SK
361
C 59

ALBERT R. MANN
LIBRARY

NEW YORK STATE COLLEGES
OF
AGRICULTURE AND HOME ECONOMICS

AT
CORNELL UNIVERSITY

Cornell University Library

SK 361.C59

Forestry in relation to wild life conser

3 1924 003 446 279

mann

Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

<http://www.archive.org/details/cu31924003446279>

FORESTRY IN RELATION TO
WILD LIFE CONSERVATION

A REPORT PREPARED IN THE MINOR FIELD IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE

by

10-11-22
ARTHUR L. CLARK

June 1922

Ithaca

N. Y.

C.T.

322812

Contents

Page

Introduction

General considerations -----	1
Interest in the subject	
The uses of the forest	
Factors determining use	
Conservative use	
Purpose and scope of the paper -----	2
Purpose of the study	
Recreation broadly considered	
Scope of the paper	
Method of presentation	
Acknowledgments	

The Relationships in the Forest Community

The requirements of trees -----	4
Habitats discussed	
The forest community -----	5
Definition	
Relationships	
The primeval forest considered -----	7
Bacteria and fungi	
Higher plants	
Insects	
Amphibians	
Reptiles	
Birds	
Direct influence on vegetation	
Direct influence on animal life	
Mammals	
Attracted by vegetation	
Attracted by animal life	
Man	
Streams	
Influence of the forest on streams	
Aquatic life of the forest streams	
Conditions imposed by civilization -----	13
Forest area reduced	
Factor of value to man introduced	
The functions of forestry	
Direct values of the forest	
Indirect values of forest	
State control of forests	
Reserve areas	
Forestry methods compared to those of nature	
Major premise derived -----	17

Conservation and Recreational Use.

The aims of forestry -----	18
Privately owned forests -----	19
Management to promote wild life	
Value and harvest of the crop	
Size of forest required	
Difficulties encountered	
Forests owned by long lived corporations, or by the State or Nation -----	22
General plan of management	
Reserved areas for special use -----	23
Watersheds	
Streams and lakes	
Roads and trails	
Wild life sanctuaries	
Timber production	
Silviculture on State forests -----	28
Intermediate cuttings	
Reproduction cuttings	
Forest protection -----	31
Fire	
Insects	
Forest management -----	33
Determination of forest use	
Working plans	
Forest policy -----	34
Modern tendencies	
Private forests	
State forests	
Organization of interests	
Need for cooperation	
Formulation of broad conservation policies	
<u>Summary</u> -----	37
<u>Bibliography</u> -----	40

FORESTRY IN RELATION TO WILD LIFE CONSERVATION

Introduction

The increasing use of forests for recreation purposes is creating a widespread and active interest among a large number of persons in the conservation of wild life itself and also of forests. For it is coming to be seen^{that}/only with the aid of the forest can wild life be made to fulfill its proper function in supplying the needs of mankind.

There are three broad uses recognized for the forests; namely; supply of forest products, protection against erosion and regulation of streamflow, and recreation. A combination of these three uses is of course often possible.

The determination of the use to which a particular forest should be assigned, considering all forests as a national resource and, therefore, demanding conservative use, depends on the ability of that forest to supply^{that} in/use the greatest good to the greatest number for the longest time.

In the determination of use, it must be understood that the forest ~~is~~ a complex community of many forms of plant and animal life which may rank as resources in themselves, or by their relationships constitute a combination of resources, or which may exercise an important influence on other resources. It is further evident that the relationships which exist in this society may be upset by the disturbance of any one factor.

No natural resource, however, should be held unused merely for the purpose of maintaining this balance of relationships. The demands for lumber require cutting of the forest. To ensure a permanent supply entails management to this end. The birds and mammals useful as food, game, or for their fur, should be harvested, and the maintenance of their supply assured by management. The fishes of the streams, both game and commercial, are a resource to be used and managed, while the streams, which are influenced by the forests, are necessary not only for fish but for health and industry, and should, for these reasons, be controlled against pollution and flood.

The use of these resources may therefore be assumed to be necessary and, within limitations, justified. But use should be so controlled that there will be a minimum of disturbance to the other factors in the forest community, and that adequate provision will be made for a future and permanent supply. Such treatment constitutes wise or conservative use; it is also conservation in its best sense.

The purpose of this paper is to show that wild life is an integral part of the forest community, to point out some of the important relationships which exist between the forest and the wild life therein, and to indicate how these resources may jointly be used to the greatest advantage, with a minimum of disturbance or loss to either. Its preparation was prompted in part by the increasing interest in the use of forests for recreation, which makes a study of the relationships in the forest community per-

inent at this time. In it, wild life is considered primarily as coming under that use of the forest which contributes to its value for recreation.

The term recreation, in a broad sense, as it has come to be used in forestry literature, includes all the uses that may be made of the forest by those who seek the rest and change of environment which it affords. Thus defined, recreation includes not only the use made of the forest by those who visit it on holiday trips of longer or shorter duration, but as well its use for the restoration of health. Those who frequent the forests are actuated by many motives. Some require elaborate conveniences. Others are impelled by the call that demands large stretches of wilderness, free from roads or other artificial works of man. Those of artistic temperament seek the stimulation that comes from aesthetic appreciation of natural beauty, while a very considerable number of persons are drawn to the forest by their interest in one or another form of sport. It is because the birds and the mammals of the forest and the fish in the forest streams, are more often that of in connection with the recreation that is afforded so many persons by hunting and fishing, rather than in terms of food or fur value, that wild life has come to be classed under the recreational rather than the supply use of forests. This is frankly an arbitrary assignment, dictated by convenience. but it has one justification, namely that when viewed from this angle the perpetuation of wild life assumes more importance than it might have elsewhere, especially when an interest is created that leads to

the reservation of specified parts of the forest as refuges or sanctuaries, particularly during the breeding periods.

This paper deals only with that part of the recreational use of forests that concerns wild life. Further, it confines itself primarily to conditions found in the eastern United States. The conclusions reached are particularly applicable to state owned lands, altho the general principles set forth are pertinent, with limitation or extension, to other conditions. The method followed is to treat the various forms of wild life by groups rather than by specific forms, except where a concrete example seems to be demanded. As regards forestry it proposes to treat only of the broad principles, altho indicating in a general way methods that might be used to secure closer cooperation between the practice of forestry and of wild life conservation.

This paper was prepared at Cornell University under the direction of Professor Ralph S. Hosmer and I wish to record my gratitude to him for the helpful and sympathetic advice and criticism rendered thruout its progress, and to Dr. George C. Embury for his valuable suggestions in regard to the portion dealing with wild life.

