in the form of additional grazing fees, increased expenditures for this purpose would seem wise as well as reasonable.

That the receipts from grazing now exceed those from timber by more than a million dollars and form 59 per cent of the total receipts from all sources is due to the fact that practically the entire forage crop can under present conditions be utilized, while the annual timber cut is but an insignificant fraction of the sustained yield obtainable from the Forests, or of the total cut of the country. There is very

little range which is not accessible to live-stock, but the bulk of the timber is still out of reach of the lumbermen.

The receipts of 1919 were 175 per cent of those of 1915, while the cost of operating the Forests has remained practically stationary during these four years. The appropriation act for the current year made increases in the items for a number of the individual Forests, aggregating $266,074. Most of these increases were to strengthen the protective system on the Forests where the danger of costly and destructive fires is greatest because of the inaccessibility of the country. These new funds did not become available until after July 25, when the fire season was reaching its height, which precluded the carrying out of the plans contemplated when the increases were asked for. Before the end of June the worst fire season ever faced in the Northwest had begun. When it ended the expenditures for fire fighting had so far exceeded the appropriation for that purpose that it became necessary to ask a deficiency appropriation from Congress of $2,950,000. Again, as in last year's report, it must be pointed out that greater outlays for fire prevention, early detection, and swift concentration of fire-fighting forces would be much more economical.

THE NATIONAL FOREST PROPERTIES.

The net area of the National Forests at the close of the fiscal year 1919 was 153,933,700 acres, as against 155,374,602 acres June 30, 1918. The corresponding gross areas were 174,261,393 acres and 175,951,266 acres. The gross area includes all lands within National Forest boundaries; the net area excludes alienated lands.

These figures indicate a decrease of 1,440,902 acres in net area and a decrease of 1,689,873 acres in gross area. Eliminations made either by presidential orders or proclamations or by special acts of Congress totaled 1,658,989 acres, in 25 National Forests. The act of February 26, 1919, creating the Grand Canyon National Park, eliminated from the Kaibab and Tusayan National Forests and transferred to the Grand Canyon National Park 606,720 acres. State selections authorized under a proclamation of June 4, 1912, were approved in the St. Joe National Forest, in Idaho, aggregating 21,262 acres. Eliminations by Executive orders or presidential proclamations, as a result of the land classification that is now nearing completion, reduced the National Forest areas 1,031,007 acres. Furthermore, a considerable acreage passed into private ownership under the usual operations of the mining laws and the Forest homestead act.

These reductions in area were in a small degree offset by three small public-land additions. Presidential proclamations increased the Dixie National Forest in Utah 8,328 acres and the Humboldt Forest in Nevada 28,020 acres. By the act of March 3, 1919, 2,886 acres were added to the Minam Forest in Oregon.

Increase of the National Forests in the East through purchases continued at a conservative rate. The total net area of public land in the National Forests established from purchase areas now aggregates 1,347,666 acres. Of this amount 1,333,405.03 acres have been purchased, the remainder being unoccupied and unentered public lands in the Alabama National Forest. At the close of the fiscal year there remained a total of 396,493 acres approved for purchase by the National Forest Reservation Commission and under process of

acquisition, and the plans for ultimate acquisition embraced additional areas aggregating 4,422,167 acres. The purchase activities were largely confined to areas previously approved for purchase and to the consummation of negotiations already pending. The National Forest Reservation Commission desires, so far as practicable, to round out and complete the present purchase areas for practical administrative units before initiating purchase activities in other regions.

At the close of the fiscal year there were pending in the Interior Department proclamations providing for additions in the Western States totaling 283,780.54 acres. Of this 75,050 acres represents additions in the State of Wyoming authorized by special acts of Congress. The prevailing sentiment in the public-land States is now generally favorable to the extension of the Forests. This is indicated by the fact that at the present time there is pending in Congress legislation providing for 10 different additions to National Forests in the public-land States in which such additions can only be made with the consent of Congress. These proposed additions aggregate approximately 1,700,000 acres. The most important of the projects now before Congress is one for adding to the Idaho and Payette National Forests the region commonly known as the Thunder Mountain country, of approximately 1,120,000 acres. This proposed addition was discussed in last year's report. It has been strongly urged by successive sessions of the Idaho State Legislature, and is very desirable in order to give this area the protection and regulation it has so long and so urgently needed.

PROTECTION.

Mention has already been made of the emergency conditions which arose during the fire season of 1919 in the Northwest. The National Forests of western Montana and northern Idaho are heavily timbered, and most of the country which they cover is exceedingly mountainous, rugged, and undeveloped. Because of its wild character, its remoteness from centers of population and bases of supply, its lack of means of communication, its large stand of valuable timber and importance for watershed protection, and because of the climatic conditions, it presents the problem of protection in its most extreme form. Nowhere else, experience has proved, is the control of fires so difficult or so expensive.

The region is subject to severe droughts, in which almost no rain may fall for months; when such drought seasons occur the forests become almost like tinder; and frequent electric storms supply the sparks. Lightning fires generally start in the high mountains, where they are most difficult to reach and fight. Their control necessitates special provision, first, for discovering and getting to them quickly before they have gathered headway; and, secondly, for throwing against them and maintaining in the field large forces of fire fighters in case their immediate suppression becomes impossible.

The experience of the past season simply emphasizes the conclusion set forth in my report of a year ago. The protective system must be strengthened along lines which will permit of quicker work. The choice is between, on the one hand, provision for a moderately expanded regular protective organization or, on the other hand, unnecessarily large danger of terrific fires and huge emergency expendi-

tures. Last summer these emergency expenditures for fire fighting in the western Montana and northern Idaho Forests came to more than ten times the regular protective funds provided for the same Forests. While the danger of great fires can no more be entirely eliminated on the National Forests than it can in our large cities, it can and should be minimized.

Control of last summer's fires was made especially difficult by various circumstances. The delay in the enactment of the Agricultural appropriation bill embarrassed the early building up of the protective organization. Labor was at times difficult to secure to the extent needed, and was generally less efficient than usual; while it was always hard to secure men experienced in fire fighting for foremen. Very serious, however, was the further fact that the Forest Service has been losing its trained men very rapidly, owing to its inability to hold men at the present rates of compensation prescribed by law; and in consequence in many cases the forest officers were comparatively new men or men who had been recently transferred from some other district and had not yet become thoroughly familiar with the local country. Undoubtedly this was responsible for failure in a number of instances to get fires extinguished more promptly and economically.

Through a succession of unusually dry years the Forest Service has been able to prevent a catastrophe. It has held down the loss of merchantable timber to an amount which, under the circumstances, is reasonably small. It has prevented injury and destruction to property worth several hundred million dollars. On the other hand, a large expenditure has been required to fight fires, and in the aggregate a large area of old burns has been burned over, with resulting destruction of a great deal of young growth. The reasons for the failure to secure better results may be summed up as follows:

(1) The Forests have not yet been sufficiently opened up with roads and trails. It is still necessary in many cases to build trials through the woods to the fires. This may require several days, during which a fire may have become a great conflagration.

(2) The regular protective force is insufficient.

(3) The Forest Service is almost wholly unequipped with motor transport. Aside from the fact that the cost of hiring trucks to transport men and supplies for fire fighting is very large, the difficulty of obtaining such transportation sometimes results in failure to reach a fire before it is too late. Adequate equipment with motor trucks would save a great many thousand dollars each year.

(4) Successful fire protection is absolutely dependent on a permanent force of trained men. Without that, fires which should be put out promptly with little loss or cost spread widely and require many thousands of dollars to prevent disaster, let alone extinguish them.

(5) Public sentiment in many places has not yet roused to the need of care in the forest and public cooperation. There are still too many railroad fires, too much carelessness in the woods, particularly from smoking, and too many fires from clearing land.

The answer to the forest fire problem is therefore more roads and trails, sufficient salaries for our forest officers to enable the building up and holding of a well-trained force, greater leeway in furnishing motor equipment for fighting fires, which could also be used in road improvements, and a more vigorous campaign to educate the public to better cooperation in fire protection.

There were relatively few large fires during the fiscal year on the National Forests elsewhere than in the northern Rocky Mountains and Pacific Coast States, although unfavorable conditions were widespread. In the last six months of the calendar year 1918, after an an early summer fire season of unusual danger in all parts of the West, except in Colorado, Wyoming, and South Dakota, where light rains fell with sufficient frequency to mitigate the drought, the situation improved materially as the season advanced. The fall rains generally set in early; and in the Southwest, where the fire danger occurs in two distinct seasons, one in the spring and early summer and one in the fall, the fall fire season was of short duration, with good showers at frequent intervals. In southern California conditions were threatening until late in the fall, but throughout the State the fires of the latter part of the calendar year 1918, were well controlled. Especially notable was the reduction in the number of man-caused fires in California which followed a vigorous campaign of public education waged by the Forest Service in cooperation with State and other public agencies. In Minnesota no large fires burned on the National Forests, in conspicuous contrast with what happened in other parts of the State. In the southern Appalachian Forests the climatic conditions during the fall were less favorable than normally, but only one large fire occurred; this was on the Shenandoah, in October.

