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WILD LIFE A FOREST RESOURCE AND A FOREST WILD LIFE PROGRAM

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WILD LIFE A FOREST RESOURCE

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BIRDS AND MAMMALS

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WILD LIFE DEPENDENT ON FOREST LANDS

Wild life since the mythical days of Robin Hood has been inseparably associated with the forests in song, story, and in fact. European history records the protection accorded the wild life of the forest that the nobility might have the full enjoyment of the chase. In some parts of Europe at the present time wild life is managed as one of the forest resources. The close association of the forests and game and the specific place given game as a forest resource in European forestry probably goes back to the time when game production was the primary purpose of the forest, and when foresters were in the main gamekeepers.

American history teems with accounts that show conclusively the importance of game as a food supply, as a source of clothing and many other materials needed in the everyday existence of our earlier civilization, and as a source of commercial return. Lacking this great resource of food and materials for livelihood and barter, the westward progress of the pioneers would unquestionably have been greatly retarded. Fur trading was one of the first, if not the first economic activity of the westward movement. The rich value contained in the pelts of fur animals was one of the important commercial attractions that drew the white man into the westward regions. Most species of these fur bearers thrived in the wooded areas.

As industry and agriculture advanced westward the natural ranges of wild life species were more and more restricted to the forest regions until today a great part of our wild life, with the exception of migratory wild fowl and certain upland game birds, is dependent on forest and wooded land in one form or another for all or part of its habitat.

Wild life, from the viewpoint of environment, may be divided into four general classes, viz: forest, range, farm, and water and marsh.

Much forest wild life requires large areas of woodland. In this class are included elk, moose, deer, bear, some species of grouse, turkeys, and some fur bearers and predators. Range wild life includes the plains animals, such as buffalo, antelope, jack rabbits, and some species of grouse and prairie chickens, which for the most part seek the open, and thrive there under natural conditions. Farm wild life includes small birds and mammals and such game species as pheasants, Hungarian partridges, quail, squirrels, and rabbits, which profit by the easily obtained food supply on farms and prefer areas where brush cover and open spaces occur. Migratory wild fowl mostly seek wild coastal lakes and marsh areas for resting places, food, and breeding grounds.

Although specific figures are not available, it is safe to state that the forested and wooded lands of the country provide all or part of the habitat for a major percentage of the remaining wild life, which for the purpose of this report includes birds and those mammals of importance for food, fur, hunting, and aesthetic qualities, and those commonly classed as predators.

The forest is a favorable natural habitat of wild life because, for most species, it furnishes three prime essentials: food, breeding grounds, and protection from enemies and the elements.

Forest and other wooded lands furnish these environmental conditions in whole or in part for all classes of game, fur bearers, and other wild life, except those that frequent the open country and unwooded marshes. In general, the topography and the flora of the wooded lands of mixed growth are most suitable to accommodate a great abundance and variety of animal life. Marginal areas are particularly favorable. Streams, lakes, wooded swamps, open marshes, ridges, and rough mountain areas afford a vast range of climatic conditions, varieties of food, and other factors of environment necessary for a great variety of dependent animal life. The forest mantle provides the cover needed for protection against natural enemies, and the increasing numbers of hunters.

Space limitations will permit the citation of only a few specific examples of forest requirements for wild life. H. L. Stoddard reports as a result of investigations in Georgia that in seed years pine mast is one of the chief foods of quail during the fall and early winter. Longleaf pine cones open rapidly and the seed falls within a 2-week period. Since it sprouts quickly, it furnishes food for only a short time. Loblolly pine cones open slowly and furnish a food supply well into the winter. Stoddard's investigations disclosed that in 1925 pine mast formed 32.5 percent of the quail food during the above period. The food supply is naturally affected by seed years and, when pine seed is not available, quail seek sweetgum seeds, acorns, or, as in the Central States, seeds of legumes which grow in woods, together with field weed seeds, corn, other grains, many wild fruits, and insects. In Northern States pine seeds are less important. Ruffed grouse derive a still larger part of their food from the forest. In addition to tree seeds, this species eats insects and a great variety of buds, leaves, and fruits.

Among the larger game, deer obtain practically all of their food from the forest. An examination of the deer range in Pennsylvania by experts from the United States Biological Survey and the State game commission disclosed that deer food consisted almost wholly

of products of forest land. In the late fall in that State, they fatten on oak and beech mast. During winter they subsist on buds and twigs of most tree species. When food is scarce, especially during periods of heavy snowfall, they subsist largely on laurel or rhododendron and the inner bark of trees. In spring and summer and early fall they eat clover, vetches, weedy plants, berries, and fruits, and browse. Deer are largely species of the forest. They are traditionally a part of the forest, and their existence is dependent upon its presence.

Cover is essential to the existence of wild life. Aldo Leopold, a specialist in game management, in an article in the *Journal of Forestry* for October 1931, entitled "Game Range", says that all animals require from one to four types of cover in their environment. This is essential both for food and protection. Game species of low mobile powers, according to Leopold, prefer as their abiding place an area where various types of cover meet. For example, quail in the Central States are most frequently found where farm woodland and cultivated land adjoin. They require the forest cover for protection from natural enemies and a haven into which they can fly to escape from cats, snakes, and other ground enemies. Gradual reduction in cover by grazing farm woodland in the Central States and by removal of hedgerows and brush on the farms has been an important factor in the serious depletion of the quail in that section. Evidence of this importance of cover is shown by developments, as cited by Mr. Leopold in his *Game Survey of the North Central States*.

Forests and wooded lands have been obstacles over large areas to the encroachments of agricultural settlement, and have thus tended to preserve favorable environmental conditions for wild life, enabling many important species to persist in numbers, where in contrast many plains-dwelling species have been crowded out. Antelope, for example, which once thronged the feeding grounds and watering places of the Great Plains have been reduced to a mere fraction of their former numbers.

Although migratory water fowl, whose principal habitats are marsh and lake areas, are not directly dependent upon the forest, some species find food in forest mast, and further, the water supply for many of the marshes and lakes used by ducks and geese is dependent on maintenance of a forest cover on the headwaters of tributary streams. Thus the forest contributes in an essential way to their well-being.

PRESENT ECONOMIC AND SOCIAL WILD-LIFE VALUES

WILD-LIFE POPULATION

Reliable factual information regarding the full extent of our wild-life resource is sadly lacking. Many States do not have estimates of game population nor reliable figures of kill which might serve as a basis for calculations of population. A few States, where the importance of the game resource is recognized, have compiled considerable data on both population and kill. Such information for the most part pertains to the various species of deer, as these animals are doubtless the most widely distributed and most hunted big game species as well as those most commonly found in parks and preserves. In the West the Forest Service, in cooperation with the

Biological Survey and the State game departments in many States, has for many years made estimates of numbers of various species of game animals on the national forests and has compiled records of kill by species. The Biological Survey has also made independent counts and estimates of game animals in many localities. Such figures for game populations are, of course, estimates only. On the national forests they have, however, been kept for a sufficiently long period to indicate trends in game population.

Certain local situations requiring application of plans of game management have necessitated more detailed counts and estimates. Notable examples are the Jackson Hole elk herd, the Oregon-Nevada antelope herds, and the Kaibab deer. The accuracy of such estimates depends on the size of the areas concerned and the physical conditions obtaining in each locality. Such counts are of inestimable value, not only in the formulation of plans of management for the specific areas concerned but as indicators of game population and probable game forage requirements and capacity under other comparable environmental conditions. It should, however, be borne in mind that such counts or detailed estimates as have been made center around a few well-known species of game animals, principally deer, elk, antelope, and bear, and that nowhere is there to be found any reliable estimate of the existing numbers of small game, birds, or fur bearers, or in fact reliable statements as to what should be the population of such animals and birds or the extent to which they may be developed and perpetuated.

In general the data extant on the quantity and value of wild life give no more than an inkling of the astonishingly large and widespread importance of the resource. Lack of reliable nation-wide data is in itself sufficient to justify a systematic organized effort to obtain comprehensive information regarding our country's wild-life situation. Common sense demands that working plans not only for the development of this resource but for its coordination with broad plans embracing other forms of land utilization must be based on sound, fundamental facts.

Table 1 contains the estimates of big-game population on the national forests by States. The national forests of the Western United States comprise about 75 percent of the total western big-game range. It should again be borne in mind in considering this table that the numbers of animals shown are estimates only, and the figures represent comparative density of game by regions rather than actual densities. It has been demonstrated by experience, in cases where actual counts have been obtained for comparison with previously estimated numbers on the same area, that game estimates are in most instances materially less than actual numbers disclosed by counts. Consequently, the figures contained in the table are considered to be conservative.

Several interesting indications are to be found in table 1, showing the results to be expected in the development and use of the game resource, under a system which provides for multiple use of all forest resources. In the multiple-use management of the national forests game has for many years had a definite place, particularly in the West where there has been for the most part a close coordination of effort between State game departments, the Biological Survey, and the Forest Service. Some species of big game in the national forests

of the West have increased definitely in numbers under this management. The high density of the Pacific-coast region is itself very much lower than that for California alone, where about 65 acres per big-game animal is the average for the State. In the East the figures are equally significant. In the South and Central regions, the acreage per head is high and this indicates the need for a study of the development of the game resource. In Pennsylvania, the sole representative of the Middle Atlantic region where game management has for some time been practiced, the density (chiefly due to the deer population) is nearly as great as that in California.

TABLE 1.—*Estimate of big-game animals on national forests by regions as of December 1931*

EASTERN STATES

Animal	New England ¹	Middle Atlantic ²	Lake	Central ³	South ⁴	Total
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Bear, black.....	880	300	1,789	325	969	4,263
Deer.....	3,945	5,000	20,145	635	11,220	40,945
Elk.....		5	14		475	494
Moose.....	10		2,834			2,844
Mountain sheep.....		2				2
Total.....	4,835	5,307	24,782	960	12,664	48,548
Area per animal ^{5 7}	<i>Acres</i> 102	<i>Acres</i> 69	<i>Acres</i> 70	<i>Acres</i> 958	<i>Acres</i> 244	<i>Acres</i> 136

WESTERN STATES

Animal	Pacific Coast	North Rocky Mountain	South Rocky Mountain	Total	All United States, 1931	All United States, 1926
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Antelope.....	2,030	3,363	7,332	12,725	12,725	6,942
Bear, black.....	23,409	10,785	6,389	40,583	44,846	41,965
Bear, grizzly.....	13	526	208	747	747	814
Deer.....	418,485	118,535	315,765	852,785	893,730	613,750
Elk.....	19,719	24,485	52,181	96,385	96,879	82,478
Moose.....	3	2,044	2,444	4,491	7,335	5,142
Mountain goats.....	4,380	6,882		11,262	11,262	9,418
Mountain sheep.....	472	3,488	7,093	11,053	11,055	11,235
Total.....	468,511	170,108	391,412	1,030,031	1,078,579	771,794
Area per animal ^{6 7}	<i>Acres</i> 83	<i>Acres</i> 195	<i>Acres</i> 109	<i>Acres</i> 111	<i>Acres</i> 112	<i>Acres</i> 154

¹ Only New Hampshire represented.

² Only Pennsylvania represented.

³ Nebraska, Tennessee, and West Virginia.

⁴ Alabama, Arkansas, Florida, North Carolina, Oklahoma, and Virginia.

⁵ Figures on net area.

⁶ Figures on gross area forested land, antelope excluded.

⁷ Areas as of June 1932.

SOCIAL VALUES

In Europe hunting was traditionally the sport of the nobility or of the privileged classes. The American ideal, in contrast to European tradition, is hunting for all who wish to enjoy it. There are several motives and reasons which underlie this traditional American conception of hunting.

The first Americans had to rely on wild game to fill the family larder. The pursuit and killing of game was a vital necessity, and skill in the use of firearms was the natural result. The skilled hunter,

and the "crack shots", had a definite standing in the early American community life. The Thanksgiving turkey came from the wild—unmangled by poor marksmanship. These attributes of the hunter, when hunting was an essential factor of livelihood, have been transmitted more or less to succeeding generations as traditions of American life. They in part inspire the hunting urge today, which, however, is directed primarily for the purpose of sport.

Our early American stock lived in the country. It was essentially rural. The movement to the cities came with later industrial development. The man who moved from the rural district to the city retained the desire for the sport to which he was accustomed. He reverted to it when opportunity arose, and he in turn taught his sons to appreciate and enjoy it.

Additional leisure for the average man, through the seemingly inevitable shorter hours and fewer days of work, will add tremendously to the number of those who seek out-of-doors recreation. Hunting and fishing will attract large numbers of these folk. These sports have an attraction not akin to formalized recreation. Some kinds of hunting especially offer a means of satisfying the human urge for temporary return to the primitive. They offer variety. They demand virility, courage, and fortitude. They are a test of skill, and require arduous endeavor, wherever man pits his skill and endurance fairly against those of the game he pursues. Insofar as a return is made to original methods of hunting, the sporting aspect of hunting is improved and chances for survival of game are increased.

The human need for recreation is given detailed treatment in the section of this report entitled "The Forest for Recreation." Wild life in general affords enjoyment, the opportunity for building health and character, and for increasing scientific knowledge for all who care to pursue as well as for those who care only to observe.

The report of the Senate Committee on Conservation of Wild Life Resources (S.Rept. 1329), estimates that there was during the decade ending in 1930 a 400 percent increase in the numbers of people who enjoy the pastimes of hunting and fishing. The report also contains information collected by a representative of the Southern Newspaper Publishers Association, who, seeking to determine for purposes of publicity the relative news value of hunting and fishing as compared with baseball, football, golf, and tennis, assembled figures available for 14 Southern States. These showed that there were 4,420,876 hunters and fishermen in 1929 against a combined total of 4,916,652 for all other sports mentioned. The report estimates the number of licensed hunters in the United States in 1929 at 7,000,000, and the total of all hunters and fishermen as probably 13,000,000.