The Relationships between the Forest and Wild Life

Trees require for their existence, certain more or less definite conditions of soil, moisture, and climate. The spruce, balsam, American larch, and paper birch are confined to the North

because of climatic conditions. The cypress, limited to the South by climatic factors is further confined to the swamps, by reason of moisture requirements. The pitch pine, tho not necessarily confined to dry sandy plains, exists under those conditions of soil and moisture where few other trees can live.

The requirements of trees may vary with the species and even with the individuals; in some cases, however, the requirements are very definite, and certain trees, or groups of trees, are recognized as characteristic of certain locations. The American larch is recognized as belonging to the swamp, altho it may occur on hillsides; the red cedar is characteristic of hillsides and old pastures, tho it may grow in swampy places.

The conditions required by a given kind of tree create what is termed a habitat for that tree. The northern swamps, for example, provide features favorable to the growth of the American larch, balsam, black ash, red maple and others. The presence of these trees, by adding protection against sun and wind to the original condition of the swamp, create other features which constitute a habitat for other forms of life. By the development of a series of such conditions or consequences, a community of many forms of plant and animal life is created and held together. The forest, then, must be considered as a community of many forms of life.

Plants, by their nature, are confined to a more or less definite habitat and location. Animals are, for the most part able to move about, and can, therefore, be assigned only to a general habitat. Certain forms, however, may be recognized as

belonging distinctly to the forest community. The white pine weevil, wood frog, pileated woodpecker and the beaver may be assigned to this class. Other forms are occasional visitors as the toad, grackle and cotton-tail rabbit, while still others rarely or never enter the forest, in which class may be cited the meadow lark and woodchuck. All degrees of gradation between these broad classes may be found, and there may also be variation in the habits of the individuals in any class.

It is difficult, if not impossible, in our present state of ecological knowledge, to see or appreciate all the conditions which attract the various forms of life to any community. In the forest, however, certain influences of the trees have been determined, or are obvious, of which the protection provided by the forest cover against sun, wind and rain is perhaps the most important to the forest community. The temperature in the forest is also moderated to some extent, depending on the location, type and composition of the forest cover. To the wild life the trees may further provide a measure of protection against enemies, and a supply of food. This may come directly from the trees, as seeds, nuts, bark, or leaves, or indirectly, by the attraction to the forest of animals which serve as food.

Every member of the forest community has some direct or indirect influence on every other member, so that the wild life in turn, has certain influences on the forest trees, either beneficial or harmful. These influences are but little understood, except in a few cases and in a general way, but it is recognized that there

are intricate relationships in nature which operate together to support, and to also to control the undue increase of all forms of life. These forces of nature are so balanced in the competitive struggle for existence that but one reproduction unit commonly succeeds another. Were any species of terrestrial plant or animal allowed to reproduce and multiply unchecked, it would in a few years cover the earth and crowd out all other forms of life.

To appreciate this balance in nature, let us consider the conditions in a primeval forest before it has been affected by the inroads of civilization and settlement. For our purpose it is necessary only to consider the important forms of life in the forest community, and to treat them briefly in groups, proceeding from the lower to the higher forms in our classification, and noting the more important influences which they exert.

The bacteria and fungi in the forest cause decay and decomposition of organic matter, and convert it into the nourishment necessary for the life of higher vegetation. Were it not for these agents of decay, all the chemical elements capable of sustaining life would have been used up long ago, and life on this earth would have ceased.^{(1)*} On the other hand, these forms also cause some well known diseases of plants and animals, which tend to hold their numbers in check.

The higher plants use and store the nourishment provided by the bacteria and fungi and convert it into plant tissue which directly or indirectly provides food necessary for the existence of all animal life.⁽²⁾

* References to bibliography are numbered consecutively thruout the text

The insects by feeding on the herbs, shrubs and trees transform the plant tissue into animal life, and thus provide food for other forms of life, including parasites and insects within their own group, which hold them in such perfect check that their depredations are not serious.

The amphibians feed largely on insects; the frogs and toads help in the control of these insects which live on or near the ground, while the salamanders and newts diligently search out the hiding places of insects, or their eggs and pupae, on or under the rocks and forest litter.

The reptiles serve to maintain the natural balance by feeding on animal life. The green and the garter snakes which are perhaps more generally abundant than other kinds, feed largely on insects. The majority of snakes include in their diet frogs, toads, salamanders, and other snakes, small mammals and birds, and are especially fond of eggs.

The birds of the forest may for convenience here be grouped into two classes: 1. Those that have a direct influence on the trees and other vegetation thru destroying insects or feeding on seeds. 2. Those whose influences is more directly on the animal life, other than insects. The forms that serve as food for birds are thus held in check. Each group in turn provides food for its enemies. These various inter relationships result in the maintenance of ^anatural balance.

In the first group there are birds which frequent every part of the trees and other vegetation in search of food. The wood-

boring insects are controlled by the woodpeckers; the smaller insects, hiding under the bark, do not escape the creepers and nut-hatches; the larvae feeding on the leaves, or hidden in nests are destroyed by the thrashers, mocking birds and cuckoos; the tiny insects on the smallest twigs are hunted diligently by the warblers and vireos, while the chickadees seem to scour the trees, from the smallest branches of the top to the very base of the trunk, collecting what others may have missed. Insects feeding on the undergrowth do not escape such birds as the thrushes and finches, and those on the ground are discovered by the towhee and grouse. The ~~latter~~ also, in spring, eats the buds of tender shoots for its food, and the trees may be benefitted by this pruning. Even those insects which attempt escape by flight may be caught in mid air by the kinglets and flycatchers. Each type or species of tree or vegetation as well as every habitat, has its characteristic fauna more or less definitely defined.

That birds are usually more common in broadleaf, than in coniferous forests, is evidence in itself that the balance of nature is being maintained, for deciduous trees have more insect enemies, and the supply of food is therefore greater. Packard⁽³⁾ lists 442 species of insects affecting the American oaks, while but 170 are listed ~~for~~ the pines, and less than 400 for all coniferous trees. However, the black throated green warbler and the pine warbler are characteristic of coniferous forests. The towhee and wood thrush are characteristic of deciduous forests. Each has its particular preference or habitat within the forest, the former frequenting

young coppice and thicket borders, the latter preferring tall timber and shady ravines. In short, there is not a hiding place that is entirely safe from enemies, and not an insect, or any other form of life, that does not have its enemies which, under normal conditions, effectually control its increase.

Many of these birds also eat seeds of plants, which by digestion may be destroyed and their increase controlled, or by accident seeds may be dropped and distributed. That a hardwood forest usually follows the destruction of a coniferous forest, which destruction might occur under natural conditions by the action of the elements, cannot be due, as is sometimes supposed, to seeds which have lain dormant in the ground for years, since the viability of most seeds is now known to extend over but a few years. Forbush⁽⁴⁾ has shown in an interesting and convincing manner, that where species occur which by reason of heavy seeds could not have been carried by the wind, this succession of hardwood species is due largely to distribution of the seeds by birds and mammals.