The following table gives certain statistics regarding the 1918 fires. The total number, 5,573, shows a reduction of 2,241 from the number which occurred in the previous calendar year. The area of National Forest lands burned over was 694,651 acres, as against 962,543 in 1917; the estimated damage on these lands was $688,332, as against $1,358,627; and the total cost of fire fighting was $714,009.63, as against $1,121,451.

Fires on National Forests, calendar year 1918.

Extent and causes of fires.	Number of fires.	Percentage of total.	Extent and causes of fires.	Number of fires	Percentage of total.
Area burned over:			Causes of fires:		
Under 0.25 acre	2,475	44.41	Railroads	618	11.09
Between 0.25 acre and 10 acres	1,572	28.21	Lightning	2,457	44.09
10 acres and over, damage under $100	1,146	20.56	Incendiary	257	4.61
10 acres and over, damage $100 to $1,000	270	4.85	Brush burning	361	6.48
10 acres and over, damage over $1,000	110	1.97	Campers	943	16.92
			Lumbering	104	1.86
			Unknown	658	11.81
			Miscellaneous	175	3.14
Total	5,573	100.00	Total	5,573	100.00

Of the 110 fires listed above as having burned over an area of 10 acres and more with damage in excess of $1,000, 35 were in Idaho, 30 in Oregon, 14 in Washington, and 12 in California. In total number of fires of all classes California came first, with 1,148, followed by Idaho with 832, Oregon with 775, Montana with 573, and Washington with 563. Seventy per cent of all the fires occurred in these five States.

Since the fire season of 1919 is not yet closed, final statistics regarding this year's fires can not of course be given. Preliminary estimates indicate an area burned over up to September 30 of approximately 1,500,000 acres, while the fire fighting expenditures from July 1 to September 30 were close to $3,000,000.

MANAGEMENT.

Timber.

There was a decrease of 3 per cent in the cut of National Forest timber under sales, and of 0.5 per cent in the receipts from sales. In a period when the lumber cut of the United States as a whole dropped off 11 per cent, this sustained use of National Forest timber indicates the stable source of supply which has been established in the National Forests for the local lumber industry and for the general timber requirements of the country. New sales of timber decreased 45 per cent. This decrease is attributable to the war production conditions existing during the first part of the year and to the high cost of steel rails, machinery, and other materials, which has discouraged the development of new lumbering enterprises in the National Forests.

Since April, 1919, the lumber market has been characterized by advances in prices exceeding in rapidity anything previously known in the history of the industry. This condition appears to be due to the sudden and wide-spread resumption of building activity and to the shortage of existing lumber stocks. The production of lumber is responding but slowly to this demand on account of the shortage of labor and the high cost of supplies. The advance in lumber has, however, been reflected during the last three months in a sharpened demand for National Forest stumpage, which bids fair to increase materially the rate of cutting. Such increases will be progressive and somewhat slow, because a certain length of time is required for the appraisal and advertisement of large tracts and time is needed also for new installations under present conditions.

One of the more important developments in forest management which must be pushed with vigor is to determine within closer limits than has yet been possible the quantities of timber which may be cut from forest units on a basis of permanent production. The demand for National Forest timber in some localities has about reached the growing capacity of the areas forming the logical source of supply. It is of the utmost importance that the industrial developments supported by National Forest stumpage be permanent and that no pressure for the immediate use of timber be permitted to exhaust such National Forest areas within a few years, leaving a wake of sawdust piles and deserted lumber camps. The general principles upon which this development of National Forest management has been undertaken are: (1) To define areas, on the basis of topographic features or of industrial and economic factors, from which a steady yield of timber should be obtained; and (2) to determine the safe limit of yearly sales from each area in order that the yield may be continuous. Securing permanent and desirable conditions for labor in forest industries is an important phase of this development.

A second important extension in the effective use of National Forest timber is to obtain exact data upon their resources for making

paper, both as to suitable woods and as to hydraulic power; and to make these resources available to paper manufacturers under practicable terms in view of the transportation and other conditions attending the extension of their industry into the Western States. The National Forests contain upward of 200 billion board feet of timber suitable for the manufacture of news print. Sales of pulpwood are now being made at a number of points as part supply for established paper plants. Several large tracts of timber of paper-making species have been appraised and advertised for sale or offered to the paper trade. Transportation conditions, labor problems, and the large investments required for the installation of paper plants have held back the development of such enterprises on the National Forests, notwithstanding the favorable timber and water-power conditions which are to be found at many points. This development, however, is bound to come, in view of the general paper situation in the United States; and the Forest Service is preparing for it.

Owing to the handicaps imposed by the reduction of field personnel in consequence of the war, timber surveys have been materially curtailed since 1916. With the prospect of increased activity in sales to lumber manufacturers and the need to be ready for the demand for timber likely to arise from paper manufacturers, it is important to expand again the timber-survey work. This work is fundamental to plans for wise management. During the year 448,547 acres were cruised and mapped by intensive methods and are now ready for timber sales, while 37,551 acres were covered by extensive reconnaissance.

The Agricultural appropriation act for the fiscal year contained a special provision for granting National Forest timber required for war purposes to any department, board, or committee of the Federal Government. Owing to the late passage of this measure, but one permit was granted under it to the War Department. This covered 6,000,000 feet, board measure, of which approximately 3,750,000 board feet were cut. Permits aggregating 5,758,000 board feet were issued to the Alaskan Engineering Commission under the act of March 4, 1915. This commission has cut to date approximately 30,000,000 board feet, under permit from the National Forests in Alaska.

Details regarding the cut and sale of timber are embodied in the following tables:

Timber cut under sales, fiscal year ended June 30, 1919.

State.	Board feet.			Value.		
	Commercial sales.	Cost sales.	Total.	Commercial sales.	Cost sales.	Total.
Alaska	44,764,000	.....	44,764,000	$99,893	.....	$99,893
Arizona	41,174,000	333,000	41,507,000	95,135	$264	95,399
Arkansas	21,772,000	242,000	22,014,000	62,224	195	62,419
California	84,703,000	1,210,000	85,913,000	189,785	666	190,451
Colorado	46,762,000	1,320,000	48,082,000	87,827	995	88,822
Florida	578,000	.....	578,000	1,234	.....	1,234
Georgia	1,725,000	.....	1,725,000	4,744	.....	4,744
Idaho	63,550,000	4,252,000	67,802,000	160,011	3,170	163,181
Michigan	236,000	.....	236,000	344	.....	344
Minnesota	8,468,000	.....	8,468,000	33,107	.....	33,107
Montana	66,031,000	5,971,000	72,002,000	144,768	4,958	149,726
Nevada	1,504,000	61,000	1,565,000	2,110	45	2,155
New Hampshire	4,116,000	.....	4,116,000	21,268	.....	21,268
New Mexico	40,633,000	419,000	41,052,000	91,139	367	91,506
North Carolina	4,876,000	.....	4,876,000	15,506	.....	15,506
Oregon	114,911,000	2,669,000	117,580,000	233,781	1,576	235,357
South Dakota	14,663,000	757,000	15,420,000	33,323	697	34,020
Tennessee	1,711,000	156,000	1,867,000	3,874	117	3,991
Utah	13,759,000	915,000	14,674,000	31,044	699	31,743
Virginia	6,709,000	16,000	6,725,000	17,768	15	17,783
Washington	78,073,000	576,000	78,649,000	119,013	308	119,321
West Virginia	2,000	.....	2,000	10	.....	10
Wyoming	25,436,000	700,000	26,136,000	57,573	598	58,171
Total, 1919	686,156,000	19,597,000	705,753,000	1,505,481	14,670	1,520,151
Total, 1918	707,182,000	21,641,000	728,823,000	1,511,825	16,300	1,528,125

Timber sold fiscal year ended June 30, 1919.

State.	Board feet.			Value.		
	Commercial sales.	Cost sales.	Total.	Commercial sales.	Cost sales.	Total.
Alabama	.....	15,000	15,000	.....	$82	$82
Alaska	47,650,000	.....	47,650,000	$81,216	.....	81,216
Arizona	69,967,000	494,000	70,461,000	139,249	396	139,645
Arkansas	10,627,000	286,000	10,913,000	47,096	217	47,313
California	239,919,000	1,981,000	241,900,000	565,006	1,087	566,093
Colorado	54,536,000	1,501,000	56,037,000	123,158	1,130	124,288
Florida	1,911,000	.....	1,911,000	4,825	.....	4,825
Georgia	1,977,000	.....	1,977,000	4,927	.....	4,927
Idaho	79,898,000	6,329,000	86,227,000	151,532	4,727	156,259
Michigan	268,000	3,000	271,000	292	2	294
Minnesota	4,043,000	.....	4,043,000	19,086	.....	19,086
Montana	28,462,000	8,256,000	36,718,000	60,642	6,662	67,304
Nevada	854,000	72,000	926,000	1,060	54	1,114
New Hampshire	2,580,000	.....	2,580,000	11,376	.....	11,376
New Mexico	15,299,000	541,000	15,840,000	42,826	399	43,225
North Carolina	36,549,000	.....	36,549,000	112,350	.....	112,350
Oregon	92,192,000	2,866,000	95,058,000	237,355	1,636	238,991
South Dakota	24,843,000	811,000	25,654,000	68,905	698	69,603
Tennessee	4,776,000	200,000	4,976,000	15,404	150	15,554
Utah	11,983,000	1,399,000	13,382,000	27,998	1,092	29,090
Virginia	4,509,000	16,000	4,525,000	9,886	15	9,901
Washington	32,312,000	637,000	32,949,000	71,728	334	72,062
West Virginia	2,000	.....	2,000	10	.....	10
Wyoming	8,052,000	860,000	8,912,000	19,493	770	20,263
Total, 1919	773,209,000	26,267,000	799,476,000	1,815,420	19,451	1,834,871
Total, 1918	1,425,258,000	28,041,000	1,453,299,000	3,295,516	21,341	3,316,857

Number of timber sales, classified according to amount of sale, fiscal year ended June 30, 1919.