The maintenance of satisfactory hunting conditions in the face of so great a demand for hunting privileges will require more and more effective game and land management on all lands usable by game, in consistent relationship to other uses.

ECONOMIC VALUES

This discussion is concerned primarily with positive values of wild life as a whole rather than destructive tendencies of certain species that may require control in any effective wild life program. No attempt has been made to segregate the economic value of wild life

on forest land alone, because of insufficient data. The available figures do show the great importance of the resource. In the past a great deal of thought and effort by biologists and other interested individuals and organizations has been devoted to wild life chiefly from the standpoint of preservation of species and the maintenance of hunting and fishing. Present-day problems of land management are turning the attention of land managers and economists to the present values and potentialities of this important land resource.

The financial burden on individuals and on the public arising from idle lands—principally those of marginal and submarginal agricultural character—and of depleted and devastated lands is constantly increasing. The alleviation of this condition requires that every resource capable of doing so must be made to yield a direct return. Forest wild life is capable of bearing a sizable share of the load. Direct values attributable to it are, (1) income from sale of hunting licenses and other fees, and (2) meat and fur values. Indirect values include, (1) receipts from the sale of hunting and fishing equipment by the manufacturers of arms, ammunition, fishing tackle, clothing, and other outdoor supplies; (2) expenditures of sportsmen for board, transportation, guide, and other local services; (3) annual expenditures of sportsmen and clubs, for hunting and fishing privileges on private lands; and (4) value of wild life, chiefly birds, as destroyers of insects preying on agricultural crops.

Table 2, the data for which has been prepared by W. L. McAtee and F. P. Callaghan, of the Biological Survey, records an annual income to the States of nearly \$10,000,000 in 1930–31 from sale of hunting licenses alone. This represents less than 1 percent of the total annual value attributed to wild life. In many States this license income represents the total outlay of the State for game management and administration. It is that part of the direct annual income from game which is reinvested in the business. A few States supplement this income from the general fund, but, by and large, game management is at present chiefly self-supporting.

That the annual meat and fur value of game is considerable is reflected in the estimated total of more than \$190,000,000 for the whole country, or nearly a fifth of the total annual value of wild life.

TABLE NO. 2.—*Estimate of the annual positive values of wild life*

HUMID AREA—EAST OF THE ONE HUNDREDTH MERIDIAN

State	Direct values			Recreational values			Total
	Meat and fur (14 cents a land acre)	Destruction of insects by birds (22.6 cents an acre)	Fish (44 cents an acre water surface)	Hunters' fees 1930–31 ¹	Spent by hunters (\$25 each) ²	Spent by tourists (13 cents an acre) ³	
Alabama.....	\$4,594,598	\$8,729,736	\$22,879	\$110,530	\$1,989,500	\$4,326,233	\$19,773,476
Arkansas.....	4,706,240	8,941,856	228,096	78,427	1,599,475	4,437,472	19,991,566
Connecticut.....	431,872	820,556	40,832	⁴ 115,988	⁵ 776,525	413,088	2,598,861
Delaware.....	176,064	334,521	114,048	⁴ 3,390	⁵ 44,975	197,184	870,182
Florida.....	4,915,545	9,339,536	1,071,488	119,644	1,205,900	4,881,011	21,533,124
Georgia.....	5,261,760	9,997,344	152,064	85,646	1,204,450	4,930,848	21,632,112
Illinois.....	5,021,452	9,540,760	175,155	239,489	7,582,525	4,714,528	27,273,909
Indiana.....	3,229,632	6,136,300	87,014	279,262	⁵ 7,619,650	3,024,652	20,376,510
Iowa.....	4,980,505	9,462,960	157,977	283,073	⁵ 6,990,725	4,671,430	26,546,670
Kansas.....	7,326,950	13,921,205	108,134	⁴ 131,384	3,265,100	6,835,545	31,588,318

TABLE NO. 2—*Estimate of the annual positive values of wild life*—Continued

State	Direct values			Recreational values			Total
	Meat and fur (14 cents a land acre)	Destruction of insects by birds (22.6 cents an acre)	Fish (44 cents an acre water surface)	Hunters' fees 1930-31 ¹	Spent by hunters (\$25 each) ²	Spent by tourists (13 cents an acre) ³	
Kentucky.....	3,600,217	6,840,413	117,427	74,174	2,122,925	3,364,753	16,119,909
Louisiana.....	4,068,646	7,730,428	872,115	102,469	2,394,225	4,035,699	19,203,582
Maine.....	2,703,792	5,137,204	885,632	113,240	⁵ 2,806,375	2,748,928	14,395,171
Maryland.....	890,713	1,692,355	671,897	115,476	1,552,900	1,025,606	5,948,947
Massachusetts.....	720,294	1,368,559	63,923	291,239	⁵ 2,851,175	687,731	5,982,921
Michigan.....	5,150,208	9,785,395	140,800	⁴ 646,476	7,582,775	4,823,936	28,129,590
Minnesota.....	7,244,876	13,765,265	1,076,838	⁴ 170,052	4,604,225	7,045,542	33,906,798
Mississippi.....	4,154,035	7,892,666	141,644			3,899,168	16,087,513
Missouri.....	6,157,939	11,700,084	195,148	⁴ 244,088	⁵ 4,941,900	5,775,744	29,014,903
Nebraska.....	6,881,996	13,075,793	200,499	⁴ 187,509	⁵ 4,573,975	9,209,408	34,129,180
New Hampshire.....	809,177	1,537,437	87,296	⁴ 136,214	⁵ 1,430,300	777,171	4,777,595
New Jersey.....	673,254	1,270,183	199,936	⁴ 273,004	⁵ 4,831,300	684,236	7,931,913
New York.....	4,269,798	8,112,616	436,480	1,108,605	⁵ 14,523,325	4,093,772	32,544,596
North Carolina.....	4,367,104	8,297,497	1,037,977	177,100	2,701,250	4,361,843	20,942,771
North Dakota.....	6,288,396	11,947,953	184,166	⁴ 45,721	659,425	5,893,638	25,019,299
Ohio.....	2,810,304	5,339,577	84,480	⁴ 456,583	11,389,725	3,414,528	23,495,197
Oklahoma.....	6,219,494	11,817,039	181,068	92,076	2,248,300	5,828,742	26,386,719
Pennsylvania.....	4,016,947	7,632,199	82,790	⁶ 1,095,025	13,410,025	3,754,483	29,991,469
Rhode Island.....	95,603	181,646	50,969	⁴ 19,654	222,625	103,833	674,330
South Carolina.....	2,732,352	5,191,468	139,110	146,706	2,267,850	2,578,284	13,055,770
South Dakota.....	6,887,372	13,086,008	210,355	86,320	1,714,600	6,457,568	28,442,223
Tennessee.....	3,735,155	7,096,794	94,336	68,088	1,130,325	3,496,230	15,620,928
Texas.....	23,510,860	44,670,635	985,036	220,516	2,840,800	22,122,547	94,350,394
Vermont.....	817,510	1,553,269	123,904	61,451	⁵ 1,102,050	795,724	4,453,908
Virginia.....	3,607,475	6,854,202	665,984	239,777	⁵ 3,484,650	3,546,566	18,398,654
West Virginia.....	2,152,371	4,089,505	41,676	⁴ 151,448	⁵ 2,299,050	2,010,944	10,744,994
Wisconsin.....	4,950,937	9,406,781	228,098	157,453	4,293,375	4,664,691	23,701,335
Total.....	160,161,443	304,297,745	11,357,271	7,927,297	136,258,275	155,633,306	775,635,337

ARID AREA—WEST OF THE ONE HUNDREDTH MERIDIAN

State	Direct values			Recreational values			Total
	Meat and fur (4 cents a land acre)	Destruction of insects by birds (13.3 cents an acre)	Fish (44 cents an acre water surface)	Hunters' fees 1930-31 ¹	Spent by hunters (\$25 each) ²	Spent by tourists (13 cents an acre) ³	
Arizona.....	2,913,536	9,687,507	41,113	⁴ 75,395	⁵ 681,725	9,481,139	22,880,415
California.....	3,984,691	13,249,098	236,992	⁴ 423,718	5,358,550	12,950,246	36,203,295
Colorado.....	2,653,614	8,823,368	81,664	218,607	⁵ 2,521,300	8,648,473	22,947,056
Idaho.....	2,133,862	7,095,092	150,374	⁴ 173,446	⁵ 2,219,500	6,979,481	18,751,755
Montana.....	3,742,745	12,444,629	224,153	⁴ 163,122	⁵ 2,374,575	12,230,150	31,179,374
Nevada.....	2,811,417	9,347,963	244,710	⁴ 15,195	147,975	9,209,408	21,776,668
New Mexico.....	3,136,076	10,427,455	36,889	98,541	⁵ 534,875	10,203,148	24,436,984
Oregon.....	2,447,539	8,138,067	307,507	⁴ 225,981	⁵ 1,612,525	8,045,356	20,776,975
Utah.....	2,103,910	6,995,502	790,169	102,428	⁵ 1,174,050	7,071,168	18,237,227
Washington.....	1,711,001	5,689,080	645,145	357,286	⁵ 5,102,125	5,751,366	19,256,003
Wyoming.....	2,498,406	8,307,201	90,112	⁴ 79,051	⁵ 577,225	8,146,444	19,698,439
Total.....	30,136,827	100,204,962	2,848,828	1,932,770	22,304,425	98,716,379	256,144,191

TOTAL, ALL AREAS

United States.....	190,298,270	404,502,707	14,206,099	9,860,067	158,562,700	254,349,685	1,031,779,528
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¹ Includes amounts from combined hunting and fishing licenses but not from fishing only.² Expenditures incident to hunting exclusive of license fees.³ Percentage of tourist expenditures attributed to attraction of wild life.⁴ Seasonal figures 1930-31.⁵ Based on combined hunting and fishing licenses plus hunting licenses.⁶ Returns cover period May 1, 1930, to Aug. 31, 1931.

That those who go in search of game contribute in many ways to business activity throughout the country is shown in the total returns of about \$158,600,000 for hunters' expenditures and \$254,300,000 of tourist expenditures credited to wild-life attraction. Hunters' expenditures include equipment, arms and ammunition purchases and in addition transportation, lodging, food, guide, and other personal expenses. Tourist expenditures are concerned with all of these but arms and ammunition purchases.

The Michigan Department of Conservation reported that hunters spend \$5,000,000 for sundry items. The expenditure for gasoline was estimated at \$500,000.

In Utah data on hunters' expenditures were obtained during a period of regulated deer hunting on the Beaver Ranger District of the Fishlake National Forest. Not including the hunters' time, the average cost per hunter amounted to \$35.65. The total expenditures for 2,542 hunters amounted to \$90,622.30. Only direct equipment costs, transportation, and supplies were included in these figures. They are believed to be quite typical for the State.

In addition, throughout the eastern regions, some private-land owners derive a substantial income from leasing their lands to hunting clubs or from selling hunting privileges to sportsmen. In the southern pinelands, Leopold states (*Journal of Forestry*, 28:321-326), the quail crop has an established market value for leasing purposes of 15 cents per acre per year. In his survey of the Central States, he says that in certain States of this region, preserves are leased for 10 to 15 cents per acre and toll charges of \$1 to \$5 per man-day are received. Such returns from a game crop, would be of tremendous assistance to the landowner in meeting carrying charges.

To the farmer, the dollars-and-cents value of wild life in destroying insects harmful to crops is very difficult to evaluate but without question is enormous. An idea of the value involved is given by W. L. McAtee's figure in table 2 of 22.6 cents per acre in the eastern region and 13.3 cents per acre in the western, or a total value for the United States of \$404,502,707. This amounts to a substantial subsidy for the landowners of the United States.

The values shown in table 2 have been cited not as a strictly mathematical evaluation of the worth of our wild-life resource. They are estimates for greatly fluctuating values and no claims of great accuracy are made for them. But they do serve to indicate its present widespread economic importance as a direct land resource susceptible of expansion and development under wise multiple-use land management.

RELATIONSHIP OF WILD LIFE TO OTHER FOREST USES

Wild life is directly concerned with practically all other forest-land uses. To discuss all these relationships in detail in this report would involve the treatment of a great part of the field of plant and animal biology. It is desired to set forth only a few of the significant facts in which those concerned with forest and game management are becoming more and more interested, as the sciences of forestry and wild-life management develop with increasing knowledge.

TIMBER PRODUCTION AND UTILIZATION

In general it can be stated that those things necessary for the protection of the forest from fire, as well as the application of such

measures as are necessary to keep forest land productive, contribute to the welfare of wild life.

The requirements of game, previously mentioned in connection with habitat, for various types of cover, are directly concerned with silvicultural methods used in cutting, slash disposal, and reforestation. Cutting operations open up the forest canopy and provide food and cover by encouraging the growth of low herbaceous and shrubby vegetation, and succulent sprouts highly relished by various wild-life species. On the other hand, game populations so increased may be expected to diminish gradually as the forests mature and food supply diminishes. Management must seek a proper balance based on the relative importance of each resource in the locality concerned.

For several years after unburned hardwoods are clean cut, sufficient food is available for deer but the shelter, except where mild climate prevails, is inadequate. Either advance growth should be available or maturing timber is needed to provide shelter.

Aldo Leopold, in the article in the *Journal of Forestry* already cited, asserts that in the layout of plantations, the effect of food and cover requirements on deer population should be considered. If the daily cruising radius of a deer is about 2 miles and the seasonal about 15 miles, the planting program should provide the different types of cover sought by them accordingly. His investigations of game in the Central States show that a bird supply on farm wood lots is dependent on the farmer leaving his brush on the ground and preventing destruction of undergrowth which furnishes cover for the birds.