Turning now to the second group, those birds whose influence is more directly on the animal life other than insects, we find birds with a wide range of activity, which may be only occasional visitors to the forest. Of these, the hawks, owls, and eagles feed largely on animal life, mostly birds, mammals or fish, according to the species, —altho the sparrow hawk and screech owl also feed on insects.

The northern shrike, crow and jay feed to some extent on birds or eggs and small mammals, as well as on insects and grain, and

may also act, together with the buzzards, as general scavengers. All of these birds are a necessary part of the natural system of regulating life. They are harmful to the individuals on which they prey but distinctly beneficial on the whole. They in turn fall prey to other stronger or more skillful hunters.

The mammals in our classification constitute the highest and last group among the animals. In the forest community we find those which have been attracted to it primarily because of the vegetative growth, and these in turn have attracted other forms, which hold their numbers in check.

The deer, moose and wapiti, browse on the herbs, shrubs and lower branches of trees. The great group of rodents, most abundant and varied in habit and function of our native mammals, depend for their existence mainly on vegetable food. The porcupine strips the bark from the trees; the beavers fell the trees for their food and to build their dams and shelters; the rabbit eats the smaller vegetation, and in winter together with the mice and rats, gnaws the bark of shrubs and young trees. All these in summer eat some vegetation and seeds, and may also act as scavengers. The squirrels eat the seeds and nuts, which also they may bury or hide in time of plenty, and sometimes forget, thus unconsciously aiding in the distribution of these forms.

All of these mammals play the part of turning plant material into flesh, and by so doing attract the carnivorous animals to the community. In this latter group are found such mammals as the weasel, fox, and lynx, whose general food and habits are well known,

and whose primary reasons for being in the forest are beyond dispute. The raccoon, bear and skunk should also be included here, altho flesh is in general a minor article in their varied diet, which may include nuts, fruit and insects. The shrews, which for their size are extremely ferocious and destructive of small animals, also feed on insects and seeds. The moles are mainly insectivorous and the bats entirely so.

Lastly, in this order of things, comes man, the American indian in our forests, and because he possessed the power to reason, he shaped tools to aid him in the competition for life, and became supreme. He was, however, distinctly a part of the forest, using what he needed for his existence and maintaining rather than upsetting the balance of nature.

This brief review of the forest community and relationships would not be complete without a mention of streams, which are closely related to the forests. It is an old saying that the forest is the mother of rivers, and altho the exact influence of forests on springs and streams is still under dispute, it is universally recognized that a forest cover decreases the surface run-off, and regulates the flow of streams.

The life of the streams should also be included as a part of the forest community, and there are certain forms which are typical of forest streams. The eastern brook trout prefers such streams, due partly to the cooling influence of the forest on the temperature of the water and to the absence of flood or of excessive sediment caused by erosion. The same order of dependence is found here as

on land.—aquatic plants supporting herbivorous forms, which in turn provide food for the carnivores. These, again, supply an important element in the diet of some of the birds and mammals which frequent the habitat provided by streams.

We have seen that in the normal order of existence there are close interrelationships in function and in habit between all forms of life, and that all are beneficial, since each is dependent on, or controlled by, some other. Let us turn now from the primeval forest to a consideration of conditions which have arisen since the advent of the white man and civilization to this country, but a comparatively short time ago.

The attractiveness of this country to settlers was due to the richness of its natural resources, and its rapid development was made possible by the destruction and use of the forests and wild life. The forests were cleared to make room for settlements, and later lumbering of certain of the more valuable species became a most important industry. With the forest area reduced, competition for space and food became more keen among the wild life. The destruction by the settlers of certain forms for food, fur, or as a protective measure, further upset the finely adjusted balance of nature. Artificial conditions were imposed on all sides by the advance of civilization, and those species which were unable to adjust themselves to the new conditions were destroyed; others, finding the situation improved, and their enemies reduced in numbers, multiplied rapidly and became obnoxious pests.

Man himself has had to make adjustments to the ever changing

conditions created by his own activity. The factor of value to man has been introduced, and with forest depletion has come an increase in the value of forest products, as well as an increase in the number of species which are considered valuable.

The same is true of wild life; it is doubtful if the early settlers wasted their powder on such small game as quail as long as turkeys and grouse were abundant, but in New York State turkeys have long since disappeared, grouse are scarce, and quail have been hunted until they are now practically exterminated. The value of furs has risen steadily, and species of fur-bearing animals are now in demand, which but a few years ago were considered worthless for this purpose. Lastly, man's use of the forests for his health and recreation has given a new value not only to the forest trees but to the wild life which makes up the forest environment.

This latter use may properly be considered as having the highest value among the recreational uses of the forest, altho it is difficult to measure it directly in dollars and cents. The President of the Iowa State Board of Conservation ⁽⁵⁾ reports that 1,500,000 persons spent an average of 3 hours each in the parks of that State in 1916. At a recreational value of 30 cents an hour, the return was \$450,000 on an investment by the State of \$100,000. He also estimates that the immediate community receives 75 per cent of the benefits from a park. On advice from Col. Boothby of the Maine Central Railroad, Evans ⁽⁶⁾ reports that 250,000 visitors were in 1907 attracted to the State of Maine largely by the fishing and hunting provided there. It is estimated that these visitors spend an

average of \$100.00 apiece while within the state, which gives an annual income of \$250,000,000 from this source. Pratt ⁽⁷⁾ estimates that in 1903, when lumber production was approaching its maximum in New York State, that this industry constituted not more than 20 per cent of the business of the Adirondack Mountains region and that it was greatly exceeded by business relating to recreational use. To what extent human efficiency is affected by health is shown by statistics of the U.S. Army for 1918 ⁽⁸⁾ which with a mean strength of 2,518,499 men, suffered a total loss of 40,692,302 man-days due to disease. The ratio of ineffectiveness, per 1000 men, was 44, and this is in an organization where special effort is made to keep men in condition. In these days of keen competition among men and nations, when efficiency is the key note of progress, a healthy mind and body is a fundamental requirement, and these are afforded by outdoor recreation.

With the introduction of new values, the best forestry practice in order to serve the highest use, considers both the direct and the indirect values of the forest. The direct values are obtained by the harvest of the wild life useful as food or fur, which the forest is able to support, as well as the ultimate harvest of the forest trees when they have reached maturity, and before decay has set in to destroy them by natural processes. The indirect values come from the presence of wild life, the influence on stream-flow, and the benefit derived from the entire forest community by its use for outdoor recreation.

The private owner cannot be expected to consider the value of his forest for stream-flow regulation or for public recreation, but

he cannot afford to ignore the indirect value to the forest trees of the presence of a normal population of wild life, which also can be managed to yield a direct annual or frequently recurring harvest. The forest trees constitute but a fraction of the direct value of the forest.