State.	$100 or under.			$101–$500	$501–$1,000	$1,001–$5,000	Over $5,000.	Total.
	Commercial.	Cost.	Total.					
Alabama	.....	8	8	.....	.....	.....	.....	8
Alaska	500	.....	500	1	3	18	.....	522
Arizona	696	169	865	4	1	6	1	877
Arkansas	38	76	114	8	5	3	4	134
California	373	353	726	14	9	12	9	770
Colorado	529	232	761	12	7	15	7	802
Florida	24	.....	24	.....	.....	1	.....	25
Georgia	57	.....	57	.....	.....	1	.....	58
Idaho	599	1,364	1,963	12	6	12	9	2,002
Michigan	8	1	9	.....	.....	.....	.....	9
Minnesota	6	.....	6	.....	.....	1	1	8
Montana	674	1,894	2,568	[1] 21	7	8	2	2,606
Nevada	69	6	75	.....	.....	.....	.....	75
New Hampshire	120	.....	120	2	1	3	.....	126
New Mexico	694	251	945	7	4	6	1	963
North Carolina	109	.....	109	5	5	5	1	125
Oregon	243	466	709	7	2	3	3	724
South Dakota	342	144	486	8	6	12	2	514
Tennessee	56	56	112	1	.....	2	1	116
Utah	458	725	1,183	7	4	1	1	1,196
Virginia	266	8	274	2	.....	2	.....	278
Washington	213	128	341	6	1	3	3	354
West Virginia	1	.....	1	.....	.....	.....	.....	1
Wyoming	152	140	292	3	3	.....	1	299
Total, 1919	6,227	6,021	12,248	120	64	114	46	12,592
Total, 1918	6,670	5,907	12,577	160	89	147	64	13,037

[1] 1 cost sale.

REFORESTATION OF DENUDED LANDS.

Notwithstanding the drought during the last two seasons, a good percentage of success has been secured in most of the forest plantations on denuded lands in the National Forests. This is probably due to the experience which has been gained in the production of nursery stock and in the more effective methods of planting it in the field. A total of 6,911 acres was planted and seeded during the fiscal year. The largest planting operations are being conducted in the Northwest. Small plantations in the Lake States have been very successful, and the work will be largely extended in this region within the next five years. Some of the older plantations conducted by the Forest Service, particularly near Halsey, Nebr., are now assuming forest proportions and establishing veritable forest conditions in the midst of vast areas of treeless land.

The details of planting and sowing operations are given in the following table:

Planting and sowing on National Forests, by States, 1919.

State.	Area planted.	Area sowed.	Total.	State.	Area planted.	Area sowed.	Total.
	Acres.	*Acres.*	*Acres.*		*Acres.*	*Acres.*	*Acres.*
Oregon	1,449.00	.....	1,449.00	California	179.00	.....	179.00
Idaho	1,344.00	150.00	1,494.00	New Mexico	31.00	.....	31.00
Montana	1,000.00	.....	1,000.00	Arizona	3.00	.....	3.00
Colorado	612.32	.....	612.32	Nevada	1.20	.....	1.20
Washington	533.00	.....	533.00	South Dakota	1.00	.....	1.00
Nebraska	513.63	.....	513.63	Florida	.33	.....	.33
Minnesota	441.00	.....	441.00				
Michigan	399.00	.....	399.00	Total	6,761.38	150.00	6,911.38
Utah	253.90	.....	253.90				

Range.

Very exceptional range conditions characterized the seasons of 1918 and 1919. The closing of the 1918 season marked the termination of a prolonged drought throughout the Southwest, particularly in New Mexico, Arizona, and Texas. A very severe winter with a heavy snowfall followed, which caused heavy losses of stock of all classes. The 1919 season throughout the Southwest was unusually favorable for forage growth. Throughout Montana, Idaho, Utah, Wyoming, northern Colorado, the western half of Nebraska, and North and South Dakota, however, one of the most severe droughts in the memory of the oldest stockmen has prevailed. This drought probably reached its greatest intensity in Montana, northern Wyoming, eastern Utah, and Idaho. For three years the precipitation in this region during the growing season has been very light, but the 1919 conditions were the worst. The snowfall at the beginning of the year in the entire drought region was unusually small, and while a few heavy snows fell in the latter part of the winter, the snow did not pack and disappeared rapidly when warm weather set in. Temperatures during April and early May were much above normal, causing the snow to melt and run off sooner than usual. This caused a shortage of water for irrigating and stock watering purposes.

Forage growth of all kinds started early, with indications of a good season. Heavy freezes, however, during the last few days of May destroyed all of this new vegetation, upon which the sheepmen were dependent for feed for their flocks during the lambing period. These conditions also affected the cattlemen to some extent, as their stock did not immediately begin to increase in flesh. A long period of low precipitation immediately followed in the States above named, which greatly reduced forage growth.

The stream flow was far below anything previously recorded, and this had a direct influence upon the raising of farm crops, particularly hay, which has been reported as from 20 to 50 per cent below normal.

The production of forage on the unreserved public lands was very restricted, and the stockmen using these areas were forced to seek other range. The National Forest ranges, being at higher elevations, were not so greatly affected, and stockmen who held Forest permits were considered very fortunate. During the early part of July heavy rains occurred in northern Arizona, southern Utah, and parts of Nevada, which relieved range conditions materially throughout this region and reduced the drought area considerably. During the latter part of July rains occurred in northern Utah and southern Idaho. While they came too late to cause any appreciable increase in the hay crop, an immediate improvement in the summer, fall, and winter range was noticed, thus still further reducing the drought area.

The range situation looked so critical early in July that the Department of Agriculture considered it necessary to assist the stockmen in the drought regions. A committee organized for this purpose immediately undertook a canvass of the drought-stricken region to determine the numbers of stock for which other pasturage or winter feed would have to be provided in order to avoid placing this stock upon the market, and also sought to locate in other States places where feed or pastures could be secured for wintering stock shipped in from the drought-stricken region. The Forest Service cooperated with the

committee in making the canvass, by gathering data regarding the stock on the National Forest and adjacent ranges. It appeared that very heavy shipments would have to be made from the intermountain region. The situation in Montana and Wyoming was even more critical, for in many places in these States the estimates indicated that at least 75 per cent of the stock would have to be shipped to market or feeding points.

The relief committee, with the cooperation of many county agencies, agricultural representatives, and other Department representatives, is assisting stockmen to avoid the necessity of placing their drought-stricken stock on the market at a sacrifice by directing them to winter feed. In addition, it has been developed that large quantities of hay are available in the Middle Western States at prices sufficiently low to permit of its shipment into the drought regions for winter feeding. This fact with the localized rains that occurred over a large portion of the region during the latter portion of the season will greatly reduce the number of stock to be disposed of on account of lack of feed. The conditions in eastern Idaho, Wyoming, and Montana have not greatly improved, and it will be necessary for the stockmen in those States to make heavy shipments.

Live stock and wool prices fell off materially during the year. In the fall of 1918 prices were unusually good. An unusually mild winter, except in the Southwest, brought the stock through in excellent condition, without the necessity of heavy expenditures for hay or concentrated feed. The first evidence of declining prices was observed in the wool sales last spring. In addition the stockmen had serious difficulties in securing competent help. Old employees familiar with range conditions and Forest regulations readily found more remunerative and easier positions in other lines of work.

The importance of the National Forest ranges to the stockmen was strongly emphasized by the events of the year. Never before was the demand for range on the Forests so great. This was particularly true in the drought-stricken regions, where stockmen, using the unreserved public domain or private pastures, eagerly sought Forest permits in order to save their stock. The value of the system of range regulation in use has been so thoroughly demonstrated that at the public lands convention held in Salt Lake City on August 21—a gathering of representative stockmen from all of the Western States—the convention went on record in favor of placing the remaining unreserved public lands under Federal control and having them managed under a plan similar to that in effect on the National Forests.

A plan for granting 5-year permits was put into effect on a large number of the Forests. It is too early to determine the results.

Larkspur eradication upon the scale desired proved impossible, partly for lack of men to supervise the work, partly because the scarcity and high cost of labor prevented the stockmen from cooperating extensively. However, larkspur was eradicated from 1,657 acres during the year, making a total of 3,580 acres grubbed since the work began, at a cost of $5.50 per acre. The stockmen contributed about one-half the expense. A resultant saving in cattle of $34,000 annually is estimated, on the basis of the average previous recent death loss and a valuation of $50 per animal.