The heavy deer population on forested lands in Pennsylvania has seriously affected certain forest areas, according to Henry E. Clepper in his bulletin entitled "The Deer Problem in Pennsylvania." He shows that protective measures resulted in an increase in numbers of deer in some sections to the extent that in their search for food they destroyed all advanced tree reproduction by browsing, and ate all foliage and twigs within their reach.

GRAZING OF DOMESTIC LIVESTOCK

Probably in no other phase of forest-land management is the interrelation of wild life production and other forest uses so apparent as in the use of the forest range by wild life and domestic livestock.

Measures adopted on the national forests during the past 20 years, resulting in an increase of grazing game animals, and requiring in many instances adjustments between game and domestic stock, have sharply focused the attention of foresters and game specialists upon the need for carefully planned and coordinated use of forest grazing areas.

The outstanding example is on the Kaibab Plateau where an area now comprising about 857,000 acres, was set aside in 1906 as a Federal game preserve, with deer the principal game species. A measure of protection was afforded by the operations of the United States Biological Survey up to 1923 in destroying predators, and conditions were made favorable for the deer in other ways. As a result, deer increased until the forage-producing capacity of the area was insufficient not only for the deer and domestic stock, but even for the deer alone. Notwithstanding a reduction of domestic livestock, to a point where competition with the deer was at a minimum, the continued increase

in deer resulted in great damage to the more valuable forage plants and timber reproduction. By 1929 expert biologists estimated that it would take a minimum of 50 years under practically complete protection to restore the area to its original condition and that the productive capacity had been reduced to a degree which would sustain not more than 5 to 10 percent of the game which it was capable of supporting under proper conditions of normal use. Action has been under way for several years to remedy the situation and the excessive deer population has been reduced. Restoration of properly balanced wild life and vegetative conditions presents intricate problems of biological relationships and management.

There are many other places where action taken primarily for the purpose of game protection has brought results comparable with conditions on the Kaibab, and where the problem, from being one of game protection, has changed rapidly to many problems or a single interrelated problem involving game, livestock, recreation, timber, and other intricate phases of forest-land management.

The Jackson Hole elk herd in Wyoming is an example, known Nation-wide by foresters, biologists, sportsmen, and others interested in wild life, of the need for intensive research and the best obtainable knowledge and skill in solving problems of the relation of game to grazing land use.

Similar problems of concentration of game and its interrelation with domestic livestock grazing arise where grazing game animals are introduced into localities favorable to them. Elk plantings furnish examples of this nature. In 1913 a shipment of elk was made from the Jackson Hole herd to the Sitgreaves National Forest in Arizona. Seventy head of this shipment survived and were liberated in the locality south of Winslow, which had especially favorable environmental conditions. It was estimated in 1919 that there were 350 to 500 head of the animals. At the present time the estimate is over 5,000 head. During recent years damage has occurred to brush and tree growth along the streams. Unlike deer these animals are apparently constantly spreading to new range. The area is used by domestic sheep and cattle. The problem is one of working out the proper relationship, that each may be given its proper weight and place in the scheme of forest-land management applied on the area.

The relation between game animals and domestic livestock is not altogether concerned with particular conditions of concentration or competition between the two. Increasing knowledge of forage requirements for game, the plant species which they select and upon which they will thrive, as differentiated from the plant requirements of domestic livestock, offer excellent opportunities for determining a well-balanced relation between numbers of game and livestock, and of both to timber production under a system of correlated use of forest lands. Correction of current instances of improper balance is a matter of temporary concern. Satisfactory determination of permanent ratios, however, requires additional research and fact finding for a multitude of varying conditions and, in the final analysis, should afford the means of obtaining the best development and use of the game resource in its proper relation to timber and other lines of production. For example, the Forest Service, from information now available, believes that the present deer population on the national forests in Colorado, estimated at about 41,000 head, could, from the

standpoint of forage requirements of both deer and livestock, be increased to approximately 150,000 without interference with livestock or timber production if additional winter range were made available outside the national forests. Similar increases of double the present numbers of deer and development of the wild-life resource are possible on other national forest areas.

Use of forest lands by wild life involves not alone the relationship between wild animals and domestic stock, but concerns also the proper balance between and interrelation of various classes of wild life. Experience in many places has amply demonstrated that the satisfactory status of the natural wild-life population may be disturbed by changes in food and cover conditions that favor one or more species over others, or by special measures provided for the protection of certain species from natural enemies or man. Here again the ultimate goal of land use is not the correction of what may be a temporary condition, but rather the application on a broad scale of principles that will result continuously in a smoothly flowing, properly balanced use for production of timber or other products and uses of forest land and of the various wild-life species which should be included in the objectives of wild life management on the area.

Competition between wild-life species may at times be a vital factor. In the southwestern part of the Sacramento Mountains in New Mexico, on the Lincoln National Forest, wild turkeys are very scarce. They have in fact nearly disappeared from that part of the mountains. On this particular range deer have increased on private holdings and adjacent national forest land to a point where they, together with domestic stock, have destroyed much of the more palatable shrubs and must turn to mast, i.e., acorns and juniper berries which they eat practically as soon as these fall from the trees. The use of the acorns and juniper berries by deer, together with reduction of other turkey feed through overgrazing, destroys the winter forage supply for turkey. In the north end of the Sacramento Mountains deer are not so plentiful and there are great numbers of turkeys.

An instance of competition between elk and deer has been noted on the Sitgreaves National Forest in Arizona, where a deer refuge is located within the elk range. Each winter the elk as they increase in number demand more of the forage along the south exposures of the canyons. In the winter of 1931 elk concentrated on one area, defoliating junipers to a height of about 8 or 9 feet and eating up other forage plants in proportion. Of the mule deer wintering on this range, 16 head were observed this spring (1932) in such poor condition that bones stood out all over their bodies. In the winter of 1931 and 1932 elk took practically all of the juniper within reach on several other areas within this refuge. If this herd of elk is allowed to continue to increase, it will be only a matter of time until it will exterminate the deer as the elk can reach higher and, therefore, can get food after none is left within reach of the deer.

Adequate discussion of the influence of predators in relation to a proper balance in nature by their repressive effect upon excess population of the smaller herbivores, such as mice, rabbits, and squirrels, which feed on forest vegetation, or to dwell on the effect of bird life in limiting destructive insects would require extended treatment. Briefly the relationship in the aggregate is of far-reaching importance in the fundamental management of forest lands.

WILD-LIFE MANAGEMENT

All of the relationships existing between game and other of the various products, uses, and services inherent in forest lands emphasize the extremely fundamental character of the problems confronted in obtaining satisfactory control and balance of the intricate and inter-related natural factors, and in the application of sound plans involving not only game but timber and all other products and uses of forest land.

DEVELOPMENT OF WILD-LIFE MANAGEMENT

Wild-life management as a phase of general multiple-use forest-land management, and especially with respect to game birds and animals, contemplates proper stocking of forest areas with game; removal of the surplus of either sex under proper procedure; the furnishing of suitable food and cover requirements for wild life; the regulation of protection from natural enemies and other injurious factors; fundamental research and fact finding; public education; and other measures that may be necessary to the welfare of wild life in a proper coordination with other products, uses, and services of forest lands. It contemplates the removal of the crop of game and fur bearers in accordance with the principle of sustained yield, which involves continuous production for human benefit, and yields the greatest economic and social return. Management requires cropping and utilization under plans providing for perpetuation and development of breeding stock.

The public mind has yet to be attuned to a full conception of the possibilities of wild-life management. Some people overlook the fact that protection alone may defeat its own purpose. Progress is being retarded even at present by those who are honestly loath to accept or cannot see the application of the principles of wild-life management even on areas where it is an obvious necessity.

This attitude or conception is due to inordinate depletion of wild life through reduced range and cover, lack of proper regulation of kill, and resultant threatened extinction of species and curtailment of suitable hunting. The disappearance of the passenger pigeon and the heath hen, of which there is now one remaining individual; the decimation of prairie chicken and wild duck; the reduction of the buffalo to the status of a park animal; the suppression of the antelope nearly to the last limits of survival—these well-known abuses have left, with lovers of wild life, as an almost indelible impression, the belief that the dominating action to check further depletion must be protection.

Protection was the underlying idea in the original conception of the game refuge, aside from special cases where the purpose was perpetuation of species or other special reasons. It was believed that if refuges could be established permanently that they would become breeding grounds from which game animals, as increases occurred, would drift to adjacent areas and supply such adjacent areas in number sufficient to provide good hunting.

The expected result has not occurred with certain important species. On the contrary, it has been demonstrated that deer especially are very local in their range, and that they will concentrate on their home range in the face of starvation rather than travel to areas a few miles distant where food is obtainable. Over a period of years, however, they will gradually extend their range. This characteristic of deer may limit locally the value of the refuge idea, and has resulted

in overpopulation and in many instances in depleting the forage supply on the refuge. This accentuates the importance of having a system of management which will provide for a game supply on all forest lands susceptible to such use, except in cases where game or wild life of any given kind must be eliminated for specific reasons or for purposes not admitting of wild-life use.

The game policy of the American Game Association proposed at the seventeenth annual game conference in December 1930 was the first general presentation of a plan for systematic game management.

ADEQUACY OF PRESENT PROVISIONS FOR MANAGEMENT

As has already been indicated in the discussion of social and economic values of wild life, the present information as to wild-life populations and annual kill are fragmentary and inadequate. There is much fundamental biological research needed in regard to wild-life interrelationships, breeding and feeding habits of various animals, diseases, etc. German foresters recognize the value of such information. Their management plans as to regulation of kill are based on accurate game counts. The annual kill is carefully regulated, both quantitatively and qualitatively.

Such intensive management would not now be generally practical in this country, where we are concerned with vast areas of land in contrast to the small, intensively managed areas in the German forests. While conditions here are radically different from those in Germany, we also need definite and reliable information regarding our wild life resource upon which to base sound management.

Table 3 shows the distribution of the land upon which wild life abides, according to ownership or control, whether in Federal, State, county, municipal, or private. This diversification of ownership of land by individuals and Federal and municipal governments, coupled with the fact that the 48 different States, with widely varying legislation regarding wild life, claim regulatory power over the wild life within their boundaries, obviously results in a complicated situation having endless ramifications affecting national or local aspects of wild-life management.

TABLE 3.—Areas forest land usable for game management, by type of ownership and region

Region	Federal	State, county, and municipal	Private		Total	Lands owned or leased by States for public shooting grounds ¹
			Farm woodland	Other		
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
New England.....	544,000	852,000	6,400,000	19,638,000	27,434,000	375,000
Middle Atlantic.....	366,000	4,299,000	8,693,000	16,412,000	29,770,000	4,101,000
Lake States.....	3,534,000	4,899,000	14,244,000	37,668,000	60,345,000	4,269,000
Central.....	799,000	327,000	33,438,000	31,495,000	66,059,000	143,000
South.....	3,899,000	535,000	69,750,000	142,684,000	216,863,000	246,000
Eastern United States.....	9,142,000	10,912,000	132,525,000	247,897,000	400,476,000	9,134,000
Pacific coast.....	41,158,000	1,916,000	9,499,000	28,722,000	81,295,000	-----
North Rocky Mountain.....	33,059,000	1,404,000	2,680,000	6,044,000	43,187,000	-----
South Rocky Mountain.....	69,362,000	3,248,000	5,242,000	11,748,000	89,600,000	-----
Western United States.....	143,579,000	6,568,000	17,421,000	46,514,000	214,082,000	-----
Total United States.....	152,721,000	17,480,000	149,946,000	294,411,000	614,558,000	9,134,000

¹ Figures probably very incomplete.

For example, the Forest Service's administration of national forests in 31 States of the Union embraces an area of approximately 140 million acres, not all of which, however, is forested. The net forested area of the national forests is approximately 108 million acres. The regional administrative units of the Forest Service cover all or parts of two or more States. The Forest Service then is in the position of being responsible for the administration and protection of large areas of land involving the proper management of wild life, together with timber and other resources, without having direct control of game except as a final recourse for protection of the land and other resources.

Not only does the Forest Service not have use or control of this wild-life resource, but administrative plans that it develops and which tie in with wild-life management must be shaped and fitted to meet in some degree requirements of State game departments and State legislation. This situation may affect vital administrative measures.

Certain States have ceded the authority to the United States to administer the game on national-forest lands. Georgia, by act approved August 15, 1922; North Carolina, by act approved March 9, 1915; and Tennessee, by act of March 28, 1917, consented to the making by the Congress of the United States or under its authority of all such rules and regulations as the Federal Government shall determine to be needful in respect to game animals, game and nongame birds, and fish in such lands as shall have been, or may hereafter be, purchased by the United States under act of March 1, 1911.

Arkansas, by act of February 9, 1925, consented to the same Federal control of game animals, game and nongame birds, and fish as in the above instances, but limited it to specific counties.

Some States have recognized the value of game to the private landowner and have enacted laws encouraging game management and allowing the private landowner to share in its benefits. Various plans are now being tried out. The "Texas shooting preserve statute" requires the landowner wishing to sell or lease shooting on his land to purchase a license which is renewable on condition that the licensee has enforced laws and kept a record of hunters and kill. State protection against trespassers is not extended to those charging over 25 cents per acre or \$4 per man-day. The Michigan "shooting preserve statute" authorizes on licensed preserves a regulated pheasant kill under a special long season. To qualify under this privilege the owner must release twice the proposed kill under warden supervision and operate the preserve satisfactorily. Under the Williamston plan operating in Ingham County, Williamston Township, Mich., the farmers pool their land resource and issue tickets to members, who may dispose of them as they see fit. The number of tickets to each family represents the number of hunters his land can carry simultaneously. Under the Pennsylvania plan the State leases auxiliary refuges at a nominal rate, and the owners of immediately adjacent land agree to allow public hunting with permission in consideration of State patrol, State restocking, and laws regulating conduct of hunters. Indiana has enacted a tax law of fundamental importance to game, particularly quail. This law encourages the development of ungrazed woodland and extends to registered woodland a flat valuation of \$1 per acre, against which

the usual current local tax rate is applied. There is no yield tax, but the owner must agree not to pasture and must have the area surveyed. These isolated cases indicate the growing appreciation of the value of the wild-life resource and the need for its perpetuation and management.