Consideration, in forest management, of the regulation of stream-flow and of the recreational values is usually possible only in publicly owned forests. The general policy governing the management of such forests is to reserve certain areas against cutting, as along roads, trails, or water courses, and near other points of special interest or value to the recreationist, as well as the watersheds of important streams.

The tendency to reserve areas against cutting has reached an extreme in New York State, where, with a total area of 31,490,560 acres, 1,992,516 are in State Forest Preserve.⁽⁹⁾ This constitutes 6.3 per cent of the entire area of the State, or 16.6 per cent of the 12,000,000 acres classified as forest land, and the state is charged by an Article in the Amendment to the Constitution to keep this property forever as wild forest lands, whereon no timber may be removed, destroyed, or sold. This is the situation in a State where 41 per cent of the total area is in forest land of which 62 per cent contains material which is suitable neither for lumber nor pulp, and furnishes only fuel or acid wood;⁽¹⁰⁾ where nearly 50 per cent of the domestic newsprint production is centered, and where 85 per cent⁽¹¹⁾ of all the raw material for its important wood using industries now has to be imported from without the state.

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

This tendency to reserve large areas against cutting is due largely to a popular misconception that forestry is detrimental to wild life and to recreational use, and that cutting means devastation. The ultimate object of nature's method in a forest is to obtain reproduction, and in order to make room for the development of young growth, the mature trees which have served their purpose, and immature trees which are overcome by competition for light, food, and growing space, are slowly destroyed. True forestry practice has the same objective, but it assists nature, to the profit of man by cutting the trees when they are mature or overcrowded, but while they are still sound and useful as timber. Forestry goes further by selecting for reproduction species of trees which will be most valuable to man. The recreationist with a true sense of proportion and balance, sees more beauty and wonder in reproduction than he does in dead and down, overmature trees.

The remainder of this paper considers the practice of forestry as it affects wild life and recreation, and is designed to show how forestry practice, which in some cases may be harmful to these interests, may be modified to the advantage of all. It presupposes that the interests of forestry, wild life conservation and recreational development, realize their interdependence and are willing to cooperate more fully for the benefit of the whole, as well as themselves, by methods of forest management and policy, which will accomplish this end.

The methods suggested are based on the major premise that under normal conditions all forms of life are beneficial, and ^{that} Nature tends

always to regain its equilibrium when it has been upset. In support of the latter statement there may be cited the case of those predatory animals which depend for their subsistence, either directly or indirectly, on mice or rabbits, and which show a fairly regular periodic fluctuation in numbers, that can be correlated with the abundance of their food supply. ⁽¹²⁾ It is not an uncommon observation that an unusual increase in mice or small rodents often brings a flight of owls to the vicinity to feed on them until they are reduced in numbers and no longer obnoxious. ⁽¹³⁾ Forbes ⁽¹⁴⁾ likens these interrelations to a series of expanding and contracting springs. each of which in expanding is checked, pushed back, or compressed by the others. The moment one weakens, and becomes slightly contracted, others expand to fill the vacancy. When one expands unduly, others exert increased force to contract it again.

It is possible to aid and even to control nature in this work of regaining the desirable balance which man is forever destroying. The methods suggested below are an attempt to work with natural laws rather than against them, to the end that a maximum harvest of all forest products may be obtained with a minimum of disturbance to the orderly system of nature.

The Practice of Forestry in Relation to
Wild Life Conservation and Recreational Use.

Forestry is the science and art of managing forests in continuity for forest purposes. It is not confined merely to the pro-

duction of timber, as is too often supposed, but deals also with the other uses of a forest, including stream protection, wild life conservation, and recreational use, with which this paper is particularly concerned.

The proper organization of a forest property for management and for maintenance, determines in time and place the most advantageous use of the property, with the ultimate aim of developing each function to its maximum.

Forestry should not be confused with the usual lumbering operations in which the future crop is rarely considered. The private owner unless prompted by other motives than that of obtaining a reasonable profit on his forest investment, is often obliged, under the present conditions, to cut his forest in whatever way will return to him the greatest profit at the smallest cost. Cutting with the definite object of keeping a forest on the land and obtaining a sustained yield has as yet rarely been practiced in this country. because under existing economic conditions it has not been profitable, except to long lived corporations and to the state or Federal Governments.

If the private owner will consider and appreciate the value of the wild life, which his forest may support, if properly managed, he may find that this feature is capable of producing a substantial revenue which will make it desirable and profitable for him so to modify his cutting operations as to insure a permanent forest for this use; this will also provide for a sustained yield of timber. The possibilities in the development of wild life in a forest, to yield a permanent supply and revenue, will vary with the size of the

forest and with the natural habitat which it provides.

The wild life which may best be encouraged in any forest are those non-migratory species which are native to the locality, and which do not require a greater area than the forest affords. The wider ranging, or migratory species may be found in the forest occasionally, but cannot be controlled. Conditions for the growth and reproduction of the desired species should be made as favorable as possible by the elimination of enemies, by providing adequate cover and protection, and by harvesting the crop only at a rate which reserves a liberal breeding stock.

The value of the crop, except in the case of fur-bearing animals is small in comparison to the value of the sport provided. The exclusive privileges of hunting and fishing may often be leased, under proper regulations, at a liberal figure.

Control of the harvest, to reserve a sufficient breeding stock, may be accomplished in the agreement with the lessee, by limiting the number of sportsmen and the number of hunting days, or by defining a game limit for the season. It may be further controlled by reserving a well defined central breeding area on which no hunting is allowed.

Riley⁽¹⁵⁾ reports that in the Cochetopa National Forest, Colorado, beavers have been placed under a plan of management which promises effectively to control their escape from the forest, with consequent damage to outlying ranches, and to check their undue increase as well as to supply a considerable revenue. He recommends the preparation of maps of the state or national forests which

shall designate certain watersheds where trapping of stated animals should be forbidden for a period of years, and others where trapping rights should be leased for short periods, subject to renewal and under the supervision of game or forest wardens.

Dearborn (16) shows that the United States could sell at home twice as much fur as it is now producing, and that landowners can increase and improve the fur taken on their property and make it a regular source of income. He reports that in 1919, this government received an income of \$4,000,000 from the harvest of sealskins taken on the Pribilof Islands by the Bureau of Fisheries. It also took from these islands 938 blue fox pelts having a value of \$165,000. He reports that in 1919 the total value of furs imported into the United State was more than \$76,000,000 and that the gross trade of fur merchants in New York alone during the year amounted to upwards of \$375,000,000.

Fur farming is an important industry in Canada and is becoming so in this country. Jones (17) shows that the protection afforded by woods improves the fur value of foxes and other forest inhabiting species and that such areas are best adapted for the production of these animals.