It was planned to carry on the eradication work for the season of 1919 on all projects not completed, and to undertake grubbing on new

areas where cooperation could be secured and funds were available. The exact acreage infested is not definitely known, but from the number of cattle reported as dying on infested ranges it is evident that a large saving is feasible. With the present great demand for Forest range and high prices for cattle the need for continuing the eradication work can not be overemphasized.

The following table shows the number of permits issued and number of stock grazed upon the Forest ranges during the fiscal year ended June 30, 1919:

Grazing permits issued and number of stock grazed.

State.	Cattle, horses, and swine.				Sheep and goats.		
	Permits issued.	Number of stock grazed.			Permits issued.	Number of stock grazed.	
		Cattle.	Horses.	Swine.		Sheep.	Goats.
Alabama	2	59					
Arizona	1,570	360,011	6,509	637	160	364,853	6,604
Arkansas	452	4,591	80	494	15	49	230
California	3,021	208,683	7,019	3,324	551	606,526	13,286
Colorado	4,455	380,460	9,503		872	1,044,208	1,322
Florida	23	787		6			
Georgia	48	440	14	15	3	23	
Idaho	4,213	190,608	13,794		1,093	1,758,877	
Michigan					2	91	
Montana	2,865	170,674	16,524		521	835,224	134
Nebraska	54	12,757	713				
Nevada	502	77,432	4,320		109	390,753	
New Hampshire	15	158	12				
New Mexico	2,020	174,979	5,309	467	576	440,302	39,051
North Carolina	186	1,157	52	56	5	82	
Oklahoma	57	3,304	294				
Oregon	2,478	162,004	10,066	88	537	753,418	52
South Dakota	786	38,185	3,184		8	12,200	
Tennessee	47	431			5	75	
Utah	7,249	172,246	9,914	67	1,641	811,510	110
Virginia	273	2,614	15		1	6	
Washington	1,031	30,743	2,318		196	236,307	
Wyoming	1,181	143,204	3,611		329	680,670	
Total, 1919	32,528	2,135,527	93,251	5,154	6,624	7,935,174	60,789
Total, 1918	32,600	2,137,854	102,156	3,371	6,513	8,454,240	57,968

There was a reduction of 72 cattle and horse permittees and an increase of 111 sheep and goat permittees, making a net increase for both classes of 39 as compared with the previous year. Fewer cattle, horses, and sheep were grazed, but the number of swine and goats slightly increased. The horses grazed on the National Forests are very largely of a small and inferior type which do not return a profit to the owner; consequently there has been a marked tendency on the part of these owners to dispose of their horses and substitute more valuable kinds of stock.

It will be observed that the decrease in the number of cattle was insignificant—only 2,327; but that the number of sheep was decreased by over 500,000. During the grazing seasons of 1917 and 1918 the number of cattle on the National Forests was increased over 379,000 head and the number of sheep over 611,000 head, as a war emergency measure. Since the closing of the war it has been necessary to reduce the number of stock on many of the ranges to prevent serious damage to the ranges. Investigations showed that forage could be provided for practically the full number of cattle, but that a reduc-

tion in the number of sheep to practically the prewar number was imperative. The bringing into use of more range for cattle through the eradication of poisonous plants, securing a more uniform utilization of the forage on the cattle range through better distribution, and the adoption of the common use of range by cattle and sheep whereby a limited number of cattle utilize forage not palatable for sheep are the reasons why there has been practically no reduction in the number of cattle.

LIVE-STOCK ASSOCIATIONS.

Regulated management of the National Forest ranges during the past 14 years has had a marked influence on the formation of live-stock associations and the development of this field of activities. The old system under which each permittee gave individual attention to his stock while on the range is being widely replaced by a pooling of interests along certain lines, accomplished by forming live-stock associations with executive committees to handle many of the details of stock management. Many of the executive committees employ herders for the stock while on the range, buy and distribute salt, in some cases buy bulls, and take charge of other management and improvement matters which promote the best interests of the permittees and the highest use of the range. The method employed is the adoption of special rules, passed by the association and approved by the Forest Service. Compliance with these rules is then required of all users of the National Forest range involved. Practically all of the more progressive associations have adopted such special rules as meet the needs of their localities. Membership in the association is open to all live-stock owners using the range in question, and a majority of all users must belong to the association in order to secure its recognition by the Forest Service.

The advantages of cooperation are shown by the number of live-stock associations recognized by the Forest Service. In 1917, 359 stock associations were cooperating with the Service. Last year there were 544, an increase of over 51 per cent. So firm are the owners of live stock that graze upon the National Forest ranges in their belief in the value of organization that of the 4,246 permittees in the States of Oregon and Washington over 3,000 are members of live-stock associations.

In many cases advisory boards have recommended reductions in the number of stock upon a given range; they have also suggested changes in grazing seasons, with a view to securing the greatest benefits to the users and an improvement in the range. In practically all cases associations have interested themselves in constructing range improvements such as drift fences, in water development, in the eradication of poisonous plants, and similar matters. The expenses for the improvements are secured through assessments. The value of organized cooperation is most evident on range allotments where conditions of use are very intensive and the permitted stock belongs to a large number of small owners.

WATER POWER.

Not much water power development has taken place since the United States entered the war. Increased war demands for electric power could not be deferred for the time necessary to construct

water-power plants but had to be met in greater part by the construction of new steam plants and by the interconnection of existing plants. At present financial and industrial uncertainties and the unsatisfactory character of Federal laws are resulting in further postponements of water-power utilization. Any considerable utilization of our undeveloped water powers must await both the enactment of legislation and the stabilization of the general economic situation.

The receipts from water-power permits and easements were $72,322.06, as compared with $93,976.35 for the fiscal year 1918. Ten applications for preliminary rental permits were received, 14 for final rental permits or easements (of which 9 were for transmission lines only), and 11 for free permits or easements (of which 3 were for transmission lines only). Data concerning projects under permit at the close of the year are given in the following tabulation:

Water-power sites and transmission line rights of way under permit and easement, fiscal year 1919.

Class of permits or easements.	Transmission lines only.			Power projects[1] (reservoirs, conduits, power houses).		Total number permits or easements.
	Number of permits or easements.	Length in miles.		Number of permits or easements.	Estimated average output (in horsepower) at minimum discharge.	
		Within Forest boundaries.	On National Forest land.			
Permits or easements in force at close of fisca. year:						
Rental permits or easeemnts—						
Preliminary	.....	.....	.....	13	180,633	13
Final	148	1,063.78	789.01	91	767,751	239
Free permits or easements	20	146.70	111.09	92	8,580	112
Total	168	1,210.48	900.10	196	956,964	364
Construction completed at close of fiscal year:						
Rental permits or easements	147	1,061.00	786.95	76	311,293	223
Free permits or easements	20	146.70	111.09	81	7,734	101
Total	167	1,207.70	898.04	157	319,027	324
Construction incomplete at close of fiscal year:						
Rental permits or easements	1	2.78	2.06	8	223,037	9
Free permits or easements	.....	.....	.....	8	814	8
Total	1	2.78	2.06	16	223,851	17
Construction not stated at close of fiscal year:						
Rental permits or easements	.....	.....	.....	20	414,054	20
Free permits or easements	.....	.....	.....	3	32	3
Total	.....	.....	.....	23	414,086	23

[1] With or without transmission lines.

Recreation and Game.

Plans for the management of the National Forests must aim to provide for an orderly development of all their resources, for the use and benefit of the public. Such plans would be incomplete if they failed to take into account the wild life and the recreation resources.

Use of the National Forests for recreation was greater than ever before. There is not a single Forest, and there is scarcely a ranger

district, which does not have some features of recreation interest. Sometimes it is the mountain scenery, sometimes the beauty of forests, lakes, and streams, sometimes the opportunities for sport in the form of fishing, hunting, or mountain climbing, and sometimes it is still other kinds of attractions which lead yearly increasing number of visitors to the Forests for recreation and health.

Because of this expanding use adequate administration of the recreation resource has become of marked importance. The western National Forests are, by virtue of their location and character, the natural public playgrounds for most of the country west of the Mississippi, and they also draw many thousands of visitors from the East. They must be handled with full recognition of their recreation values, present and future. This requires careful and forward-looking plans providing both for the protection and the development of this important resource.

Protection of the recreation resource involves measures that will safeguard for the use and enjoyment of the public the natural attractions which appeal to visitors and cause them to seek the Forests and also measures that will reserve for their use adequate supplies of wood and forage and afford pure water. Development of the resource is a still larger matter. It involves many things, but the most urgent primary need is provision of facilities for traversing the Forests and for living while in the Forests.

All these matters received attention. In cutting timber, operations are adjusted to protect scenic features, roads, camping places, and the like against loss of attractiveness. Forage is reserved for the horses of recreation parties. Water protection is looked after through sanitary regulations, the provision of hotel and other accommodations is encouraged, information of various kinds supplied, and in general the convenience and comfort of visitors promoted.