THE PISGAH NATIONAL GAME PRESERVE MANAGEMENT PLAN

The important requirements of game management have been embodied in the plans of the United States Forest Service for the Pisgah National Game Preserve. The important facts and features of this plan are as follows:

The preserve was created by proclamation of President Wilson, October 17, 1916, on lands which the Government had acquired in January 1915 under the Weeks law from the Vanderbilt Estate. The number of deer on the 98,513 acres now in the preserve was probably less than 1,000 at the time it was established.

In order that the Federal Government might assume sole control of game, the State of North Carolina on March 9, 1915, ceded to the Federal Government the authority to make and administer rules and regulations relative to game, birds, and fish, and Congress on August 11, 1916 (39 Stat. 476), authorized the President to designate areas that should be set aside for the protection of game animals, birds, and fish and provided a penalty for trespass. From January 1915 to October 17, 1916, the acquired lands now forming a portion of the Pisgah National Game Preserve were open to public hunting, and shortly after the preserve was established trespass was bold and frequent. By 1919 law enforcement was very active, and the turning point in trespass came about 1922. The game census for this area shows an increase in deer from 1,000 in 1916 to 5,500 in 1931. The game-management plan states:

Outstanding values as to natural resources of timber, water, and soil, characterize the Pisgah district of the national forest of the same name. The wild-life resources and their management and development are an integral unit of the successful administration of the forest and preserve, which are coextensive. This fact makes it imperative that the wild-life plan be closely harmonized with other plans and objectives. Fortunately, this may be readily accomplished with few compromises.

Briefly, the plan involves stocking depleted game areas; removal of the surplus of any species of either sex on a definite area under an established procedure that includes transfer of live animals to other areas for restocking and hunting; the proper determination of boundaries of the hunting area, seasons, and bag limits; the improvement and maintenance of the capacity of the area to produce forage; intensive studies of the wild life on the preserve in all its aspects; and education of the public from many angles for the purpose of eliminating influences adverse to game management.

This plan contemplates the minimum disturbance of wild life and seeks to preserve a proper balance between the plant life and animal population. The underlying idea is to apply the weight of corrective measures so that desirable species may be favored, as, for example, by the control but not the extermination of predators. The desirable species are to be maintained at the maximum reproductive capacity by removal so far as possible of the less desirable individuals. The

natural fauna is considered adequate in point of variety and abundance to furnish the stocking required.

The plan of wild-life management for the Pisgah National Game Preserve is probably one of the most forward-looking game plans in this country. It embodies many of the essential features of good conservation practice, such as unity of control, the principle of sustained yield, and correlated multiple-use forest-land management.

WILD-LIFE SUPPLY

Table 1, allowing for considerable variation in estimates, indicates wide differences in game supply by broad regions of the United States. Certain species of wild life are unquestionably increasing in an appreciable degree and over considerable areas. The estimated increase in numbers of game animals on the national forests during the period 1926-31, for example, is 40 percent. This increase can be attributed primarily to the practice of good land management over a long period, which has provided the variety of food, cover, and protection essential for game welfare. Better regulation of hunting is provided through the cooperation of the State game departments and the Forest Service than can be afforded to areas of diverse ownership. Many States do not have the finances to provide adequate regulation when such regulation is dependent entirely on State patrol. Another important factor in the management of national forest lands is the technical research, advice, and assistance provided by the Biological Survey.

Outside of the national forests in several States certain species of game are increasing where conditions have been made favorable for them, and regulation has been applied. Elsewhere, and in general, game has without question decreased and is still decreasing on much of the forested area of the country. There are numerous reasons for this condition. Increase of hunters is one. The statement in the report of the Senate Committee on Conservation of Wild Life Resources which notes a 400 percent increase in hunters and fishermen in the decade ending in 1930 has been previously cited. Greater mobility of hunters who, first by automobile and lately by air, can travel great distances to obtain their favorite form of sport, lack of adequate control of hunting, fire, and disease have all played their part. Moreover, notwithstanding the inroads upon game supplies from the above causes, deterioration and destruction of food and cover and other right environmental conditions of habitat have been important factors in still further reducing the numbers of game. Reduction in quail in the Central States and other eastern regions is due in large measure to removal of quail cover by clean farming operations and woodland grazing, according to Aldo Leopold. In this region agriculturists have exhorted the farmer to clean up his farm, brush, and fences, plow up hedgerows, and clear away brush from farm woodlands. This has effectively reduced the quail and grouse population on farms.

Quail in the San Joaquin Valley region of California are generally decreasing in numbers, and the area over which they occur in sufficient abundance is rapidly narrowing, according to men who have observed conditions for many years. This decline in numbers and range is

directly attributable to deterioration of habitat. Quail formerly inhabited the valley in great numbers, and the finest part of their habitat was in the brushy foothill regions where there was abundant food and cover. Overgrazing of these foothill areas has destroyed much of the herbaceous vegetation and low shrubs that furnished not only cover but also quail food. Good land management, restoring the productive capacity of the land for grazing of livestock, would coincidentally restore the conditions favorable to quail.

Good wild-life management on forest lands in the ultimate analysis is simply one phase of good multiple-purpose forest land management, which seeks for the highest quality and quantity output of products, uses, and services. In general the practices that contribute to the perpetuation and development of other products, services, and uses may be made to contribute to the welfare of wild life.

FOREST LAND USED BY GAME

Recent estimates by the Forest Service place the total forest-land area of the United States, in round numbers, at 615 million acres, variously distributed by region and ownership, as already shown in table 3.

FEDERALLY OWNED OR CONTROLLED

The Federal Government owns, or controls, in round numbers, 153 million acres of forest land, or approximately 25 percent of the total area of forest lands in the United States. In the three western regions the Federal Government's share is 67 percent of the total forest land in the West. In the eastern regions the Federal share of forest land is only 2 percent. The importance of these figures lies in the fact that Federally owned forest lands, particularly the national forests and the national parks and monuments, in general constitute the largest and most consolidated areas susceptible of wild-life management, particularly in the West.

Of the Federal area, national forests embrace 107,773,000 acres, or 70 percent; national parks and monuments, 4,420,000 acres, or 3 percent; and the remaining 40,528,000 acres, or 27 percent, is made up of Indian reservations, public domain, and other lands. All of these areas comprise large acreages of protection forest where the forest growth is mainly woodland and chaparral. On the public domain there is no administration of game except such as may be done by the States. Indian reservations, generally speaking, are susceptible of game management. However, on some reservations peopled by primitive Indians, game and fish constitute a relatively important source of food supply to these Indians, whose right to continue to hunt and fish at all times as they have been accustomed to for generations has been guaranteed under treaty provisions. It is understood that as Indians increasingly adopt the white man's practices they do not rely on game for food so much as formerly. In the western regions, 26,311,000 acres are in game refuges, Federal game preserves, and other areas wholly or partially closed to hunting.

These great acreages of Federal forest land, most of which is well consolidated in extensive tracts, offer the very finest opportunity in the country for the development of the wild-life resources for public benefit. The environmental conditions for game and other wild life are of the best. All of this land except the public domain areas

is under management for one purpose or another, some of it with the primary objective of wild-life conservation. Where the timber resource is a principal objective, such management in the main is beneficial to the welfare of wild life. In the national parks wild life is one of the important attractions. The development of the wild-life resource on all of these Federal lands, including parts of the public domain in its proper relation to other resources and use values, will add materially to the public benefits, social, as well as economic, derived from their management.

STATE, COUNTY, AND MUNICIPAL OWNERSHIP

The nearly 17½ million acres of State, county, and municipal forest lands amounting to 3 percent of the total forest area, of which roundly 11 million acres is in the Eastern and 6½ million in the Western United States, include many areas used especially for wild-life purposes, and most of the areas utilized for wild life in parks and zoological gardens. In the Middle Atlantic and Lake regions they include large areas of public shooting grounds.

Although comprising only a small percentage of the total forest land area of the country, these areas afford probably the best opportunity, particularly through State forests and parks, for the proper coordinated development of wild-life values. This is especially the case in the East where most of the forest lands are in private ownership, and the management of wild life is thereby a much more complicated problem.

With the increase in area of these lands, owing to reversion of tax-delinquent lands and other forms of State acquisition, the development of the wild-life resource under coordinated multiple-use management will have great possibilities in alleviating the financial burden that such lands entail and in furnishing other public benefits that are afforded by wild life.

PRIVATE OWNERSHIP

Of the privately owned forest land amounting to about 444 million acres, the large acreage in farm woodlands in the Eastern United States, and more especially in the Lake, Central, Middle Atlantic, and South regions (table 3), is particularly significant in relation to the management of small game species such as quail, certain species of grouse, pheasants, and rabbits—the last mentioned of which furnishes shooting, according to the Biological Survey, for by far the majority of the hunters of the United States. Again, the large areas of farm woodland are in the Eastern United States, the area of the greatest concentration of population. Because of their general distribution, these lands to a great degree furnish the forest-land part of the game habitat for these regions. Other lands in private ownership not classifiable as farm woodlands play their part in the same manner, but are probably not as important in this respect because they are not of such general distribution, and because they contain considerable acreages of more or less unbroken timber or woodland, more susceptible of use by big game. Such privately owned lands contain areas available for lease and management by individuals and clubs as private hunting preserves.

Here again recognition of wild-life values and their development under coordinated multiple use land management may be made to

ease the financial burden of the private owner and provide other public wild-life benefits. A happy circumstance also is that good management of the woodland and timber resources will contribute in great degree to the welfare of wild life.

FOREST LAND WHOLLY OR PARTIALLY CLOSED TO HUNTING

Table 4 presents a classification by ownership of Federal forest-land area wholly or partially closed to hunting. These areas, according to the available information, amount to about 29 million acres, or 5 percent of the total forest-land area of the United States. This acreage includes some of the especially valuable game and wild-life breeding grounds of the country, many areas suitable for fundamental research and for obtaining basic facts regarding wild life, areas devoted in part to the aesthetic values of wild life in its natural habitat (notably the national parks and monuments). In addition to the Federal lands, there is an indeterminate acreage of State, county, and municipal forest land which would fall in the same category and which would amount to several million acres.

TABLE 4.—Area of public forest land wholly or partially closed to hunting ¹

Region	National-forest land			National parks and monuments	Total
	State refuges ²	Federal game preserves ³	Game areas by administrative restrictions		
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
New England.....	8, 000			12, 000	20, 000
Middle Atlantic.....	18, 000				18, 000
Lake States.....	837, 000	3, 000			840, 000
Central.....	224, 000	30, 000		111, 000	365, 000
South.....	371, 000	269, 000		110, 000	750, 000
Eastern United States.....	1, 458, 000	302, 000		233, 000	1, 993, 000
Pacific coast.....	5, 107, 000	21, 000	234, 000	1, 122, 000	6, 484, 000
North Rocky Mountain.....	4, 165, 000		2, 192, 000	898, 000	7, 255, 000
South Rocky Mountain.....	9, 968, 000	909, 000	625, 000	2, 167, 000	13, 669, 000
Western United States.....	19, 240, 000	930, 000	3, 051, 000	4, 187, 000	27, 408, 000
Total, United States.....	20, 698, 000	1, 232, 000	3, 051, 000	4, 420, 000	29, 401, 000

¹ Areas given, particularly in West, include some nonforest land. These figures represent the best estimates obtainable from available information.

² There are some State game refuges on forest lands on the public domain for which definite figures are not available.

³ Some areas included here open to regulated hunting.

NOTE.—There are some areas of Federal game preserves on forest land not within the national forests or parks for which figures are not available.

The areas in this table represent forest lands so far as data were available, where special measures have been adopted for game protection and management by the Federal Government, and where hunting in some cases may be allowed to meet management requirements. Areas in national parks and monuments, migratory bird refuges, and other Federal wild-life areas, where hunting is prohibited, are also included.

Some areas of nonforest lands are included, in the West particularly, where sufficient data were not available to afford a satisfactory

segregation. The percentage of this nonforested land is, however, so low that it will not materially affect the totals. The figures exclude, as far as data were available, water areas within the forest areas. No attempt has been made to include private lands posted against hunting, because the actual hunting status of such lands is indefinite; they are often hunted by the owner or others to whom he may extend or sell the privilege. The column "Game areas by administrative restriction" in table 4 includes national-forest lands closed to the grazing of domestic livestock.

The areas in State refuges on national-forest lands are transitional only. In several States some of the areas listed are subject to opening for hunting when conditions justify such action and areas that are now open are subject to restrictions on hunting.

The division of this whole area between the western regions (93 percent) and the eastern regions (7 percent) is in contrast with the distribution of total areas of forest land shown in table 3, where some 65 percent of the 615 million acres of forest-land area of the United States is attributed to the eastern regions. The 27 million acres closed to hunting in the western regions is 13 percent of the total forested land area of these regions, whereas in the East the area closed to hunting is less than 1 percent of the total forested area.

PUBLIC SHOOTING GROUNDS

The ideal and traditional conception of the public shooting ground idea is shooting for all who desire it for sport or other social reasons. Much of the social benefit to be derived from wild life, particularly for the rank and file of the hunting public, is dependent on maintaining large areas of land available for this purpose.

With the passing of public lands into private ownership, especially in the East, the land open to public shooting has become more and more restricted. In many sections of the East the situation is acute and involves all species of game animals. Privately owned lands are often posted against hunting. Many areas are leased by individuals or clubs for exclusive use. Hunting grounds for the ordinary hunter who cannot afford to pay high charges are very limited in many localities.