It is impossible to make a general statement concerning the size of the area required for public or private reserves. A comparatively small and narrow strip controlling a stream can produce a substantial annual revenue from fishing or hunting privileges, according to the use for which it is developed. A larger area, usually would be required to make hunting privileges valuable, the size depending

on the habits of the species developed, and the method of hunting. The greatest difficulty will usually be found in preventing trespass and poaching. In many localities the area must be sufficiently large and productive to afford a revenue which will provide for its protection. Owners of small, but adjoining, forests can frequently cooperate, and combine their holdings to make an area large enough to justify this expense. The modifications in the cutting of these forests will be the same, in principle, as is suggested below for the larger state forests.

Forests owned by States, or by long lived corporations, usually cover a large area embracing a great variety of types and conditions, and because of the permanency of ownership, can be managed on a long period rotation. The management of state forests on a low profit basis is justified since these forests provide for stream protection, wild life conservation and recreational use. The immeasurable and indirect benefits derived from these uses, even though they may not be expressed in dollars and cents, may properly be considered as a part of the profit from the forest.

In producing a long period crop, forestry immediately justifies itself by separating agricultural from non-agricultural land, and considering for forest use only such land as by reason of its soil, topography, or location is undesirable for agriculture. Further separation of the forest land, to serve its most advantageous use, is considered under stream protection and recreational use.

Since protection from erosion, and the regulation of the flow of important streams by the maintenance of an unbroken forest cover on their watersheds, is not financially possible for the private owner, it becomes the duty of the state to provide the necessary protection forests, and to reserve them for management to this end. Such areas lend themselves well to development for recreational use, since they naturally occupy the higher land and mountain slopes, and are usually the most picturesque spots in the locality. In order to provide an unbroken forest cover for protection and also wilderness conditions for the more extensive type of recreational use, cutting may be forbidden on these areas, except where necessary and advisable for the establishment or improvement of trails, fire lines, look out stations, or camp grounds.

Recreational use properly demands further reservation of areas for its purpose than is provided by the hillside or mountainous protection forests. The lakes and streams are important in this use and the forests bordering them should be reserved. In this connection it may be noted that there is an interesting streamflow experiment now in progress at Wagon Wheel Gap, Colorado, which has as one of its objects the determination of the influence which a narrow strip of forest, bordering a stream, may have on the regulation of its flow. In a preliminary report of this experiment, by Bates and Henry,⁽¹⁸⁾ it is stated that quantitative analysis of the discharge into those streams from surface run off resulting from summer rains, indicates that it is only the water falling in the streams, and on moist ground within a few feet of them, which temporarily augments their flow.

Since this is true, it is likely, when the final results of the experiment are available, that it will be shown that the influence of surface run off in contributing to floods, may be avoided and the stream kept free from silt, by maintaining a narrow strip of forest along the banks.

Such a strip will serve another important function in moderating the fluctuation in the temperature of the stream water by the influence of the shade provided by the forest and the decreased air temperature therein. Embury (19) has shown that the eastern brook trout cannot long survive a temperature of much over 81.5° F., and that the brown and steelhead trout are killed by a temperature of 85.5° F. All trout undoubtedly prefer the lower temperature provided by cool spring-fed streams. High temperatures caused by exposure, have ruined the trout fishing in many of our streams which might still be productive if a border of trees had been left, or might again become productive if such vegetation were now allowed to develop.

In view of these facts it is justifiable, and to serve the most advantageous use it is necessary, to extend the protection forest, as such, in narrow strips bordering streams and lakes. This extension would also serve the needs of recreationists, as suggested above, by improving the fishing, and by providing contiguous areas for this use.

To provide for the complete and most intensive recreational use of the public forests, tho in this case for purely

aesthetic reasons, it is further necessary to reserve narrow strips bordering the important roads leading thru the forest, and to provide other small areas adjoining the roads, trails, streams or lakes, which are suitable for camp grounds by reason of their location or scenic value.

A limited selection cutting, or an intermediate cutting on a reserved area should not necessarily be forbidden, if, in the judgment of the forester in charge, it will add to the recreational or scenic value of that area. Frequently a well directed cutting will open up a desirable vista which was hidden from view by the forest. A camp ground may be made more attractive and useful by an improvement cutting which may clean out, or open up the stand, or remove the crowded and suppressed trees. Thompson (8) reports that on one of the Minnesota State Forests, on Star Island and nearby sections extensively used by tourists, dead and badly diseased timber valued at \$37,000 was removed in the winter of 1918. Three years later it was difficult to see that any cutting had been made.

There is one other type of reservation which should be included in the State Forest, or in any forest where the conservation of wild life is an important feature. A suitable area should be selected which will provide necessary and favorable conditions for the maintenance of all the forms of wild life which are desired in the forest, or which may be introduced. This area may well be located near the center of the forest, or several sites may be chosen in different

parts of a large forest. Some species, as the beaver, which if uncontrolled become very destructive and detrimental to other uses, may require a separate reserve, outside of which they should be vigorously controlled.

These reserves, or sanctuaries for wild life, should be in charge of a game protector who should eliminate, as far as possible, the natural enemies of the desirable species, and protect the area against fire and trespass. Recreational use of the sanctuaries should be strictly prohibited, especially during the breeding season, but the areas may be open to visitors, under special permits, for educational or other special purposes.

Extensive cutting should not be permitted within the boundaries of the sanctuaries. A limited selection cutting may, in some cases, improve the conditions by opening up the stand to secure a growth of low and succulent vegetation, or to secure reproduction. Some forms of intermediate cuttings may be beneficial in making parts of the area more accessible and easier to control. It is the disturbance effected by the presence of men and teams which renders cutting within a sanctuary unwise, unless it is accomplished at such a time, and in such a way, that the disturbance is reduced to a minimum. This can be effected by beginning the cutting after the hunting season is over, so that the wild life, which may be driven out of the area, will have an opportunity to reproduce before the next hunting season opens. The cutting

should be completed before the breeding season begins.

The remaining area in the forest should be given over to rational utilization for timber and should be placed under a plan of management drawn up by the trained foresters in the State employ. It should be the policy of the State, primarily, to provide for the future supply of those products which, for one reason or another, the private owner is unable to supply.

It should be remembered that the greater part of our present supply of timber is coming from the last of the virgin forests, which required several hundred years to grow, and that when that supply is gone there will be nothing left but second growth, often of inferior quality. Since the private owner is financially unable to produce the high grade timber required by certain industries, because of the necessarily long rotation which involves retaining considerable capital at a low interest rate for long periods, it becomes the duty of the State to provide for this supply for future needs.