Of particular importance for the increase of use is the systematic and progressive development of roads and trails by which the Forests are being made more generally accessible. Every road and trail, whether it is built primarily for protection or for the development of some material resource, opens up new features of scenic interest. In a variety of other ways also development to meet the increased demand for recreation use is being undertaken. A number of recreation centers are being made ready for the public under plans carefully worked out by recreation engineers. Various such centers are already in use, such as the Red Fish Lake and Wood River recreation areas in the Sawtooth National Forest in Idaho, Eagle Creek on the Columbia River Scenic Highway near Portland, Oreg., Denny Creek on the Sunset Highway near Seattle, Huntington Lake in the Sierra National Forest, the Los Angeles Municipal Camp in the Angeles Forest, and the Laguna Mountains recreation area between San Diego and the Imperial Valley. At many other points the Forest Service is constructing shelter houses, improved camping places, etc.

It is becoming manifest, however, that an adequate policy of recreation involves still more. The services which can be rendered the local and general public, on the one hand, and the resources available for meeting these needs, on the other hand, need to be studied in the most comprehensive and thorough-going manner to the end that coordinated development of all these resources—whether found within

the National Forests, or in National Parks, or in properties belonging to States and municipalities—may be secured. For example, the full recreation value of the Oregon National Forest, which surrounds Mount Hood and borders on the Columbia River Valley, can be realized only through a development coordinated with what the City of Portland and the Counties of Multnomah, Hood River, and Clackamas have undertaken to do and have largely accomplished. Such a coordination has in this particular case been effected, with most happy results. Again, recreation development in the Yellowstone Park region can not be made to serve the public interests to best advantage if National Forest administration is uncorrelated with the administration of Park, and vice versa. In short the National Forests, which must be administered with a view to recreation use as one of their major functions, can not carry out that function in fullest measure except through cooperative relations with other agencies in the same field, resulting in joint effort under a truly national and common policy.

The wild life resource of the National Forests is in many ways closely related to recreation. It comprises mainly the game, the fish, and the fur-bearing animals, and the matter of most immediate importance is suitable provision in the administrative plans for the perpetuation of the existing herds of elk.

In spite of difficulties created by war and other conditions that made it necessary to carry on the ranges all the domestic live stock for which a place could safely be found, progress was made in working out better methods of elk conservation and in providing more ample feeding grounds for the herds in and around Yellowstone Park. In general, recognition of the fundamental problem involved has been secured to a greater degree than ever before, and an increased public support has been obtained in carrying out the protective and constructive work necessary to solve the problem. The Forest Service is formulating as fast as possible plans which will coordinate the various other uses of the National Forests with game conservation. This is especially important in connection with grazing use. In places it is necessary to restrict or entirely prohibit grazing in order to take care of the elk. The most important single situation of this kind is that near the Yellowstone Park.

For several years a study has been conducted by the Forest Service in cooperation with the Biological Survey of the habits of the Yellowstone elk, their requirements, and other matters, knowledge of which is necessary as a basis for a practical program. This program, which was completed during the past year, calls for certain legislative and administrative action. A beginning was made on the administrative phases by imposing added restrictions upon the use by domestic stock of portions of the National Forests adjoining the park. Some lands were wholly reserved and others restricted to limited use by cattle during certain months. A beginning was also made in the progressive exclusion of stock from areas where total exclusion could not be put into effect at once. The program for handling the Yellowstone elk was placed before the public with a view to full discussion and consideration of the proposals for State and national legislative action.

While it may require slight changes and revisions from time to time as conditions alter, it is believed that the underlying principles are essentially correct. The program was approved by the Benevo-

lent and Protective Order of Elks at its last annual meeting, as well as by the leading sportsmen of the country. The study of these herds must necessarily be continued until the working plan is fully established.

The study of the Sun River elk herd in the Lewis and Clark Forest was continued, and an examination of the area used by the Roosevelt elk in the Olympic Forest was made to determine the number of elk in this herd, the range used during the different seasons of the year, and the number and kind of animals that would have to be disposed of annually if it appears that the herd should be maintained at its present size but not permitted to grow larger, on account of lack of suitable feeding grounds to support a greater number without recurring seasons of starvation.

Marked progress was made during the year in bringing together the interests of the States and the Federal Government in game matters. In various instances it has been possible to make State and Federal authority mutually supplementary in accomplishing things difficult for the Government or State working alone.

Roads, Trails, and Other Improvements.

As was stated in last year's report, great care was exercised in the selection of projects to be constructed during the calendar year 1918, to eliminate all which would tend to interfere in any way with the prosecution of the war. Although the amount of work which had been planned was very small and was restricted to projects for which an immediate need existed or where the prosecution of the war would be aided rather than hindered, it developed that the program could not be carried out. Labor was hard to get and efficiency was materially less than in preceding years. The high price of labor and materials forced postponement or reduction of work. Restrictions placed on road materials, mainly cement and steel, delayed construction or made necessary changes in design to utilize products which were locally available. However, a large amount of investigative and survey work was carried on in anticipation of an increased construction program following the end of the war.

The following tabulation shows the number of miles of public roads constructed or improved prior to December 31, 1918, from the 10 per cent of National Forest receipts, the appropriations under section 8 of the Federal aid road act and cooperative funds.

Construction and improvement of roads and trails[1] from the 10 per cent, section 8, and cooperative funds, by States.

State.	Total mileage to Dec. 31, 1918.	Total mileage in calendar year 1918.		
		10 per cent.	Section 8.	Total.
Alaska	21.37	0.16	.....	0.16
Arizona	130.20	2.50	.....	2.50
Arkansas	22.25	1.91	4.50	6.41
California	320.94	58.50	3.50	62.00
Colorado	213.01	33.34	7.00	40.34
Florida	10.00	.....	.....	.....
Idaho	253.11	75.22	1.00	76.22
Kansas	3.40	.....	.....	.....
Michigan	22.20	.....	.....	.....
Minnesota	2.00	.....	.....	.....
Montana	209.49	12.14	4.10	16.24
Nebraska	4.60	.....	.....	.....
Nevada	137.55	.....	1.20	1.20
New Mexico	77.58	3.00	2.98	5.98
Oklahoma	28.00	.....	.....	.....
Oregon	188.84	29.64	1.70	31.34
South Dakota	14.05	.....	.....	.....
Utah	171.85	14.00	14.50	28.50
Virginia	1.50	1.50	.....	1.50
Washington	108.88	30.00	1.70	31.70
Wyoming	78.85	2.75	.....	2.75
Total	[2]2,019.67	[3]264.66	[4]42.18	306.84

[1] Does not include bridge or maintenance work.
[2] Road construction, 1,046.39 miles; road repairs, 842.76 miles; trail construction, 119.52 miles; trail repairs, 11 miles.
[3] Road construction, 77.76 miles; road repairs, 183.90 miles; trail construction, 3 miles.
[4] Entirely road construction.

Immediately upon the cessation of hostilities, plans were made for utilizing as far as practicable all funds available for road survey and construction. This was not only to make up as far as possible for the almost entire stoppage of work during the two years of the war, but, even more, to provide an opportunity for the employment of labor released from war activities and temporarily idle. It was expected that labor would be plentiful and more efficient than in 1918. Actually, however, it has been difficult to obtain a sufficient supply, the quality has not been of the best, and, as a rule, the wage rate has not decreased. The cost of materials has on the whole increased.

In preparing the plans for the calendar year 1919, it was found that as a result of the construction costs being increased almost 100 per cent, the amount of available money, even though almost four years' appropriations were available for use, would be sufficient for hardly more work than could be financed in 1917. The situation was greatly relieved on February 28, 1919, when the Post Office appropriation act was passed. Section 8 of this act appropriates $3,000,000 for each of the fiscal years 1919, 1920, and 1921, for expenditures in cooperation with the proper officials of a State, Territory, insular possession, or county, in the survey, construction, and maintenance of roads and trails within or partly within National Forests, when necessary for the use and development of resources or desirable for the proper administration, protection, and improvement of any Forest. The appropriation is available until expended. Cooperation may be waived by the Secretary of Agriculture under certain conditions for a project located entirely within the Forest boundaries.

For work located in part outside the Forest boundaries, cooperation must be secured.

The provision in the new appropriation act relative to cooperation has made possible the use of money on projects essential to the proper administration, protection, and development of the National Forests for which cooperation could not be secured because the projects were of minor value from the State or county standpoint. That the money could be utilized on administrative and protective roads and trails is equally advantageous, since the normal appropriation for such purposes was insufficient even for the maintenance of roads and trails previously built from the improvement fund.

With the increased funds it was possible to plan for the survey of 1,724.85 miles and construction of 1,643.31 miles, estimated to cost $11,900,360.59. It was expected that $4,407,302.31 of this amount would be obtained from cooperators. Arrangements were also made for a more intensive administrative study of road needs than had been possible or advisable under the smaller appropriations.

To what extent the approved plans for the calendar year 1919 will be executed can not now be determined. Increases in the estimated or actual costs, failure to obtain cooperation, and the difficulty in securing reasonable bids from reliable contractors have acted toward a reduction in the amount of work. The indications are that a large mileage of survey and construction will be completed by the end of the field season and that uncompleted approved projects will largely be under contract for completion during the winter or the construction season of 1920.