Several States in the eastern United States, because of the restricted conditions, have taken measures to relieve this situation and are establishing areas for use as public hunting grounds. Table 3 shows the area acquired or made available for this purpose. Considerable progress has been made in the Middle Atlantic and Lake Regions, each having in excess of 4 million acres.

Publicly owned or controlled lands must in the main afford areas available for public shooting grounds. The combined acreage of Federal, State, county, and municipal forest lands in the eastern United States is about 20 million acres, but a considerable part of this acreage, however, is in State, Federal, county, and municipal parks or other areas not usable for public shooting. Altogether there is probably less than 10 million acres of public-owned forest land in the East available for this purpose. This acreage will doubtless be increased as time goes on by reversion of tax-delinquent forest areas and by acquisition for National and State forests or for wild life and other purposes.

Forest land in the West under Federal, State, county, and municipal ownership or control now approximates 150 million acres, out of a total forested area of 214 million acres. This should be ample to take care of the demands for public shooting grounds for big-game species in Western States. A shortage of public shooting grounds in some localities is, however, felt with respect to migratory waterfowl and quail. The situation as regards quail has developed from the depletion caused by overgrazing on public domain and other areas, and a considerable part of the remaining good quail shooting is restricted to private lands. This situation is felt particularly during the low period of the quail-population cycle. The need for public shooting grounds for these upland birds in the West can probably be very adequately met by (1) consolidation and administration of public domain areas, (2) the use of areas recommended for addition to the national forests from the public domain for watershed protection and other purposes, and (3) by development of the game resource on these lands.

The land area available for public shooting will probably never exceed the requirements of the hunting public. Plans for wild life and forest land management should provide the maximum available area for this purpose.

In general, all forest land is susceptible of use by one or more wild-life species having economic or social value. The acreage of forest lands so used must be dependent on the importance attributed to wild life in making an evaluation of land resources as a basis for sound multiple-purpose forest-land management. Without doubt, wild life has sufficient values to be accorded a place in good land utilization on most of the total forested area and has minimum values only in exceptional situations where peculiar local conditions direct management toward special objectives which eliminate the wild life return or reduce it to an inconsiderable amount.

FISHERY MANAGEMENT IN FOREST WATERS OF THE UNITED STATES

By HENRY O'MALLEY, Commissioner of Fisheries

The forested areas of the United States, including public lands under the control of the National Forest and Park Services as well as those privately owned, constitute the most favorable habitat of many of our valuable game fishes as well as the habitat during early life of some of the commercial anadromous fishes such as the salmon and shad. A complete program of forest management, therefore, logically includes a plan for managing the supplies of fish found therein for the public good, assuring not only perpetuation of the supply for the benefit of future generations but wise husbandry permitting development of potential supplies and their fullest use for the benefit of the present.

In the following pages is presented a discussion of the place of modern fish husbandry in the larger program of forest management, prepared in response to a congressional resolution, in which is considered the influence of forests on fish life, the economic and social values of fish in forest waters, present methods available for adequately managing the fishery resources in the public interest, and the means of carrying into effect such a program in forest areas.

INFLUENCE OF FORESTS ON FISH LIFE

That forests have a profound effect on fish and other aquatic life must be evident to even the most casual observer. This influence is far-reaching and affects almost every phase of the life and activities of these animals. In streams, the growth and well-being of fish are affected by the temperature of the water, the speed of the current, the presence or absence of food, the nature of the bottom, the amount of shade and shelter provided by the vegetation on the banks and in the water, and by variations in the water level. In lakes and ponds the relative extent of deep and shallow water is also an important factor.

One of the most obvious effects of forests on stream conditions is in connection with the temperature. Forests tend to keep cool the stratum of air overlying the water and prevent the stream bed and surrounding ground from warming during the day. The result is that in forested regions the temperature of the water is usually considerably lower than in streams exposed to the full force of the sun's rays. Not only is the average temperature lower but the daily fluctuations are much less. The cooling effect of the forest is so pronounced that we have numerous instances of streams in which the temperature is lowered several degrees as a result of flowing through a forested area.

The influence of the temperature on fish is most noticeable in the case of trout, which are classed as cold-water fishes as distinguished from such game fishes as bass or sunfish, which require warmer water. The eastern brook trout thrives best at temperatures between 50° and 60° F. but may for short periods withstand temperatures as high as 75° F. when the water is well aerated. Under similar conditions rainbow and brown trout can survive temperatures of 80° F., and possibly even higher, without apparent injury. This means that in forested areas many streams are suited to trout which if fully exposed to the sun would be uninhabitable by these fish. In many localities as a result of deforestation streams which formerly provided ideal conditions for trout are now unable to support these fish. Others have become too warm for brook trout, which formerly were present in great abundance, but are still suitable for brown or rainbow trout.

Forests usually exert a favorable influence on the supply of food available for fish, but in some instances they may have an opposite effect. As in the case of land animals, fish are, in the last analysis, dependent on plants—especially the algæ—for most of their food. When the trees and shrubs on the banks of a stream are crowded closely together the shade may be so dense as to seriously interfere with the growth of plant life in the water. This, of course, results in a marked scarcity of animals, and we frequently find such areas to be almost devoid of fish. Occasionally dead leaves may accumulate to such an extent in pools and quiet streams as to seriously interfere with the growth of food organisms.

In most cases, however, the effect of forests on the production of fish food is distinctly beneficial. Fallen trees in the bed of a stream or along the shores of a lake furnish support for insects and other aquatic organisms which can usually be found in such places in large numbers. They also provide an ideal shelter for fish. Trout delight to lurk in the cool depths of pools containing fallen logs and branches beneath which they can retreat from their enemies. The impor-

tance of shelter in the daily life of fish is frequently not realized, and yet even a casual investigation will show that ordinarily very few fish are to be found where there are no hiding places near by, even though other conditions may be favorable. This is especially true of trout and bass, and every experienced angler knows that there is no better place to cast for these fish than near an old log or a tangle of submerged branches.

Food and shelter are largely dependent on a stable environment, and there is probably no way in which the forests exert a more profound effect on fish life than in regulating the run-off thus producing a regularity and permanency in lakes and streams not usually found in nonforested regions. It is well known that streams with a gentle current and no great or sudden fluctuations in level have a much richer fauna and flora than torrential streams subject to violent floods. These floods scour out the stream beds and either carry off or destroy great quantities of aquatic organisms. In some instances fish may be killed in considerable numbers, but it is believed that ordinarily it is the invertebrates on which fish feed that suffer the greatest injury.

Following the unprecedented floods in Vermont several years ago, it was found that the streams still contained large numbers of trout but that insects and other invertebrates on which trout feed were very scarce, and for months the fish showed every indication of partial starvation. Severe floods may also destroy the spawning beds and any eggs or fry which happen to be present.

Extensive fluctuations in the water level also result in large numbers of aquatic organisms being left behind and destroyed as the waters recede. Not infrequently fish, especially the younger stages, become stranded in small pools which eventually dry up or become too stagnant for their support. The evil effects of rapidly fluctuating water levels are especially noticeable in the case of hydroelectric developments. In most instances the construction of reservoirs for power purposes would be distinctly beneficial to fish if it were not for the great fluctuations in water levels which are not only destructive to the food but frequently expose the eggs and fry of fish to the effects of wind and sun.

Floods and erosion go hand in hand and the resultant deposits of silt frequently do immense injury to fish life either directly or indirectly. The extent to which fish are directly injured by the presence of large quantities of silt depends largely on other conditions in the water and also on the species of fish concerned. Some species such as catfish and carp are apparently but little affected by roily water, but trout, bass, and other game fishes undoubtedly thrive best in waters containing little silt.

The greatest damage to fish from the presence of silt is undoubtedly indirect. The deposition of large quantities of sediment in a lake or in the bed of a stream destroys great numbers of food organisms and it is not infrequent to find areas which were once rich in food now changed to wastes of barren sand. In fact, there is no type of bottom which produces less food than the shifting sands which are now becoming so common in our streams and lakes as a result of deforestation and cultivation. Vegetation is buried or prevented from obtaining a foothold and pools which once furnished food and shelter become filled and the fish driven elsewhere.

The mere presence of silt in the water has a decidedly detrimental effect on the smaller plants and animals. It has an especially disastrous effect on the plankton which in lakes and quiet streams forms such a large part of the basic fish food. Deposits of this material also form a thin but continuous layer over all objects on the bottom which smothers the smaller organisms and frequently kills large numbers of fish eggs.

In view of these facts there can be no question that the tendency in some quarters to lay all the blame for the scarcity of fish in our waters on overfishing is far from justified. That overfishing is largely responsible is evident, but in all fairness we must concede that the removal of forests and other cover that have such an important function in reducing floods and erosion have had an important part in producing the deplorable conditions we find today.

In order to obtain a proper appreciation of the importance of forests in connection with the production of food and game fishes, it is necessary to consider in some detail the extent and value of waters in forested areas suitable for fish.

ECONOMIC AND SOCIAL VALUES OF FISH IN FOREST WATERS

EXTENT OF STREAMS AND LAKES SUITABLE FOR GAME AND FOOD FISHES

There is no inclusive or complete tabulation of the mileage or acreage of streams and lakes suitable for game and food fishes covering the Nation as a whole. The only data are fragmentary, covering a single State, or, in most cases, limited portions of a single State, or certain specified areas such as the national forests. It is immediately evident that the Great Lakes and other large lakes, as well as the larger river systems such as the Columbia, Colorado, Rio Grande, Mississippi, Missouri, Potomac, etc., represent a tremendous extent of potential fishing waters. However, it is the minor interior waters which actually account for the largest areas for potential fish production, particularly of game forms. When it is realized that small pond farms and reservoirs down to one half acre in area, as well as insignificant streams and brooks throughout the country, can be and are quite productive of some species of fish, it will be seen that a listing of the potential fish habitats is in reality a complete summary of the entire water resources of the United States. Pollution has, it is true, eliminated some of these resources from consideration as fish habitats; but on the other hand there are constantly being created new areas by impounding waters for hydroelectric development, irrigation, flood control, and other purposes.

While it is not possible to make even a valid guess as to the exact acreage or mileage of fishing waters in this country, some concrete examples may be cited merely as an indication of the magnitude of the problem. The United States Forest Service advises that in existing national forests there are listed 58,194 miles of streams and 159,742 acres of lakes which may be considered as potential fishing waters, whatever their value for this purpose at the present time. The State of New York has been foremost in the scientific evaluation of its water resources from a fisheries standpoint. Two watersheds alone in New York State, including a typical forested area within the Adirondacks, have an approximate area in lakes of 54,008 acres and an approximate stream mileage of 6,402 miles. Even in arid and semi-

arid sections as in the Southwest there are sufficient permanent water courses to justify an extensive demand for fish from Federal hatcheries, and the areas to be stocked are constantly increased by the impounding of water for the purposes specified above. It is merely necessary to view States like Maine and Minnesota to realize that a considerable proportion of the total area of these States is actually under water and that the area covered by the thousands of lakes must render its economic return largely as a recreational asset in which the production of fish either for food or sport is probably a major item. The absence of a Nation-wide summary of fishable waters should not cloud the self-evident fact that problems concerning this resource are of national scope and importance.

EXTENT AND VALUE OF ANGLING FOR RECREATION

As there is no evaluation of the actual potentialities of fish production in the interior United States, there is likewise no compilation of valid figures showing the extent and value of angling for recreation. It is possible to cite the value of commercial fisheries in strictly interior waters. Selecting only the commercial fisheries of the Mississippi River and tributaries in order to avoid the confusing factor of the maritime fisheries, it may be said that in 1930 these commercial fisheries had a production value of \$4,385,000, with a yield in pounds of 108,171,000. It is indicated by the investigations of the Bureau of Fisheries in the Mississippi River for a number of years that changes taking place in the river, principally connected with erosion, are having a detrimental effect upon the fish production. The rôle of erosion in a forestry program is discussed elsewhere.

Probably the most complete data on the economic importance of angling are embodied in the Report of the Special Senate Committee on Conservation of Wild Life Resources, Report No. 1329, Seventy-first Congress, third session. This report cites license figures tending to show the public interest in fishing and hunting, and indicates that 13,000,000 people indulge in this sport. Due to the practice of a number of the States in covering hunting and fishing by a single combination license, it is impossible to ascertain the exact number of individuals who took out licenses for the specific purpose of fishing.

However, investigations by the Bureau of Fisheries show that for the period ending June 30, 1932, there were approximately 4,850,000 State licenses issued which carried the privilege of angling. These licenses paid in slightly under \$8,000,000 during this period for the above privileges. Senate Report No. 1329 further states that the value of fishing tackle sold annually is estimated by a trade association as being \$25,000,000.

Further light may be thrown by a citation of the expenditures involved in the maintenance of the supply of commercial and game fishes. There are in operation by the State and Federal Governments and private interests approximately 650 establishments devoted to the propagation of fish. The State and Federal hatcheries require the services of approximately 1,500 employees, and the combined expenditures of both agencies during 1932 were approximately \$4,500,000. The investment of the Federal Government in its fish-hatchery system is approximately \$3,500,000. There were dis-

tributed from the combined hatchery systems over 11,000,000,000 fish and eggs during 1932, of which approximately 1,000,000,000 comprised game species planted in interior waters and directly affected by the relationships of forests to waters. It should further be pointed out that there is an interchangeability between the game fishes and the so-called commercial varieties. With one or two exceptions, all of the so-called commercial varieties of the interior section are taken to some extent by the angler for recreation, and in many instances anadromous forms (fish which migrate from salt water to fresh water for spawning) are likewise sought by the angler.