The amount of area required for this special use must be determined by an estimation of future needs a century in advance. Management for this use should follow the method of reserving certain desirable species and individual trees to be favored and left to grow until fully mature. Many of them may be grown on certain areas reserved primarily for recreational use since these older big trees would add materially to the scenic value and interest of such areas and would thus serve a double purpose.

Areas in the forest which are not suited for the above men-

tioned uses or are not needed by them, should be managed to supply the current and future need for the medium and low grades of timber. It is worthy of note that to many recreationists a lumbering operation, with its camp and mill, is of absorbing interest and attraction. The operations of a well directed cutting or other forestry operation may be a helpful demonstration to small forest or wood lot owners, and may give the interested recreationist a more kindly attitude toward this branch of correct forestry practice.

There are many kinds of cuttings which are carried on in a forest, but all are directed either toward increasing the amount and value of timber produced, by means of intermediate cuttings, or toward the maintenance of the forest on the land, by means of reproduction cuttings.

Intermediate cuttings are those which are made in a forest at any time between its establishment and its final harvest. Their object is to improve the remaining stand by providing better conditions for its growth, and by removing trees of undesirable species, form and condition. The material cut seldom returns a substantial profit, but may pay for the operation. Intermediate cuttings are generally beneficial to all the uses of the forest, and if wisely conducted should not be restricted, except in those recreation areas reserved as a wilderness.

Reproduction cuttings may be considered here under two types, - selection and clear-cutting. Other methods are either modifications of the above, or are not generally applicable on State forests. The selection method, as its name implies, consists in selecting for cutting the oldest and largest trees in a stand. These may occur singly

or in small groups, and reproduction is usually abundant in the openings, from seed provided by the surrounding trees. Under this method, repeated cuttings are made at definite intervals. The selection method maintains a picturesque uneven-aged stand, and is particularly adapted to forests where a continuous cover of trees of all ages is desired, and where aesthetic considerations are important.

Cutting, under the selection method, does not create a serious fire hazard; it affords a high degree of protection to the site against erosion and land or snow-slides; it creates a minimum of disturbance to the natural balance, and a maximum of protection and cover for the wild life. It is especially recommended for adoption on protection forests, reserved recreation areas, and on wild life sanctuaries, where a limited selection cutting will improve conditions for these uses. The method, properly carried out, requires skill on the part of the forester, in selecting the trees to be cut, but in general it serves the combined uses of the forest to the greatest advantage and is recommended as the standard method to be adopted on a State forest. The forester in charge should have the power to modify the method, when in his judgment, such modifications will accomplish a more desirable result.

The selection method should not be considered the only one applicable to any forest. Each of the standard silvicultural methods recognized by foresters is designed to secure specific results. The choice as to which one shall be used depends on the species, character of the stand, type of product desired and other factors. In spruce swamps, for instance, the selection

method would be apt to result in serious windfall of the remaining trees. In close impenetrable stands of low quality, second growth timber, this method would be wholly impossible. Many other conditions will be found, usually in small sections of the forest, where clear cutting will be the only effective method of improvement. The clear cutting method provides for reproduction by seed supplied from the trees on the area which have been cut following a seed year, or by seed blown in from the side. When properly conducted the reproduction is usually abundant and vigorous, and of the desired species. Artificial planting may be used where natural reproduction fails, or to fill in spaces where it has not been satisfactory. It is also used in reforestation.

The recreationist should consider that this treatment is for the ultimate good of the forest and its improvement. Clear cutting, when properly accomplished, creates an eye sore only by reason of a failure to understand and appreciate the method and purpose which created it. Under an adequate forest working plan provision is made for disposing of the slash and other unmerchantable material which necessarily accumulates in the process of lumbering, and if reproduction is secured the stumps are quickly hidden from sight, the area loses its barren aspect, and a complete forest canopy of new growth is established in a few years. It is not devastation, but rejuvenation and improvement.

Clear cutting creates a radical change in the conditions afforded the wild life, but it is not destructive to them and is not harmful if adjoining areas of forest are available. Rightly applied it serves the major purpose of the wisest use of the particular area

where it is performed. The habitat is changed, and those forms of wild life which were dependant on that habitat, move to more suitable areas. But a new fauna and flora immediately replaces the old. Rabbits will be among the first of the wild life, suitable for game, to be found in the new habitat. If there be hardwood reproduction, the grouse will be attracted in spring by the buds of the new and succulent growth, and will there find suitable protection during the breeding and hunting season. A succession of changes will occur as the new stand develops, and will continue until a mature forest is again established, when the original or climax type of fauna and flora will be again found to be present.

Reproduction and other cutting methods are but a small, tho very conspicuous, part of forestry. The forest may be injured by various agencies which are so numerous, and many are so destructive, that the production of profitable tree crops is impossible unless adequate protection be provided. It has been wisely stated that at the present time forest fire protection is 75% of the forestry problem in the East. This danger is materially increased when the forest is open to recreational use. In New York State in 1921⁽⁹⁾, of the 726 forest fires in fire towns, hunters, fisherman and campers were responsible for 210, or 28.9% and if the 212 fires caused by smokers be added to this, the total will reach 58.1%.

The prevention of forest fires is of vital importance to all the used of the forest. Fire destroys much of the wild life on the area, particularly if it occurs in the breeding season. It injures or destroys trees containing merchantable material,

young growth including reproduction, and reduces the productive power of the forest by injuring the soil. It therefore reduces the value of the area for hunting and fishing and destroys its usefulness as a recreational reserve. The indirect losses are often far reaching and incalculable. Particularly is this true when a fire destroys a forest which protects an important stream. In such a case losses and hardships may be experienced along the entire course of that stream and for a period of years, since the forest cannot quickly be replaced. Losses from such destruction, which benefit no one, are eventually paid for by an increase in the cost of living which affects every individual.

There are many methods employed in forest fire protection, all of which are beneficial to all the uses of the forest in so far as they aid in preventing serious fires. The methods which, in addition, may have a more direct influence on wild life, are the establishment of fire lines, and the disposal of brush, by burning, or by chopping the tops of felled soft-wood trees.

Fire lines are strips of cleared land extending thru the forest for the purpose of checking fire and providing an advantageous point of attack. These strips attract into the forest the beneficial birds which commonly frequent the borders. They also attract insects which would not ordinarily be found within the forest but which are held in check, to some extent, by the practice, as a fire protective measure, of keeping these strips cleared, by means of frequent cutting and burning.

Brush burning or top lopping are effective means of reducing the fire risk on cut over areas. These operations, as well as that of clearing the fire lines, will be most beneficial

when accomplished with a minimum of disturbance to the wild life, and should be avoided during the breeding season.