The following tabulation shows the projects approved and the liabilities involved during the fiscal year and prior to that time.

Summary of road and bridge projects undertaken to end of fiscal year 1919.

Status of projects.	Number and length of project.[1]										Liability.[2]		
	Roads.						Bridges.	Total (duplications eliminated).			Federal.	Local authority.	Total.
	Survey.		Survey, construction, and maintenance.		Construction and maintenance.		Construction and maintenance.		Miles.				
	Number of projects.	Mileage.	Number of projects.	Mileage.	Number of projects.	Mileage.	Number of projects.	Projects.	Survey.	Construction and maintenance.			
Approved during fiscal year:													
Under agreement	22	507.98	29	508.89	16	384.31	1	67	1,016.87	893.20	$3,528,941.35	$2,892,551.11	$6,421,492.46
No agreement	8	237.50	18	142.60	43	350.53	4	73	379.10	493.13	537,144.87	51,800.00	588,944.87
Total	30	745.48	47	651.49	59	734.84	5	140	1,395.97	1,386.33	4,066,086.22	2,944,351.11	7,010,437.33
Total approved to June 30, 1919:													
Under agreement	29	852.68	65	1,215.23	19	435.03	1	109	2,067.91	1,650.26	4,994,218.67	4,402,024.44	9,396,243.11
No agreement	8	237.50	18	142.60	43	350.53	4	73	379.10	493.13	537,144.87	51,800.00	588,944.87
Total	37	1,090.18	83	1,357.83	62	785.56	5	182	2,447.01	2,143.39	5,531,363.54	4,453,824.44	9,985,187.98

[1] Does not include 10 per cent projects completed prior to Jan. 1, 1919.

[2] Does not include small administrative cooperative roads and trails; see text.

In addition to the projects shown in the above tabulation, $36,700 of the 10 per cent fund and $650,000 of the Post Office act fund was allotted to the various States for expenditure upon miscellaneous small projects needed for the administration, protection, or development of the Forests.

At the beginning of the fiscal year there was available for road and trail construction on the National Forests $3,857,178.69, derived as follows:

Agricultural appropriation for the construction and maintenance of permanent improvements	$400,000.00
Ten per cent appropriations for the fiscal year 1919	350,533.75
Unexpended balance of 10 per cent appropriations preceding years	302,801.39
Appropriations for the fiscal year 1919 under section 8 of the Federal aid road act	1,000,000.00
Unexpended balance of section 8 appropriation for preceding years	1,803,843.55
Total	3,657,178.69

From the appropriation made available by section 8 of the Post Office appropriation act of February 28, 1919, $3,000,000 was made immediately available. The unexpended balance in this fund on June 30, 1919, was $2,966,939.41, showing an expenditure of $33,060.59. The unexpended balance for the 10 per cent fund on the same date was $374,289.51 and for the section 8 fund $2,296,499.18, showing an expenditure from these funds of $279,045.63 and $507,344.37, respectively.

The following tabulation shows the additional amounts available on July 1, 1919, for National Forest road and trail work. The 10 per cent fund must be spent within the State from which National Forest receipts were obtained, and can not be expended outside of the Forest boundaries. Cooperation is not essential. Cooperation must be secured before any section 8 money can be expended; but projects need not be located entirely within the National Forests. With the exception of the amount set aside for administrative expenses, for the purchase of equipment, and for increasing the apportionment to States, the entire yearly appropriation is apportioned to separate States and groups of States and can not be diverted to different States except under extraordinary conditions. The appropriation made available by the Post Office appropriation act of February 28, 1919, and commonly termed the Federal Forest road construction appropriation, may be spent for projects located within or partly within the National Forests of any States. The provision relative to cooperation has already been explained. Tentative apportionment of the appropriation is made on the basis of the relative need of road development and of the most important road projects in the several States, and determination is made of the conditions upon which any project will be approved. If the conditions are not met, the money tentatively set aside for any project is available for use elsewhere in the State or in some other State.

Amounts available for roads and trails from new appropriations available for expenditure on July 1, 1919.

State.	10 per cent.	Section 8.	1920 Federal Forest road construction.	State.	10 per cent.	Section 8.	1920 Federal Forest road construction.
Alaska	$10,182.71	$46,717	$29,500.00	Alabama	$49.23		
Arizona	45,261.18	54,311	117,371.00	Georgia	419.99		
Arkansas	6,625.55	10,102	53,000.00	Maine	178.60		
California	51,703.89	140,297	284,865.00	New Hampshire	1,972.01		
Colorado	46,019.59	63,541	215,385.33	North Carolina	2,223.78	$27,684	$133,000.00
Idaho	46,307.04	104,474	338,039.50	South Carolina	88.15		
Montana	38,017.13	71,481	222,185.00	Tennessee	853.67		
Nevada	12,275.36	19,005	45,212.00	Virginia	1,313.26		
New Mexico	33,864.42	37,684	123,162.50	West Virginia	95.51		
Oregon	46,162.30	131,825	303,871.00	Special fund [1]		100,000	
South Dakota	6,713.76	7,946	20,427.17	Equipment			95,000.00
Utah	27,460.25	39,072	141,437.00	Administrative expenses			155,000.00
Washington	21,909.03	92,153	202,237.50	Unallotted balance			242,307.00
Wyoming	23,420.37	41,379	224,750.00				
Florida	1,630.31	12,329	53,250.00	Total	427,954.75	1,000,000	3,000,000.00
Michigan	58.69						
Minnesota	1,177.70						
Nebraska	1,440.40						
Oklahoma	530.87						

[1] For administrative expenses of Bureau of Public Roads and Forest Service, for purchase of equipment, and for increasing apportionment to States.

Section 7 of the act of February 28, 1919, authorized the Secretary of War in his discretion to transfer to the Department of Agriculture surplus war materials, equipment, and supplies suitable for use in road improvement. Ten per cent of the amount so transferred was made available in the discretion of the Secretary of Agriculture for use in the National Forest road work. While only a very small amount of road equipment, material, and supplies has been received, it is expected that within the coming year great assistance will be given the National Forest work by the transfer of material which would otherwise have to be purchased.

The new construction of improvements of all kinds comprised 328 miles of roads, 833 miles of trails, 885 miles of telephone lines, 78 miles of fire lines, 35 lookout structures, 35 bridges, 284 miles of fences, 510 dwellings, barns, and other buildings, 12 corrals, and 202 water improvements. The above figures include 203 miles of roads, 96 miles of trails, 110 miles of telephone lines, 148 miles of stock fences, 6 miles of fire lines, 1 bridge, and 1 water improvement built in cooperation with communities, associations, and individuals.

The value of all improvements on the National Forests at the close of the year constructed from funds derived from congressional appropriations and the contributions of cooperators is estimated at $8,703,736. Of this amount, $6,466,014, or 74.3 per cent, represents works of communication and protection; $1,935,451, or 22.2 per cent, improvements used in administration, and $302,271, or 3.5 per cent, range improvements. The lines of communication within the Forests constructed by or under the direction of the Forest Srevice now total 3,620 miles of roads, 26,840 miles of trails, and 254,00 miles of telephone lines.

COOPERATION WITH STATES.

While the forest fire protective systems maintained by the States in cooperation with the Federal Government have been extending, there has also been a recent greatly increased cost of operation. The appropriation of $100,000 is now very inadequate.

Expenditures from the Federal appropriation, and the expenditures of the States which have entered into cooperative agreements, are shown in the following table. The area protected was much greater than ever before. This was made possible by the fact that the cooperative funds contributed by States and private owners were greater than in 1918. The Federal fund was of course the same as in 1918.

Cooperative expenditures from Federal appropriation and by the States for protecting forested watersheds of navigable streams from fire.

State.	Expenditure fiscal year 1919.			State.	Expenditure fiscal year 1919.		
	Federal.	State.	Total.		Federal.	State.	Total.
Maine	$7,296.73	$125,893.03	$133,189.76	Wisconsin	$4,023.63	$16,261.44	$20,285.07
New Hampshir.	6,554.23	23,218.58	29,772.81	Minnesota	8,807.32	56,519.39	65,326.71
Vermont	2,217.62	2,158.67	4,376.29	South Dakota	282.00	4,988.00	5,270.00
Massachusetts	3,294.50	32,781.52	36,076.02	Montana	2,499.95	8,905.38	11,405.33
Rhode Island	92.25	4,097.53	4,189.78	Idaho	4,565.34	46,229.73	50,795.07
Connecticut	1,025.00	5,217.10	6,242.10	Washington	9,692.63	37,162.26	46,854.89
New York	7,221.98	117,131.08	124,353.06	Oregon	10,210.16	24,966.72	35,176.88
New Jersey	1,968.90	20,743.92	22,712.82	Administration and inspection	7,140.49		7,140.49
Maryland	2,524.65	3,819.95	6,344.60				
Virginia	2,725.34	3,259.83	5,985.17				
West Virginia	4,005.00	9,140.40	13,145.40	Total	99,921.38	625,445.54	725,366.92
North Carolina	1,207.16	2,433.77	3,640.93	Unexpended balance	78.62		
Kentucky	2,429.00	5,538.22	7,967.22				
Louisiana	2,581.00	9,451.83	12,032.83				
Texas	3,276.09	4,609.20	7,885.20	Appropriation	100,000.00		
Michigan	4,280.50	60,917.99	65,198.49				

An agreement entered into with Rhode Island made that State the twenty-third to enter into cooperation. Toward the end of the fiscal year California requested cooperation, but the agreement had not been completed when the year closed.