IMPORTANCE OF MAINTAINING AREAS FOR PUBLIC FISHING

There is at the present time a tendency, possibly more emphatic in connection with game, but readily noticeable as regards fish, toward the exclusion of the public from the more desirable angling waters. Private ownership has not as yet taken an extensive hold in the exploitation of the commercial fisheries of the interior waters. As regards angling, however, private ownership now frequently yields to a favored few the privileges of angling which the country has been accustomed to view as a general public right. Landowners under trespassing laws may in many States prohibit access by the public to waters on their property.

Clubs are leasing extensively desirable stretches of water, which forces the casual fisherman of limited financial resources to travel farther and farther afield for catches which are becoming increasingly unsatisfactory. The importance of this condition in the more thickly populated sections is indicated by the action of the State of Connecticut in leasing private streams or leasing fishing rights for the public. The commendation which has followed this plan in Connecticut and the favor with which it is viewed elsewhere is an example of the lengths to which a commonwealth may have to go in order to insure the perpetuation of a right which was considered inalienable a few years ago. In the State of New Jersey, for example, it is apparent that the major part of public fishing is maintained solely by hatchery operations. In one sense, the purchase of a fishing license in that State is a transaction which has the element of sale of game fish produced by the funds derived from the license income. The hatcheries produce sufficient fish to provide the angler a reasonable chance for a reasonable catch, and the waters are, in a sense, administered by the State for the purpose of providing an expendable resource in the form of game fish. An essential feature of the successful working of this system is an adequate mileage of public waters accessible to everyone who has paid the license fee. Where there is a considerable proportion of the fishing waters restricted to private use the hatchery operations are futile and the whole program fails. Therefore, lands held in public ownership or control for forestry purposes are a double insurance against the ultimate disappearance of public fishing by virtue of the fact that they furnish the maximum natural provision for the survival of fish life and make this resource available to all. Waters leased exclusively for the provision of public fishing, as is the case in Connecticut, represent a charge against fisheries conservation funds. The retention of lands for public forestation or forest-management programs brings the above benefits without cost in addition to the

primary purposes impelling the sequestration of such lands. The public funds derived directly from the angler are thereby available entirely for the purpose of improving angling.

The extensive withdrawal of private waters from public fishing and the growing popularity of angling has greatly increased the burden which must be borne by the waters held in public ownership. Consequently, it is imperative that a system of fishery management be developed which will yield the greatest possible return from the money and labor devoted to the improvement of angling conditions.

FISHERY MANAGEMENT

As a result of the continually increasing drain on the fish population many waters which only a few years ago were well stocked with fish are now seriously depleted. This is especially true in the national forests and parks where the great influx of campers has resulted in serious overfishing in the more accessible streams. Complaints that the fishing is becoming poorer each year are heard on every hand, and it is apparent that unless greater efforts are made to maintain the supply of game fish many of our waters will become so depleted as to furnish little sport for the angling fraternity. There can be no question that the stocking of streams and lakes with artificially reared fish has been of immense value in maintaining the supply of game fishes, but it is evident, in many cases, that this alone is not sufficient to enable us to reap the greatest benefit from our public waters. Since true conservation consists not in hoarding but in using wisely any policy of fishery management must have as its goal the greatest production of fish for the use of the public.

METHODS AVAILABLE FOR CONSERVATION AND UPBUILDING OF FISH SUPPLY

Four well known methods are available for the conservation and upbuilding of our supply of game and food fishes and should enter into any well organized system of fishery management in forest areas. These are: (1) introduction of fish into suitable waters in which they are not native, (2) artificial propagation and stocking, (3) protection from overfishing and (4) improvement of streams and lakes to provide more favorable conditions for fish.

(1) The first method—the introduction of fish into waters in which they did not previously occur—has been frequently utilized in the past, and it is in this field that fish culture has achieved some of its most notable triumphs. There are numerous instances where fish have been introduced into new waters with extraordinary success. The introduction of rainbow and brown trout in suitable waters in our Eastern States is a case in point. This has been followed by the equally successful introduction of the eastern brook trout in many streams in the West. Other game fish such as lake trout and bass have been successfully established in waters both east and west where they were not native.

Possibly some of the greatest achievements in this field have been the successful stocking of streams and lakes in which, due to the presence of impassable barriers, there were previously no fish whatever. Many of these waters now support a large fish population and furnish excellent sport to the angler. In the high mountains of our

Western States there are still many so-called barren lakes which are capable of supporting large numbers of fish if properly stocked. Of course, some of these lakes are for one reason or another not adapted to fish production but this can be readily ascertained by investigation.

(2) The value of artificial propagation in maintaining and increasing our supply of trout, bass, and other game fishes has been so conclusively demonstrated as to require no discussion at this time. There is still, however, much to be done in the development of better and more efficient methods of handling these fish in our hatcheries. There are even greater possibilities for improvement in the methods of disposing of the fish after they leave the hatchery. Undoubtedly in the past a large part of the benefits to be expected from the use of hatchery fish have been nullified by improper methods of stocking. Too often the fish have been planted in waters to which they were not adapted or under conditions where they would be overcrowded or unduly exposed to the attacks of their natural enemies. The proper utilization of artificially reared fish can only be accomplished through the development of a scientific stocking policy directed by experts in this field, which will take into consideration the species of fish best adapted to each individual stream or lake, the number of fish it can support, and the age at which they should be planted to produce best results. These and other factors must be fully evaluated before a definite policy is decided upon.

In most cases artificial stocking should be considered as supplementary to natural propagation and not as supplanting it. Some fish culturists have assumed that artificial propagation is so superior to the natural process that to all intents and purposes the latter may be disregarded. It is believed that this is an entirely mistaken attitude and that the proper function of artificial propagation is to remedy the deficiencies of the natural process.

In some waters it is no doubt true that for various reasons natural propagation is no longer to be considered an important factor and in such cases it is obvious that practically the entire burden must rest on artificial propagation. Fortunately, for the present at least, this is only true in a few localities near large centers of population where anglers are exceptionally numerous or in waters where conditions are no longer favorable for natural spawning. On the other hand, it is evident that in heavily fished waters even though conditions may be favorable for natural propagation the drain on the fish population is so great that natural spawning alone can no longer be depended upon to maintain it at its proper level. Consequently, this deficiency must be made up by the addition of artificially reared fish.

(3) Closely associated with the maintenance of natural propagation is the necessity for various forms of legal protection such as limitation of the daily catch, closure during the breeding season, the setting of size limits to enable the fish to reach sexual maturity and the closure of nursery streams. Unless this is done it is self-evident that in many instances there will be little opportunity for the fish to reproduce naturally. In some heavily fished waters it is becoming apparent that a further curtailment must be made in the bag limit and in the length of the open season if the fish are to continue to maintain themselves.

(4) In spite of these measures it is becoming more and more difficult to maintain a supply of catchable fish, and it is apparent that in order

to get the greatest possible benefit from the utilization of our waters we must have recourse to the principle of stream improvement or control. Although it is evident that the idea of environmental control is sound in theory, there has been very little practical application of the principle in this country. In Great Britain the importance of stream conditioning has long been recognized and notable success has attended its practical application to trout streams.

The purpose of stream improvement is to make the stream a better place for fish to live. Less attention has been paid to lakes, but it is evident that the principle is also applicable to them although its practical application will be more difficult. The basic idea of stream improvement is to ascertain what factors are limiting the abundance of catchable fish and then proceed to overcome or remedy the natural deficiencies. There are probably very few lakes or streams which cannot be improved to some extent, and in many instances it is possible materially to increase the production of fish at comparatively small cost.

While different species of fish frequently differ widely in their requirements in respect to certain features of their environment, there are other fundamental requirements in which most species are in essential agreement. These factors are a stable environment, pure water, adequate shelter for young and old, sufficient food for fish of all ages, and adequate spawning areas. A deficiency in any one of these requirements may result in its becoming a limiting factor even though in all other respects the stream or lake may be able to support a much larger population. If we regard a body of water as a complex biological unit, it is apparent that the correct balancing of conditions is of the greatest importance. The overdevelopment as well as the underdevelopment of any one factor should be avoided if we wish to obtain maximum production. For instance an unlimited increase in spawning facilities or in stocking would throw the fish population out of balance in relation to the food supply. The greatest annual production will be obtained when there are just enough and not too many individuals in relation to the food.

The importance of a stable environment can scarcely be overemphasized. As previously pointed out, streams or lakes with great fluctuations in the water level are much less productive than those in which the level is fairly constant. Anything which will tend to check rapid fluctuations such as the construction of dams or other obstructions which will impound the water or impede its flow will obviously be beneficial to the fish. The importance of beaver dams, for instance, in improving conditions for trout has frequently been emphasized. Obviously this phase of stream improvement is closely linked with the problem of flood control since, in general, any measures which will tend to impede the run-off will be of direct benefit to the fish. Measures which will reduce the volume of flow will also tend to reduce erosion and the deposition of large quantities of sediment, the evil effects of which have already been referred to. The beneficial effects of reforestation in this connection can scarcely be overestimated. Any cover which will reduce the run-off and erosion cannot fail to have a beneficial effect on the streams and increase their capacity for carrying fish.

Needless to say, one of the prime requirements for the production of fish is an adequate food supply, and it is probably true that in the

last analysis this is the most important factor in determining the number of fish which a body of water will support. It is also true that in many streams it is a comparatively simple matter to increase the amount of available food. Logs, boulders, and gravel greatly increase the hard stratum over which insects may crawl and also serve as a support for an abundant growth of algae on which they feed. Weed beds, especially of the submerged type, provide very favorable conditions for the growth of food organisms. Comparatively little is known, however, of the conditions which will promote the growth of many plants and animals utilized as food and much remains to be done before we will be in position fully to utilize the food-producing capacity of natural waters.

Shelter and food should be considered in relation to one another since most shelter devices tend to increase the supply of food. The functions of shelter are primarily for protection, but in fast-flowing streams such devices may slacken the current so that the fish may rest. It also appears that sections of streams or lakes where adequate shelter is present are more attractive to fish. Conversely many sections of streams or lake margins are practically free of fish owing to the absence of shelter. It has been shown recently in the case of Michigan trout streams that long stretches of heretofore troutless waters can be made to yield good catches of adult fish by the installation of proper shelter devices.

Shelter may be provided in many forms and degrees. Almost any obstruction in the water gives some shelter and a few twigs or pebbles may suffice for small fish. In streams shelter can best be provided in connection with pools. Logs and boulders are soon undermined by the combined action of fish and current and furnish excellent places for the fish to hide. Weed beds also provide excellent shelter, especially for young fish. Deflectors or dams so constructed as to cause the stream to undercut its banks are very effective.

A prime requisite for a permanent fish population is the provision of adequate spawning facilities. These, of course, will take different forms according to the species of fish concerned. In the case of trout, gravel beds in spring-fed streams are required, and the lack of such beds is not infrequently a limiting factor. In some instances such beds can be provided by the installation of deflectors which will cause the current to sweep away silt or sand covering old gravel deposits. In other cases it may be necessary to haul gravel for this purpose. Small-mouth bass also require gravel beds near the lake shore or in the bed of streams while large-mouth bass spawn on mud bottoms where the roots of plants can be easily exposed by the fanning action of the fins.

Pollution is usually not an important factor in forested areas, but in some cases sawdust or refuse from mining operations may cause considerable damage. Their effect is much the same as that of silt, being especially destructive to the eggs of fish and to their food.

MEANS OF CARRYING INTO EFFECT A PROGRAM OF FISHERY MANAGEMENT IN THE FOREST AREAS

AGENCIES CONCERNED

There are many agencies concerned with the propagation, distribution, stocking, utilization, and management of the fishery resources of the United States. These include various branches of the

Federal, State, and local governments, but the complete coordination of activities of these agencies in a general program of fishery management is yet to be attained. That Congress is aware of the necessity for unified action in the interest of wild-life conservation from a national point of view is evident from numerous reports upon the subject and from certain pending legislation.

Functions of the various national agencies and their responsibility in the whole field of wild-life conservation have already been discussed in Senate Report No. 1329 mentioned elsewhere. In this report the Senate Committee on Conservation of Wild-Life Resources expresses the conviction that the major part of a successful conservation program in the preservation and replacement of wild life belongs to the various States, but that without active participation and the leadership of the Federal Government the work will fail. The Committee also expresses the view that the Park Service and the Forest Service are the two major Federal Bureaus principally responsible for the preservation and replacement of wild life by reason of the control which they exercise over great areas of the publicly owned land. These two organizations, however, and especially the latter, are concerned with major problems in their own fields frequently of great technical complexity, and they must of necessity depend upon the expert advice and assistance of two other Federal bureaus: for the development of a program of game management, Bureau of Biological Survey; and for fishery management, the Bureau of Fisheries. In an effort more clearly to define and coordinate the functions of these Bureaus, the bill entitled "An act to promote the conservation of wild life, fish and game, and other purposes" (S. 263, 72d Cong.), passed by the Senate December 17, 1931, and now pending before the House of Representatives, provides that the Secretary of Agriculture and the Secretary of Commerce be authorized to provide expert assistance to Federal, State, and other agencies in rearing, stocking, and increasing the supply of game and fur-bearing animals and fish; in combating disease and in developing a Nation-wide program of wild-life conservation and rehabilitation, and to cooperate with such agencies to that end.

Another bill entitled "An act to provide consideration of wild-life conservation in the construction of public works or improvement of projects" (S. 5813, 71st Cong.), passed by the Senate January 26, 1931, requires consideration of the effect of the construction of any public works or improvements upon the replacement and conservation of wild life and requires the Bureau of Fisheries or any other agencies of the Government, whose activities are concerned with conservation, to advise and confer with the construction agency with a view to determining the most appropriate methods for carrying out such construction with the least injury to wild life.