Forest protection as it particularly affects wild life, includes preventive or remedial measures against insect attacks. The insectivorous birds constitute the most efficient practicable control of insects in a forest, and should be attracted and protected as far as possible. Dead and dying trees provide hiding and breeding places for insects, as well as constitute a dangerous fire hazard. They are often removed as a protective measure⁽²⁰⁾, but as these trees also provide nesting places for woodpeckers, which are valuable forest and woodland non-migratory birds, the benefit derived from removing them has, from the wild life standpoint, to be balanced against this other value. The complete removal of available nesting sites over a large area would effectively drive out the woodpeckers and would contribute to the increase of insects. The use of artificial nest boxes, as a substitute for dead trees, is practicable only on small areas where proper care can be given them.

Forest management refers to the application of forestry in the conduct of the forest business. It determines the time when trees may profitably be felled, and considers the economic aspects of all operations in the forest. It is concerned primarily with the forest from a business standpoint, and affects wild life conservation and recreational use mainly as it makes the above mentioned provisions for them in the working plan of management, and as it orders, in time and place, the most advantageous use of the property.

Forest policy is the attitude of the State toward forests, which finds expression thru laws governing the administration of public interests in the forest. The attitude of the State towards forests is showing in these days a marked tendency to consider them, even when on private lands, as a public utility, in much the same way that certain water supplies are considered a public utility and thru expropriation protected against pollution and abuse, regardless of the wishes and personal liberty of riparian owners.

One of the present aims of American forestry is to formulate a national timberland policy which, briefly stated, will make it an inducement, if indeed it does not make it obligatory, for private owners to manage their forests for sustained yield, in order to provide for the future supply of timber. It is not too visionary to believe that it may sometime become feasible, and necessary, to provide, in a similar way, for a sustained yield of wild life.

At present the private owner may handle his forests wisely, or unwisely, as it happens, and with few restrictions. He may ignore, or may contribute to the conservation of timber and of wild life for his own, or for public use, regardless of what the ethics of public welfare may decree. The State forests, however, are public property, and the policy adopted in their administration will be directed by the needs and wishes of the people, for under our form of government, the attitude of the State must always be a reflection of the attitude of the people. It is therefore the more important that with public forests all the available resources be put to the fullest and wisest use.

It has been shown that forestry is concerned with all the uses which rest on the maintenance of a forest, and that the

sportsmen and recreationists are dependant for a large part of their pleasure on the forest and the wild life therein. It is therefore of vital importance to this considerable body of persons to appreciate the purpose of forestry, and to become actively interested in the policy of the State toward forests.

Sportsmen have long been organized thru fish and game protective leagues, with a central organization, and they constitute a powerful force in directing legislative matters relating to fish and game. The Audubon Societies and other similar organizations of long standing which have a separate and distinct purpose, are effectively influential in their field. So too are the organizations composed largely of timber land owners and those directly interested in lumber production, but their interest has been directed mainly toward lumber production. From still another angle the summer camp tourists and recreationists have begun to form associations, and a national federation of outdoor clubs has recently been inaugurated which promises to become a powerful organization because of ^{its} broad interests and the large number of persons interested in the promotion of its aims.

These several types of organizations along with others not specifically listed, are in one way or another all interested in the perpetuation and right use of forests and are serving a useful purpose. But to bring about the objects that they have in common, there is needed better coordination of effort than exists at present. What is required as an effective medium thru which all can cooperate. Such a common meeting ground is afforded by a properly constituted State Forestry Association, for inasmuch as forestry is concerned with each of these special interests, an

organization standing and working for the wise use of all forest resources is the logical agency thru which to focus interest and bring to bear organized influence to accomplish the things that await to be done. This does not mean that these other bodies should be merged in the Forestry Association,- each has its specific function and should retain its identity,- but as regards forest matters the Forestry Association might well act as spokesman for the group under a carefully worked out plan of cooperation.

The New York State Forestry Association may be taken as an example of an organization which aims to combine all these interests, and its policies as stated in their publication⁽²¹⁾, are enumerated below.

To promote the Forestry movement in New York State by uniting in a single organization all who are interested.

To disseminate information concerning the purpose, value and effects of forests and to provide an organ in which interests of the lumberman, sportsman and owner, manufacturer and all others may be brought together, and to solicit free discussion on all public questions.

To extend the protection from forest fires to all forest lands and to reduce the annual destruction caused by forest fires.

To educate public opinion in order that a rational policy be pursued in managing the forest lands owned by the State.

To extend the reforestation of idle land.

To insure a future supply of timber for the wood industries.

To protect our watersheds and conserve our stream flow.

To maintain our forests so that they will protect game and fish life and best serve as a health resort and playground.

To secure more equitable taxation of forest land.

To take an active part in securing proper legislation necessary for forest conservation.

Forestry organizations of this type, if properly organized and administered, provide a common ground where each of the interests may come to a better conception of the needs of the other, and of the relationships which make them interdependant. Only when there is coordination of effort between all related interests can there be formulated and effected, broad and comprehensive State-wide or National forest policies. Only with the development of this spirit of cooperation and unselfishness, and its extension to embrace all natural resources, can there be effected a National and International policy which will truly serve the greatest good, to the greatest number, for the longest time, and meet the demands of conservation in its highest sense.

Summary

The purpose of this paper has been to show that a forest is not put to complete use until its recreational possibilities are fully developed. The term recreation is employed to include all the uses made of the forest by those who seek it for their pleasure out-of-doors, or for their health.

That the wild life in the forest should be considered in the plan of management is brought out by the consideration of the forest as a community in which animals and plants alike have a

part. Being parts of the forest, in the management of which the guiding principle is wise use, it follows that the wild life of the forest should be developed. Provision should also be made in plans for the development of State forests for their management for recreational use as well as for lumber production.

It is practicable to develop these features in a number of ways but under the fundamental principle of dividing the forest into areas, each adapted to some special use. The plan of management should thus provide for:

1. Protection areas to regulate the flow of important streams.
2. The retention of a forest cover in narrow strips bordering streams and lakes further to protect these waters, and for recreational use.
3. The reservation against heavy cutting of the forest bordering roads and important trails, to maintain its aesthetic value for recreationists.
4. Breeding areas wherein the wild life may remain unmolested.
5. Areas where timber may be produced to meet, as far as possible, present and future demands.
6. The methods of silviculture to be practised, and other adjustments required on these areas, in order to make their reservation for special use of minimum detriment to other uses of the forest.

The effect of specified methods of forestry practice on wild life have been discussed and the situations which call for special treatment have been pointed out. But to bring about such full use of the forest certain definite things should be done. These are:

1. A survey of the forests of the State which shall determine the proportion and designate the areas which should be assigned to the various uses to which they should be put in order to serve the greatest good for the longest time.

2. An organization and administrative machinery to carry out the objects found by the survey to be necessary.

With such a program it ought to be possible, thru cooperation, to consolidate the existing agencies in an organized way. Sufficient interest may thus be aroused to bring to bear influence sufficient to secure the establishment of a system of forest management that shall develop all the uses of the forest in the most satisfactory manner.