Protection from forest fires is the first essential to forest conservation. Without an organized and efficient system, such as can be maintained only with adequate regular appropriations, the forests can not be made safe. No better proof of this could be given than the situation which arose in Minnesota in the fall of 1918, when a large number of relatively small fires burned for weeks because of lack of men and equipment to extinguish them, and finally came together in five large conflagrations, according to the State Forester, which in the aggregate swept over not less than 200,000 acres, destroyed property worth about $25,000,000, and caused a loss of more than 400 lives. Estimates based on forest fire statistics collected in cooperation with State and private agencies indicate that in the calendar year 1918 not less than 25,000 fires occurred, with an area of fully 10,500,000 acres burned over and a financial loss in timber, young tree growth, and improvements of about $40,000,000. Railroads caused approximately 18 per cent of the fires, brush burning and campers each 13 per cent, lightning 10 per cent, incendiaries 9 per cent, miscellaneous causes 7 per cent, lumbering 5 per cent, and unknown causes 25 per cent.

The States of Alabama, Florida, Georgia, Idaho, Illinois, Maine, Massachusetts, Montana, New Hampshire, North Carolina, Tennessee, and Texas received assistance during the year in formulating forest policies, drafting forestry laws, and the like.

RESEARCH.

INVESTIGATIONS IN FOREST PRODUCTS.

From many standpoints the fiscal year 1919 was the most important in the history of the Forest Products Laboratory. Not only were many of the research projects started earlier in the war brought to a productive conclusion, but the peace-time application of their results was aggressively undertaken through widespread dissemination of the information and through personal contact with the wood-using industries.

During the first months of the year the laboratory was engaged exclusively on special war problems. Cooperation with the various bureaus of the War and Navy Departments which had provided special allotments was at its height, and requests from these departments had become increasingly specific. After the armistice was signed it was necessary to reduce the staff from 458 to approximately 300 persons and to discontinue some of the less important investigations. In accord with the desires of the War and Navy Departments, however, the more important projects which were nearing completion, or which were of special value, were continued. A number of new research projects were begun, but the year's accomplishments were, primarily, the outgrowth of fundamental research begun earlier in the war or prior to the beginning of the war.

Aircraft problems continued to occupy the position of greatest importance. The large fund of available data on wood, plywood, and glues found direct application in the solution of specific problems arising from time to time in the design of aircraft. Many requests were received from the War and Navy Departments for the development of various aircraft parts which could not well be designed without actual tests. Much of this work developed as a result of the successful design by the laboratory of a plywood wing rib for one of the Army planes.

Ribs for almost a dozen different types of Army and Navy planes were designed and tested by the laboratory and gradually improved to the point of maximum strength and minimum weight. These ribs were, in all cases, decidedly superior to commercial ribs of corresponding sizes. In addition to the specific design of these ribs, general laws governing the types of ribs to use for different sizes were developed, and several excellent types of large ribs perfected.

The design of airplane wing beams presented many complicated problems, and the laboratory was called upon to conduct elaborate series of tests on full-sized members to determine the relative merits of the many different types. The growing scarcity of suitable aircraft woods, demanding closer utilization of existing supplies, made it necessary to develop types of built-up beams which would permit the use of small and short stock. Tests were made upon several hundred beams of a number of different types, and several types were developed to meet the specific requirements involved.

Exhaustive tests were also made upon many different types of beam splices, and their relative efficiency was determined. As an

integral part of these tests, the efficiency of various kinds of hide and casein glue was determined. Later in the year, assistance was requested in the design of a wing beam, or the development of a type suitable for very large machines, with spans of 125 feet or more. Special series of tests were made for this purpose, and a type was developed which embodies sound mechanical principles and is remarkably light for its strength.

Much specific information was needed by the Army and Navy in regard to the struts being used on various machines, and comprehensive tests were made by the laboratory upon various kinds and sizes. These resulted in the development of two noninjurious methods of testing struts, whereby the actual strength of each strut could be determined without injuring it. Machines for the proper carrying on of these tests were also developed, and specifications for the inspection of struts by this means were prepared. This method of test is unique, in that there are no other types of structural members which can be tested to their maximum load without injury. In addition, methods for the calculation of the strength of tapered struts and for the determination of the taper which would give the maximum efficiency were developed.

An entirely different kind of investigation was undertaken by the laboratory to develop a type of strut for extremely large flying machines. A radical departure was made from all accepted types of airplane struts, and a type selected which years of experience in the construction of buildings and bridges had proved to be very efficient in long light columns. This type was then modified to suit aircraft needs, and developed to a point where it was much stronger for a given weight than any other type of strut which has so far been developed. Wind-tunnel tests on models specially constructed for the purpose showed that the air resistance of this type is less than that of any other type so far tested.

Elevator and aileron spars, which are the main structural members of airplane control surfaces, are subjected to a peculiar kind of stress known as combined bending and torsion, and their design has always been a matter of guesswork. In the case of small machines this method of design appeared to be quite satisfactory, but in the design of radically new types of great size need was found for accurate data on the design and also for a better type of spar, which would be both stiffer and stronger for the same weight. Through a unique combination of hollow wood and veneer construction, it was possible for the laboratory to improve the spars to a marked degree, both in strength and in stiffness. As a result of this development, the laboratory was finally requested to design a complete control surface, embodying this new type of spar.

Numerous and varied other aircraft developments were carried out, among them being the development of a flexible plywood for control surfaces and of a special mechanism for the proper operation of these surfaces. This plywood and the control mechanism are in process of being fitted to one of the fastest machines developed during the war.

One of the major lines of research was the determination of the effect of various kiln-drying schedules upon the properties of aircraft woods and substitutes for them. Exhaustive tests have furnished conclusive evidence that under proper control of temperature and humidity kiln-dried material of these species is as strong

as air-dried lumber. They show further that the kiln-drying schedules recommended by the laboratory at the beginning of the war and based upon the incomplete data then available were in every sense dependable and are subject to practically no material changes. Up to the date of the armistice, assistance had been given in the design, installation, and operation of 325 Forest Service water spray kilns installed in 44 manufacturing plants throughout the country, including installations at the Government cut-up plant of the Spruce Production Division, and at the Rock Island Arsenal. At the latter plant a laboratory representative demonstrated that artillery wheel dimension oak, green from the saw, can be kiln-dried with insignificant loss in from 60 to 90 days as against 3 to 5 years of air seasoning. This was contrary to previous commercial experience. Other kilns were designed for use at Government arsenals, aircraft factories, gun manufacturing plants, and vehicle plants. The Signal Corps dry kilns at Vancouver, Wash., were started in June, 1918, under the personal supervision of a kiln expert from this laboratory. The first kiln load of airplane wing beams was taken out on July 16. Thereafter the kilns were continuously operated at full capacity of about 40,000 feet per day until the end of the war. A corps of kiln experts was maintained in the field to assist vehicle, furniture, and aircraft manufacturers in the adaptation and operation of commercial kilns used in war work, and intensive courses of training for Government and commercial dry-kiln operators and inspectors were continued until the armistice was signed.

The total number of laboratory strength tests was brought up to over 300,000. About 23,000 strength tests were completed on 32 species of plywood, to determine the strength variation with different combinations of species, number of plies, and ratios of core to total panel thickness. Many additional tests were made to determine the relative amount of warping of various species of plywood, the bending strength and methods of fastening, the relative strength of rotary, sliced, and sawed veneer, and the shearing strength and shrinkage of plywood. Other tests were made on various aircraft parts of plywood, laminated, and fabricated material, such as engine bearers, struts, landing-gear disks, wing ribs, elevator spars, etc. Determinations were made of the mechanical properties of thin plywood for use as a linen substitute, and the relative efficiency of various types of riveted and scarf joints was investigated.

Tests conducted for the War Department made possible great improvements in overseas shipping containers, and many inspectors were trained in the fundamentals of box construction, for manufacturing and export inspection work. Wood preservative specifications were prepared for the Emergency Fleet Corporation and for the Railroad Administration. To assist the latter in its program of preservative distribution made necessary by the shortage of creosote, substitute preservatives were tested and recommendations as to their use were made.

Studies were completed of the effectiveness of various methods of coating and finishing wood to prevent the passage of moisture. Improved methods of finishing with varnishes were developed, and it was shown that protective coating with thin sheets of aluminum leaf is practically 100 per cent efficient. In an experimental shipment of airplane propellers from this country to France those treated by

the aluminum-leaf process developed at the laboratory were the only ones to arrive in satisfactory condition. This method has been officially adopted by the Army and Navy.

The experimental study of the conditioning and manufacture of airplane propellers began to yield information of great value. At the completion of the study it will be possible to specify accurately the species of wood and the manufacturing conditions for the production of the most efficient propellers for the many kinds of service.