In discussing the functions of the various Government agencies, the Senate Wild Life Committee in Report No. 1329 summarizes the work of the Bureau of Fisheries in connection with the conservation of fishery resources in the following words:

This is the predominating agency for the collection and dissemination of scientific and practical information concerning this resource. The cooperation of other Federal agencies whose projects or operations are such as to affect fish life or to require administration of it by the agencies concerned should be obligatory. Federal agencies in charge of drainage projects or other projects influencing water levels, erosion, or water pollution, should be required to advise

and consult with the Bureau of Fisheries to prevent unnecessary damage to fish life and to emphasize such beneficial results as may occur under proper management from such operations.

The Bureau of Fisheries maintains experimental stations and hatcheries. In cooperation with other Government, State, and local agencies, the Bureau assists in the distribution of fish, the control of inimical or undesirable forms, in research work and educational activities. This Bureau has responsibility toward the maintenance of valuable fish life in waters in the public domain and should be enabled to assign biologists and skilled fish culturists to the national-forest areas to conduct and supervise stream and lake surveys and develop a rational policy, in cooperation with States, of stocking such waters, to give instruction to rangers and others having the direct responsibility of planting fish and in general to further the execution of an orderly national program of replacement.

To further cooperation on fishery management in forest areas a series of conferences between the Forest Service and the Bureau of Fisheries culminated during the past year in a general agreement regarding the responsibilities of the two Bureaus. It was agreed that the Bureau of Fisheries recognize its responsibility in stocking waters in the public domain with food and game fishes, particularly in the national forests and parks. As a part of this responsibility it was recognized that scientific surveys of forest waters are necessary as a basis for drafting a rational program of fish planting. The Bureau of Fisheries accepts responsibility for the production of food and game fishes by artificial propagation through the feeding stage up to the time of delivery of the fish for distribution. At this point the Forest and Park Services receive and distribute the fish produced by the Bureau of Fisheries for planting in natural waters in accordance with their predetermined plan of stocking. In this way it is believed that maximum efficiency in stocking public waters will be attained, for the Forest and Park Services are best prepared to secure and coordinate cooperation in planting operations by individuals and sportsmen's organizations.

It is understood that the various States should at this time be responsible for the enactment and enforcement of laws relating to the taking of fish and the screening of irrigation ditches; moreover, they should cooperate in the artificial propagation of fish where existing Federal services are inadequate, but should not undertake the planting of fish in the public domain except in accordance with the Bureau's stocking policy and with its permission.

To carry out this plan the Bureau proposes the organization of a fishery survey in each of the six national-forest areas of western United States under the direction of a resident biologist in each area, who shall conduct and supervise stream and lake surveys in waters of the public domain and shall develop therefrom a rational policy of stocking such waters with fish. In addition to the research units, skilled fish culturists are to be detailed to each forest region to assist in determining the needs for and organization of rearing and holding ponds, to assist in the planting and distribution of fish from hatcheries, and to give instructions to rangers or others charged with the responsibility for the planting of fish.

It is obviously impossible to complete the survey work under such a program in the 167 national forests and parks in the continental United States in less than 5 years with even an adequate personnel, and under the present circumstances with reduced appropriations the program will be materially delayed. Nevertheless, a start has

been made, and biologists of the Bureau have made surveys during the past 2 years in national park and forest areas in regions nos. 1 and 4, including Montana, Wyoming, and Utah, and in region 5 in California. In view of the importance of maintaining fish life, especially in heavily fished areas adjacent to popular routes of travel, the work should be continued as rapidly as possible.

Fish-hatchery equipment is being extended in these areas. The Bureau maintains two hatcheries expressly for the purpose of stocking national parks and a third in Mount Rainier National Park is nearing completion. A district supervisor of fish culture has been appointed with headquarters at Salt Lake City, Utah, to coordinate all activities in the intermountain region, embracing the greater number of national parks and forests.

In the course of the past year efforts were initiated to attain closer contact with the Bureau of Reclamation, Department of the Interior, since the activities of that agency in constructing irrigation projects, particularly in the Northwest, have a strong bearing on the welfare of important fisheries. In most cases these fisheries may be preserved or subjected to a minimum damage by giving attention to the installation of adequate fish ladders in the dams or by the proper screening of diversion canals for irrigation. The main thought for consideration in connection with both State and Federal agencies working in allied fields is to assure that the various projects shall be actually carried on by the agency best qualified to effectively accomplish the object sought, at the lowest practicable cost.

In view of the fact that Federal agencies assume responsibility for maintaining stocks of fish in waters of the national forests and parks, little need be said with regard to functions of State governments in this connection except as concerns fishery legislation. Federal influence on fishery legislation by States is indirect but generally effective inasmuch as recommendations when offered to the States are unbiased by local interests and are based upon authoritative information. Moreover, the Bureau is authorized to discontinue fish cultural or planting operations in any State if regulations are inadequate or enforced insufficiently to protect the supply of fish in the lakes and streams. The Federal Government directly aids the States in the enforcement of laws prohibiting the sale or interstate shipment of black bass through the recent enactment of a Federal black bass law, and an enforcement officer with several deputies in various sections of the country have been appointed.

It would appear desirable, however, for the agencies responsible for the full utilization of forest areas to have more direct control of the utilization of fish in addition to the mere responsibility of producing and planting the supply. Such control is feasible in closely controlled areas such as the national forests and indeed is an essential feature of effective fishery management as mentioned above. It is not proposed in this connection to abrogate State rights by an extension of Federal authority, but regulative power, such as is exercised in the national parks, might well be extended to the national forests, especially those to be acquired in the future whereby the responsible agency might provide additional protection for threatened supplies of fish in particular waters by still further restricting bag limits, size limits, or closed seasons or areas provided by State laws. The entire question of legal restrictions upon fishing in forest areas

and its relation to the development of a program of fishery management is of utmost importance, but it is believed that no detailed plans in addition to those mentioned above can be made until basic information derived from the surveys now under way by the Bureau is available.

Close cooperation between the Federal Bureau of Fisheries and the State fish and game commissions has been maintained for many years, extending even to pooling of fish cultural resources, exchanging eggs and fry, loaning technical personnel, and distributing and planting fish. A statement of further details along this line appears unnecessary, but the Bureau feels that sentiment in practically all the States is such that when occasion arises cooperative relations of mutual benefit may develop.

The attitude of the large sportsmen's organizations, individual sportsmen, and commercial fishing interests leaves no room for the conclusion that there is an excess distribution of hatchery fish or a surplus of facilities for their production. In view of this situation the operation of both Federal and State hatcheries within any given area cannot fairly be considered a duplication of effort, since too frequently their combined output is not adequate to meet the purpose for which intended, namely, the maintenance of an abundant stock of food and game fishes. In the practical execution of these enterprises cooperative programs may be developed which will insure more effective work by the agencies concerned and prevent overlapping or duplication of effort in some particular area without affecting the essential truth that a vast field is not being thoroughly and adequately covered. This cooperation is largely in the nature of technical management and more effective routine administration. During the past year the Bureau maintained effective and mutually beneficial affiliations with some 22 States. In the majority of cases the States were the principal beneficiaries, which is in line with the original concept of the Bureau's activities to aid and promote State conservation work.

RESEARCH REQUIRED

From the foregoing sections it should be apparent that there are so many technical problems involved in establishing a comprehensive program of fishery management in forest areas, concerning which there is disagreement and controversy or lacking information, that scientific research is essential to the fullest utilization of the natural resources of these areas. The first requirements of a research program therefore include the physical assessment of the forest areas themselves from the point of view of water resources on the one hand, the fish populations present in the various districts, and the demands made upon these natural supplies by the fishermen.

For the purpose of fishery management much more information is required regarding the physical features of the individual forest areas than is available from topographic maps provided by the Geological Survey or the Forest Service. In addition to the actual location of streams and lakes and their dimensions, the fishery officers must have information regarding the flow of streams and their seasonal fluctuations, the character of the stream bed, the extent of riffles and pools, the physiography of the watershed, and the chemical composition and thermal relations of the water. All of these factors influence

more or less directly the biota, both land and aquatic, of the forest water areas.

In addition to these physical features, the fishery officers should have a reasonably complete understanding of the biological conditions in the area subject to management, especially the fauna and flora of the waters themselves. This applies especially to a quantitative as well as a qualitative assessment of the organisms present in the water and available from adjacent land areas, which are suitable as food for fishes.

A further requirement is an assessment of the existing fish populations. The different types of ecological associations among the various species of fish are reasonably well known, and their relation as competitors or predators of the more valuable game fishes in most cases is well established; but the numerical relation of the components of the fish fauna, insofar as they can be readily determined, is of prime importance to the fishery administrator, for the aim of fishery management is to produce from a given area the maximum number of food fishes of the most desirable or useful individual sizes. To assemble this information it is necessary for the fishery biologist to personally survey the waters of each forest area, making detailed observations to determine existing conditions. Such stream and lake surveys are now under way in forest and park areas in the intermountain region by the Bureau of Fisheries as mentioned above.

While conducting these stream surveys, however, it is necessary for the biologist to consider an additional factor, namely, the demands upon the supply by the existing or potential fishery. At present facilities for determining the drain upon the supply are very inadequate. In national parks the number of tourists visiting the areas in the year can be accurately determined. Park officers and forest rangers can also maintain a general check upon the number of fishermen in any given watershed. There seems at present to be no practical method, however, of determining the annual take of fish of any species in the public domain. A completed program of fisheries management should include the furnishing of such figures not only to determine the need for additional production but to provide a more accurate check upon the success of methods devised and applied to increase the yields.

In addition to conducting extensive physical and biological surveys of streams and lakes in forest areas as a foundation for a rational stocking policy in these waters, more intensive studies of the ecological requirements of the fish to be planted are required. These may be called experimental studies in field ecology, for they contemplate the establishment of areas such as individual stream systems or smaller lakes in which controlled experiments may be conducted bearing upon the various factors of production. In such experimental waters means of augmenting the food supply and the value of various food components may be studied. The effect of competing species upon each other may also be determined, proper levels of stocking intensity can be determined, the migratory and breeding habits of the various species can be investigated, and the general effects of each particular system of management can be assessed.

Closely associated with experiments in field ecology are laboratory studies for the purpose of improving hatchery technique. Studies in this field conducted by the Bureau of Fisheries during the past several

years have been successful in improving feeding rations in hatcheries and in combating disease. Notable progress has been made also in demonstrating the effectiveness of using improved strains of breeding stock to increase productiveness and the rate of growth, and to heighten resistance to disease. Improved methods of prophylaxis and treatment of diseases occurring in hatcheries have also been devised. Much remains, however, to be done in these directions, and especially must the principles devised in existing experimental stations be adapted and applied to the particular conditions that obtain in national forest areas of the West. The resident biologist in the forest areas therefore must take active part in these experimental studies, both in the field and laboratory, as well as in the stream survey programs, in order to make proper use of the survey data in the management of the fish supplies. In view of the vast areas to be covered and the diversity of technical problems requiring attention, it should be obvious that no single biologist is capable of carrying on effectively all phases of the work simultaneously, but that sufficient technical personnel should be provided to make division of the work possible, thus assuring the acquisition of the most essential information at the earliest moment.

Obviously many years will elapse before an area so great as that covered by the national parks and forests of the United States is brought under such a system of fishery management as is outlined in the foregoing pages. The program, it is believed, is practical and workable, however, for regardless of the extent of personnel or funds available any progress made in the program of investigation, propagation, stocking, or improvement will have immediate value. Even the information obtained from an area covered by a single season's operations will provide a far sounder basis for fish stocking in that area than exists at present, and within a few years time, with adequate working support, a sufficient area will be brought under scientific control to vastly augment the supply of food and game fishes and to assure the perpetuation of this resource.

A FOREST WILD-LIFE PROGRAM ¹

By PAUL H. ROBERTS, Administrative Officer Branch of Research, in cooperation with the United States Biological Survey

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The social and economic values inherent in wild life on forest land directly affect the national welfare and that of local communities as previously discussed in the section Wild Life a Forest Resource. Such values fully justify a program that will ensure the fullest development and proper use of the wild life resources consistent with the development and proper use of other resources and uses of forest lands. The first step in the formulation of such a program should be the determination of the primary objectives.

OBJECTIVES

(1) The principal objective of a wild-life program on forest lands is to obtain the best development and use of wild life as a product and a service of the land. This includes the development of the full economic potentialities of wild life in proper coordination with other resources and products of forest land. The movement to accomplish this is now only in its initial stages. Results so far obtained strongly indicate that wild life, principally game and fur bearers, will under proper management yield a fair return; that it will ease the financial burden incident to the private ownership of forest lands and particularly of those having low productive values; and that it will materially increase the services from publicly owned lands. Involved in this principal objective are a second and a third.

(2) The predominant use of the wild-life resource is for aesthetic, scientific, and other social purposes, hunting excepted. This objective contemplates the adequate protection of American animals and birds, the maintenance of a proper and in so far as possible a natural balance between the forest vegetation and the forest wild life. Many who use the forest for recreational or scientific purposes do not care to hunt, but the forest for such purposes is incomplete without its wild-life complement.

(3) The traditional and possibly the most generally accepted objective of wild-life management is the preservation to the American

¹ The program affecting birds and mammals is discussed here. The program and requirements affecting fish life are covered in a preceding section, entitled "Wild Life a Forest Resource".

people of the privileges of the hunt, and the social benefits to be derived therefrom. It involves the question of maintaining public shooting grounds or public wild-life areas for those who can not afford private shooting or private estates. It involves the maintenance and use of the wild-life resource for all hunting purposes and for all people. It contemplates the preservation of an American ideal.

(4) The preceding objectives presuppose a fourth—the education of the general public in the recognition of wild-life values and the importance of their proper management. Interest in wild life has heretofore centered largely among sportsmen and wild-life enthusiasts and their organizations, and around social values. There should be a more wide-spread public recognition of all the values of wild life as a forest or other land resource.

REQUIREMENTS TO MEET THE OBJECTIVES

The second step in the formulation of a wild life program for forest lands is the determination of the requirements necessary to meet the objectives named.