Bibliography

1. Bergen, Joseph Y., and Davis, Bradley M.
Principles of Botany. Ginn & Co., Boston, 1906,
p. 230.
2. Needham, James G.
General Biology. Comstock Pub. Co., Ithaca, 1917,
pp. 3 - 7.
3. Packard, Alpheus S.
Insects Injurious to Forest and Shade Trees.
Fifth Report of the U.S. Entomological Commission,
Washington, 1890.
4. Forbush, Edward Howe.
Useful Birds and Their Protection.
Mass. State Board of Agriculture, Boston, 1913
pp. 92 - 99.
5. Pammel, Lewis A.
Report of the President of the Iowa State Board of
Conservation. In Report of First National
Conference on Parks, Des Moines, Iowa, (unpublished)
1921.
6. Evans, Kelly.
Fish and Game in Ontario. In Report of First Annual
Meeting of the Commission of Conservation, Ottawa,
Canada, 1910, pp. 100 - 106.
7. Pratt, George D.
Public policy in Relation to the Management of the
Forest Lands in the State of New York. In the
Proceedings of the Eleventh Annual Convention of
the Empire State Forest Products Assoc., Albany,
1916. pp. 32-38.
8. Stahl, C.J. and Thompson, M.W.
Where Forestry and Recreation Meet. Journal of
Forestry, Vol. 19, No. 5, pp. 526-533.
9. New York Conservation Commission.
Eleventh Annual Report, for the year 1921. Albany,
1922. pp. 99-101, 107-109.
10. Forest Service, U.S. Dept. of Agriculture
Report on Senate Resolution 311, June 1, 1920.
"Timber Depletion, Lumber Prices, Lumber Exports,
and Concentration of Timber Ownership". Washing-
ton, 1920, pp. 16-17.

11. Reynolds, R.V. and Hoyle, R.J.
Wood Using Industries of New York.
N.Y. State College of Forestry, Syracuse,
Technical Publication 14, pp. 30-46.
12. Hewitt, C. Gordon
The Conservation of the Wild Life of Canada.
Charles Scribner's Sons, New York, 1921, pp. 213-234.
13. Allen, Arthur A.
Birds in Their Relation to Agriculture in New York
State. Cornell Reading Courses, Vol. IV, No. 76,
1914, pp. 18-56.
14. Forbes, S. A.
The Regulative Action of Birds Upon Insect Oscillations.
Illinois State Laboratory of Natural History,
Bulletin 7, 1883, pp. 3 - 32.
15. Riley, Smith
Fur Culture on the National Forests.
Journal of Forestry, Vol. 19, No. 5, 1921,
pp. 594-606.
16. Dearborn, Ned.
Maintenance of the Fur Supply.
U. S. Bureau of Biological Survey, Dept. Circular
135, 1920, pp. 4-6, 10-12.
17. Jones, J. Walter.
Fur Farming in Canada. Commission of Conservation,
Ottawa, Canada, 1914, pp. 31-34.
18. Bates, Carlos G. and Henry, Alfred J.
Stream-Flow Experiment at Wagon Wheel Gap, Colorado.
U.S. Weather Bureau, Monthly Weather Review,
Supplement 17, 1922, pp. 28-32.
19. Embury, George C.
Concerning High Water Temperatures and Trout.
Proceedings of the American Fisheries Society,
Vol. 51, 1921, pp. 58-61.
20. Weaver, Roscoe B.
The Burning of Dead and Down trees, a Practical
Protective Measure. Journal of Forestry, Vol.
19, No. 5, 1921, pp. 506-511.
21. New York Forestry.
Quarterly Journal of the Empire State Forestry Assoc.,
Albany, April 1918.

Other Publications Not Cited in Text

Bates, Carlos G.

First Results of Streamflow Experiment at Wagon Wheel Gap, Colorado. Journal of Forestry, Vol. 19, No. 4, 1921, pp. 402-408.

Bryant, Harold Child.

Education as a part of the Conservation Program.
Bulletin of the American Game Protective Assoc.,
Vol. 10, No. 3, 1921, pp. 14-16.

Descombes, Paul.

La forêt régulatrice et génératrice des eaux.
Revue des Eaux et Forêts, Vol. 59, 1921, pp. 139-142.

Dillon, J. G.

The Effect of Forest Fires on Game
Bulletin of the American Game Protective Assoc.,
Vol. 9, No. 3, 1920, pp. 5-7.

Gordon, Seth E.

The Black Bear as a Game Animal in Pennsylvania.
Bulletin of the American Game Protective Assoc.,
Vol. 11, No. I, 1922, pp. 2-5.

Hawley, Ralph C.

The Practice of Silviculture.
John Wiley & Sons, Inc., New York, 1921.

Hawley, Ralph C., and Hawes, Austin F.

Manual of Forestry for the Northeastern United States.
John Wiley & Sons, Inc. New York, 1918.

Hornaday, Wm. T.

Wild Life Conservation in Theory and Practice.
Yale University Press, New Haven, 1914.

Huffel, G.

Le Mouvement forestier à l'étranger.
Station de recherches forestières suisse.
Revue des Eaux et Forêts, Vol. 58, 1920,
pp. 249-254.

The Forest and Springs. Translated in Studies in French Forestry, by Woolsey, Theo. S. Jr., John Wiley & Sons, Inc., New York, 1920. Appendix A, pp. 361-381.

Leopold, Aldo

The Wilderness and its Place in the Forest Recreational Policy. Journal of Forestry, Vol. 19, No. 7, 1921. pp. 718-721.

Recknagel, A.B., and Bentley, John Jr.

Forest Management, John Wiley & Sons, Inc., New York, 1919.

Sherman, E. A.

The Supreme Court of the United States, and Conservation Policies. Journal of Forestry, Vol. 19, No. 8. 1921, pp. 928-930.

Shepard, Ward

Science versus tradition in Game Protection. Journal of Forestry, Vol. 19, No. 4, 1921, pp. 409-411.

The New Mexico Plan for Game Management. Bulletin of the American Game Protective Assoc., Vol. 9, No. 3, 1920, pp. 5-7.

Stuber, James W.

Organization and Publicity, - Their Bearing on Game Conservation. Bulletin of the American Game Protective Assoc., Vol. 10, No. 3, 1921. pp. 18-19.

Van Hise, Charles R.

The Conservation of Natural Resources in the United States. The MacMillan Co., New York, 1921.

Wier, J: R.

Some Factors Governing the Trend and Practice of Forest Sanitation. Forestry Quarterly, Vol. 13, No. 4, pp. 481 - 489.

Woolsey, Theodore, S. Jr.

Studies in French Forestry. John Wiley & Sons, Inc., New York, 1920.