A number of new and greatly improved formulas for making waterproof glues for plywood manufacture were developed. One of these for casein glue shows about double the water resistance of the available commercial casein glues and is very resistant to molds. The specifications of the Army and Navy for all glue and glue ingredients were prepared at the laboratory. Much of the work on glues was carried on for the purpose of preparing these specifications. Several commercial concerns have adopted the laboratory glues in production. Numerous improvements were discovered in plywood manufacture that have also been successfully adopted in production.

There were identified 30,863 samples of wood, including some foreign woods, and many microscopic examinations for decay and defects were made. Information illustrating defects in wood was collected, and an illustrated key for distinguishing true mahogany from so-called mahoganies was prepared for propeller inspectors. Studies were made of the effect of moulds on wagon and airplane woods, and of the effect of steam bending on the structure of wood.

Active work on the value of various woods for paper manufacture was discontinued during the war to devote more time to pressing war problems. However, a reliable method for determining the tearing strength of paper was developed. A recording density hydrometer was invented which will be of considerable use in the control of the soda recovery of sulphate and soda pulp mills, acid making in sulphite mills, mixing in the manufacture of ledger, bank-note, and other fine paper, and in the chemical and textile industries in general. The value of waste hemlock bark from paper mills as a source of tannin was also demonstrated. Methods for the production of soda and sulphate pulps suitable for nitrating and for rendering sulphite pulps suitable for this use were developed.

Shortly after the armistice was signed the Salvage Board of the Ordnance Department requested the laboratory to determine the suitability of second-cut cotton linters and hull fibers for paper manufacture. The War Department had on hand at that time a large tonnage of these linters reserved for the manufacture of nitrocellulose and was seeking the best means of disposing of the surplus. Commercial pulping trials and paper runs made at the laboratory soon demonstrated that second-cut linters and hull shavings can be pulped with decidedly less chemical and bleach consumption than wood, and that they are excellently adapted for the production of high-grade book, writing, blotting, tissue, and other papers. These experiments may well have a far-reaching economic influence on the future of the paper supply of this country. Arrangements have been made for a practical mill trial where the value of this raw material can be demonstrated on a tonnage basis under average mill conditions.

The laboratory cooperated with the Chemical Warfare Service of the Army in gas defense work and developed an artificially dense wood charcoal pratically the equal of coconut-shell charcoal. A

suitable gas-mask filter for the removal of solid particles was evolved and tested. Experiments were conducted also on various phases of gas offense.

The threatened shortage of wood pitch for filling the seams of wooden vessels led to experiments with various kinds of mineral pitches, and an experimental deck is now undergoing exposure tests. Several of the mineral pitches seem to be satisfactory.

The readjustment of the laboratory's work to a peace-time basis has included:

(1) The adaptation and application of the data and information obtained during the war to the Nation's industries on a normal peace-time basis.

(2) Analysis of special reconstruction problems and the extent to which the laboratory could be of assistance in solving them.

(3) Consideration of prewar projects and the advisability of resuming them or of starting new researches which appeared of greater importance from a broad reconstruction standpoint.

An illustration of the peace-time application of research conducted in connection with a specialized war project is found in the work of the propeller section. It was soon seen that the developments worked out in relation to the conditioning of wood and the use and formulas of waterproof glues had a far wider field of application than merely to airplane propellers. Following the armistice, therefore, experiments were started in several different lines of built-up construction where possibilities for the utilization of small pieces and waste material existed. Sets of bowling pins, shoe lasts, hat blocks, wagon bolsters and tongues, and other articles were made of laminated material and tested in actual use. These tests in most instances already indicate that the laminated construction for such articles will be practically as serviceable as solid material.

As a result of the war there has been a very marked stimulation in and acceptance of the value of research in forest products, and the requests for cooperation and assistance which have come to the laboratory from many different industries have more than taxed the organization. It has, in fact, become necessary to decline cooperation in a great many instances on account of the inability of the decreased force to carry on the work. There is now open to the aboratory a tremendous field of research of great economic and industrial value.

Close relations were maintained through an office of Forest Products in Washington with the various branches and offices of the War and Navy Departments located in Washington and needing the cooperation of the forest products organization, and also with the War Industries Board, the War Trade Board, the Shipping Board, the Emergency Fleet Corporation, the British and other Allied commissions, and various commercial organizations and associations having to do with war activities. In this way it was possible to furnish data and information on which immediate decision relating to the purchase, storage, or use of timber could be made. Much assistance was given in the preparation of specifications for making purchases of forest products for construction purposes, vehicles, boxes, airplane material, etc., and in the inspection of timbers for ships, airplanes, and docks. Extensive files covering a wide range of data on forest products were maintained for

quick reference. A large volume of statistical data was furnished for the use of foreign governments. The figures on production and consumption in many instances served as a basis for reaching conclusions on problems of utilization, substitution, and regulation of imports and exports.

After the armistice was signed arrangements were made to continue cooperation with the Bureaus of Construction and Repair and Steam Engineering of the Navy and with the Air Service and Bureau of Ordnance of the Army, and for the completion of many projects which will yield information useful in peace as well as war. Recognition of the fact that the Forest Service is an authoritative source of information on forest products and their uses has put the office in a position to render considerable assistance to various departments.

FOREST INVESTIGATION.

Under "forest investigations" are included a wide range of studies. Some of them have for their purpose better knowledge as to the amount, character, and distribution of our present forests; others concern the demands made upon them for the supply of material of various kinds, probable future demands, and the methods of utilization; and still others seek to make possible better methods of utilization and the most beneficial contribution of our forest resources to the public welfare, through investigations basic to the successful practice of forestry. The studies are therefore partly economic and industrial, in which case they have to do largely with the gathering and interpretation of statistics of production, consumption, present timber stands, and similar matters, and partly woods studies of all the factors which control or affect forest establishment, renewal, composition, rate of growth, and character of material produced.

During the past year the forest investigations have been chiefly those connected with war activities and with the completion of the work started during the war. Many such investigations which were in their midst when hostilities ceased called for completion because of the applicability of their results in the post-war period. Thus the study of the amount of black walnut available for airplane construction and for gunstocks was completed, and a publication prepared dealing with supplies, growth, and management of this valuable species. A summary report was also prepared of the available supplies of the kinds of timber most likely to be used in aircraft construction during peace time. The study of supplies of the most important timber species has furnished a good deal of knowledge of our timber resources which have distinct value as a basis for shaping measures aimed to secure perpetuation of these supplies, pending provision for a complete timber inventory such as is fundamental to the working out of a sound, thoroughly intelligent forest policy for the Nation. The requirements of the Government for forest products, together with the control of production for needs of the country not directly connected with the prosecution of the war, gave a more accurate conception of the broad situation in which we are placed regarding forest products. This, together with inquiries as to the timber situation in foreign countries, afforded a clearer perspective of how far our own forests can be expected to meet future domestic and foreign needs.

A few investigations were undertaken having directly in view the meeting of postwar problems. Because of the importance of Sitka spruce for aircraft production, a study was undertaken of its growth, yield, and management.

Because of the added importance, in view of renewed agitation of the national need for the practice of forestry on private lands and of a comprehensive program for securing the perpetuation of our forest resources through combined public and private action, of accurate data as to the growth and yield of the different types of forest and the costs that may be involved in securing forest replacement, many field measurements were restudied in the light of recent experience and new data were accumulated. While the facts available are sufficient upon which to base a plan for inaugurating a general policy, the actual carrying out of such a policy will demand the prosecution of forest studies more comprehensive and far more detailed than those hitherto undertaken if the plan is to be made to work fully.

Some of the fundamental prewar studies, such for instance as the relation between distribution of the different forest types and the climatic and soil factors that control them, the importance of farm woodlands in the economic management of the farm, studies of the physical, chemical, and biological properties of seed, studies of the causes of forest fires and the liability of different forest types to them, have been renewed and are to be pushed with vigor to completion. As a partial provision for meeting the need for fuller information relating to the proper handling of forests, a comprehensive scheme for forest investigation in cooperation with States and forest schools has been developed.

MISCELLANEOUS.

Thirty-seven new publications were issued. The distribution of Forest Service publications totaled 316,000 copies. About 62 addresses were made, mainly at expositions and upon requests from National Forest users, lumbermen's associations and similar trade bodies, technical societies, and educational institutions. Lantern slides were loaned to more than 208 persons engaged in educational work. These were shown 422 times and to 10,293 persons. Additions to the photograph collection totaled 1,154 and to the lantern-slide collection 1,186; and 924 lantern slides, 29 transparencies, and 472 bromide enlargements were colored. Traveling exhibits of photographs, maps, drawings, and wood samples were loaned to 128 schools and libraries. Through sales, loans, and gifts 4,890 individual photographic prints were made available for outside illustrative purposes.

Additions to the Service library in Washington totaled 765 books and pamphlets. The index of forest literature was extended by entries covering 2,725 books, periodical articles, and manuscripts. Loans from the library totaled 2,883 books and 5,841 periodicals. The 162 branch field libraries now contain 31,602 books recorded in the main library, besides various State and other publications not so recorded.