WILD-LIFE MANAGEMENT

Wild-life management, particularly of game species and fur bearers, is the first essential in the development of wild-life as a forest-land resource. Only through sound and comprehensive management can the maximum social and economic benefits from wild-life accrue. Serious diminution and depletion of wild-life values have resulted from lack of widespread and proper management of the resource.

The reduced game and fur supplies in many parts of the country, the depletion of quail nearly throughout its range, of prairie chicken in the plains country, and deer and grouse in many States and localities is due primarily to lack of wild-life management.

Management of wild life in broad terms includes its restoration, protection, propagation, care, and regulation of use. The chief distinct problems that wild-life management must meet are:

(1) Restoration and development of game, fur bearers, and other wild life in the Central, Lake, South, and parts of other regions of the East.

(2) Restoration of wild life on areas where depletion has occurred in the West and development of the resource on all forest lands of the West.

(3) Preservation of species now threatened with extinction for scientific and other reasons.

(4) Widespread distribution of game and other wild life and, in so far as environmental conditions will permit, distribution of species to afford hunting and to meet the demands of those classes of people who enjoy other aspects of wild life.

(5) Proper biological balance between species.

(6) A sustained yield of the wild-life crop, particularly game and fur bearers.

UNIFICATION OF WILD-LIFE AND FOREST-LAND MANAGEMENT

Unification of wild-life and forest-land management is the second essential requirement of a wild-life program. Wild-life management is only one phase of broad forest-land management and accordingly

must be correlated with the management of other products and services such as timber, forage, watershed protection, and recreation, and with the management of the land itself. Land management, for example, must provide the natural food, cover, protection, and other environmental conditions upon which wild life is dependent.

Unification of wild-life and forest-land management is made difficult by the fact that in general the control of game is in the State, while the ownership and control of land may be private, State, or Federal. In this respect it differs from most if not all other products, the ownership and control of which go with the land. This situation creates three rather distinct problems depending upon the ownership of the forest land:

(1) On privately owned lands, control of game by the State without unification of game and land management has resulted in lack of consideration of game values and requirements in the handling of much private land. This has led to game depletion by destroying proper environmental conditions for game in some regions by overgrazing and fire. The landholder has had little direct interest in game as a land resource, has not had control over it, and hence in many cases has in great measure failed to provide the conditions necessary for its maintenance or development. He is, however, in the best position to provide the proper environmental conditions. The problem is to develop ways and means of inducing him to do so.

The American game policy proposed by the American Game Association at the seventeenth annual game conference in December 1930, states with respect to the private landholder:

Only the landholder can practice management efficiently, because he is the only person who resides on the land and has complete authority over it. All others are absentees. Absentees can provide the essentials; protection, cover, and food, but only with the landholder's cooperation, and at a higher cost.

With rare exceptions, the landholder is not yet practicing management. There are three ways to induce him to do so:

1. Buy him out, and become the landowner.
2. Compensate him directly or indirectly for producing a game crop and for the privilege of harvesting it.
3. Cede him the title to the game, so that he will own it and can buy and sell it just as he owns, buys, and sells his poultry.

The first way is feasible on cheap lands, but prohibitive elsewhere. The second is feasible anywhere. The third way is the English system, and incompatible with American tradition and thought.

Despite the fact that the second way of inducing the private landholder to practice game management seems the most feasible method of meeting the requirement for unified game and land management on private lands, there are some difficulties in carrying it out. The individual landholder, except possibly in minor instances, can not manage and control game incident to his control of the land. Game is too mobile and individual holdings are often too small in area to afford satisfactory units of management. Under such conditions the solution appears to be in cooperative arrangements between groups of individual landholders and the States, which will provide for the grouping of lands for wild-life management for a common purpose, contributing toward the best utilization of all the land resources. The return to the landholders is through the medium of fees, which may be charged for shooting on their land.

This phase of the problem centers primarily in the East where 85.6 percent of the forest land is in private ownership, as contrasted with

14.4 percent in the West. Experimental projects of this kind are now under way. Impetus should be given to the rapid development of ways of meeting the situation on a broad scale.

(2) On State lands, ownership and control of both game and land should provide an excellent opportunity for unified management. Even here, however, the control and management of the game may be in one State department and the management of State lands in one or more other departments. In certain instances where wild life and other forest-land resources are administered by separate State agencies, the two are in direct competition in the independent acquisition of lands of the same general character, and one or the other, because of greater activity, aggressiveness, or public interest, may be forging ahead. Sound land management would dictate a coordination of objectives and a unification of interests if wild life and other land-resource management are to attain desired results within the State.

(3) On Federal lands, the Federal Government has an interest in the development of the game resource as well as in the development of other resources and uses. Without the same control of game as of other resources, it must in general depend on cooperation with the States in working out measures of benefit not only to game but to other resources, uses, and services of forest land affected by game; for example, timber, forage, watershed protection, and recreation. This is especially true of the national forests which embrace 140 million acres in 31 different States, and are in practically every instance multiple-use forest units.

The working out of satisfactory arrangements with the State constitutes one of the important problems in the correlation of wild life and other land management on the national forests and most other Federally administered forest lands. Correlation of game and land management on national-forest lands in cooperation with a State is exemplified on the Pisgah National Game Preserve in North Carolina where the value of game preserves and need of game management as a demonstration of what might be done on similar areas early resulted in the State ceding jurisdiction of game to the Federal Government and later approving the plans developed for the area.

PROVISION FOR PUBLIC HUNTING GROUNDS

The third requirement in a wild-life program for forest lands is adequate provision for public hunting grounds. One of the best established and most ingrained American traditions is that of the privilege of the hunt. In earlier days public lands covered a vast expanse, wild life was abundant, and the privilege was open to all who would make use of it. With the passing of public lands into private ownership, accompanied by diminishing game supply, restriction of areas available for public shooting was inevitable. Today in the East, with more than nine tenths of the forest land in private ownership, and with closure of great tracts of this area to public shooting, open lands available for those who enjoy the sport and who reap accompanying benefits are entirely inadequate to meet demands.

With increasing restriction of shooting on private land, public shooting grounds are becoming increasingly essential if hunting is to be available to the rank and file and this social value of game is to

be realized. Thorough fact finding and analysis is required to determine the true situation in various regions. It is a matter which should be kept definitely in the foreground if the greatest public benefits are to be derived from the game resource.

Senate Resolution No. 175 specifically mentions among other things leased hunting and fishing rights, the development of which would afford valuable resources for recreation, and improvement in national health, besides giving wealth producing and steady employment to a large number of persons, etc. However, although there can be no question about the leasing of private lands if not contrary to the laws of the States in which the land is located (as discussed in the section "Wild Life a Forest Resource"), the leasing of public lands is of doubtful value. There are no instances available of existing leases on Federal, State, or other publicly owned or controlled land, for such purposes as would furnish the basis for sound judgment as to the probable benefits of such action. It is believed, however, that the objectionable features of a leasing system on public land outweigh any possible financial benefits, that it is not consistent with the best use and development of the game resources for public benefit, and that funds needed for development of the game resource and land management can be obtained more effectively in other ways. It should be possible adequately to meet the costs of such management through the medium of hunting and fishing license fees, the income from which should be sufficient to cover the costs of correlated land management in so far as the wild-life resource is concerned. In the East the provision for public hunting grounds should be an important consideration in any plans of forest-land acquisition.

PROVISION OF ADEQUATE AREAS FOR WILD LIFE

The fourth requirement in a wild-life program involves the forest land itself. It includes adequate area of such lands to provide for: (1) General forest habitat requirements of wild-life species, (2) public shooting grounds, already discussed, (3) special wild-life areas for specific purposes of protection or management, (4) areas devoted to the preservation of wild-life species, (5) areas for all purposes of wild life in parks and zoological gardens. In addition, adequate areas of nonforest land are needed as winter range in order to permit the fullest proper development of the wild-life resource on some forest lands.

All forest lands are usable by one or more wild-life species of social or economic importance. Accordingly any area that is devoted to forestry in the future can be used for wild-life production.

Forest and other land-area requirements of wild life are closely associated with ownership and control of land between the broad classes of Federal, State, and private. One of the broad problems surrounding land requirements for wild life, therefore, is to meet such requirements for the most part under existing and future conditions of tenure, in a way to accomplish satisfactory progress in meeting wild-life objectives.

ON PRIVATELY OWNED AREAS

Privately owned forest lands amount to 444 million acres, or 72 percent of the total of 615 million acres of forest land in the United States. Of this total 150 million acres or 24 percent of all forest land

is in farm woodlands, and 294 million acres or 48 percent is in other private holding.

In the East private ownership comprises about 95 percent of the forest area at present and must therefore be depended upon to a corresponding degree to support wild life. Game birds such as quail, grouse, and pheasants, insectivorous birds, and small game animals, particularly rabbits, are readily sheltered in farm woods and other private holdings. The larger private holdings meet to a considerable degree the requirements for the large game animals, and here the demand for lease or purchase of hunting privileges may be largely met. Where public lands are very limited, it may be possible for the State, through lease or other control of these privately owned forests to establish public hunting grounds, to reserve areas for scientific study, or to arrange for public recreation grounds.

In the West, privately owned forest lands amount to 63,935,000 acres or 30 percent of a total forest land area of 214,082,000 acres. Together with public lands they will meet the general forest-land requirements for wild life.

ON STATE, COUNTY, AND MUNICIPAL FOREST LANDS

The 17,421,000 acres of State, county, and municipal forest lands in the United States—10,912,000 acres is in the East, and 6,568,000 in the West—forms so small percentage of the total forested area as to be relatively unimportant in meeting general forest-habitat requirements of game. However, requirements for wild life in parks and zoological gardens can be met almost entirely on such forest lands. State and county forest lands will also aid materially in meeting total area requirements for special wild life purposes. State and county holdings are now insufficient to provide adequate areas to meet demands for public hunting grounds. Present areas should be used to the fullest possible extent for this purpose and the question should also receive consideration in the management of future enlargements of State and county forest land areas.

ON FEDERALLY OWNED OR CONTROLLED LANDS

Federally owned or controlled forest lands, comprising an area of 152,721,000 acres or about 25 percent of the total forest land area of the United States—143,579,000 acres is in the West, and 9,142,000 acres in the East—are of material importance in fulfilling general forest land requirements of game.

In the West federally owned or controlled lands are adequate for the best development of the wild-life resources; they supply public hunting grounds for all game with the exception of migratory birds; and they meet special wild-life needs, supplying areas to be devoted to the preservation of wild-life species, to wild-life development projects, and to the promotion of aesthetic enjoyment of wild life as in national parks and monuments.

The 26,311,000 acres now used in meeting special needs of wild life is doubtless, subject to adjustments as to location in some cases, sufficient to meet the requirements.

In the East, Federal lands form so small a percentage of the total forest land area as to be incapable of fulfilling area requirements for wild-life on anything like the extensive scale possible in the West,

and additional areas are desirable. Extensive areas are, however, extremely important in meeting in part public hunting ground requirements as well as requirements for special purposes.

Federally owned nonforest lands, in the West particularly should assist in meeting requirements for winter range. There are no satisfactory estimates of the total area needed for this purpose. It would undoubtedly in the aggregate amount to many millions of acres.

ESTABLISHMENT OF STATE GAME COMMISSIONS

The fifth requirement is the establishment in all the States of active, nonpolitical State Game Commissions, having full authority to regulate seasons, bag limits, license fees, closed areas for any purpose, and other phases of game and wild-life management. This would be of material benefit to nation-wide wild-life conservation. In general there is too little effective effort devoted to wild life conservation. Regulation of hunting, prevention of trespass, supervision and patrol of areas closed to hunting, and other measures necessary for wild-life administration are entirely inadequate.

WILD-LIFE RESEARCH

Basic wild-life research as the foundation of management and administration is of fundamental importance as a sixth requirement in a wild-life program for forest lands. The United States Biological Survey under the McSweeney-McNary Act (45 Stat. 699) is carrying on such research regarding the interrelationships of wild life species especially rodents, predacious animals, game animals, fur animals, birds, reptiles, and amphibians. The present program of research includes relationship of game to other forest-land resources, including breeding and feeding habits, maintenance of numbers and harvesting surplus, wild-life values, and many other phases of wild-life biology. Present work should be expanded by bringing the appropriations for this purpose up to the amount authorized by 1938 and by such additional amounts thereafter as may be needed.

The Federal Government through its Biological Survey should be in a position to furnish fundamental facts about wild life to its own units concerned with land management, and to aid the several States in the development of their wild-life resources. This is particularly necessary at this time when acute problems present themselves with respect to making wild lands pay their way, and in the rehabilitation of impoverished areas of constantly increasing size and economic burden.

Several States, notably California, Massachusetts, Michigan, New York, Pennsylvania, and Wisconsin, through their conservation commissions, game departments, or educational institutions, are conducting important studies of various wild-life problems. Private industry has also conducted far-reaching investigations. Notable examples are the Sporting Arms and Ammunition Manufacturers Institute, and the E. I. du Pont de Nemours & Co., Inc. Work of this character, both by State and other institutions and private industry, should be expanded as rapidly as funds can be made available.

EDUCATION

Public education is necessary as a seventh requirement to obtain a general recognition of the values of wild life as a forest-land resource and in accomplishing other objectives of a wild-life program. Lack of sportsmanship in adhering to bag limits, in observance of closed seasons, and in opposing efforts to impose necessary restrictions as to methods of taking and other regulatory measures designed to protect game birds and animals and other wild life, is in many instances due to lack of a real appreciation of game and other wild-life values. Adequate protection from the "poacher", the "sooner", and the "game hog" cannot be entirely achieved by State or Federal enforcement. When the landowner realizes the values in the game on his lands and gets a return therefrom, he will become an important part of the game development and protection forces.