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of the

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THE AMERICAN WILDLIFE INSTITUTE desires to express its gratitude and appreciation of the work of the Program Committee and the many individuals and groups who cooperated.

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PART I

GENERAL SESSIONS

FIRST GENERAL SESSION

Monday Morning—February 17—Tennessee Day

Chairman: G. R. Mayfield

Conservation Commission and Vanderbilt University, Nashville, Tenn.

CALL TO ORDER

The opening session of the Sixth North American Wildlife Conference, sponsored by the American Wildlife Institute and held February 17 to 19, 1941, at the Hotel Peabody, Memphis, Tennessee, convened February 17th in the Ballroom, and was called to order at 10:10 a.m. by J. Paul Miller, Secretary.

He read telegrams to the Conference from C. M. Palmer, former Secretary of the American Wildlife Institute, and from J. D. Chalk, Commissioner of Game and Inland Fisheries of North Carolina, and introduced the Chairman of the day, Professor G. R. Mayfield.

ADDRESS OF WELCOME

G. R. Mayfield

The thing that makes me happy today as Chairman of the Conservation Commission is that I bring you good news from the legislative halls. Dr. Pearson said last night that thirty-eight years ago he came to this State and succeeded in having enacted the first general bill for the protection of birds in Tennessee. I can announce to you with great joy this morning that as a result of the recent assembly there is not one local bill left on the conservation statutes of the State of Tennessee.

Having been in this business of conservation for thirty years, and having fought for its principles, usually without success, and having seen the disastrous effects of local bills in making a checker-board of this State, you can't imagine how happy I am this morning to announce to you that the slate has been wiped clean of local bills and that our game protectors and our officers of conservation can now work for the whole State.

I have also another piece of good news for you this morning. Reel Foot Lake has been taken out of the realm of special legislation and put under the control of the Department of Conservation and the Conservation Commissioner.

If I could say just one thing to you who are strangers within our gates, it is that I hope you can learn to understand Tennessee. You have read about Andrew Jackson and about James Robertson, you have read of James K. Polk and of our other great heroes, you have read of the Battle of New Orleans, the Battle of the Alamo, and the other battles in Mexico, you know what Tennessee did in the Civil War and what it did in the World War; but I want you to know Tennessee from a different standpoint.

I want you to know Tennessee, in the first place, from the standpoint of geography and topography. Within this State you can go from the climate of the Gulf of Mexico to the climate of Canada. Many a time I have stood on top of the mountains in East Tennessee and seen there birds and trees and wild flowers that flourish in Canada. And here on the Mississippi and in the swamps along the western end of the State, you can see the birds and the flowers and the growth characteristic of the shores of the Gulf of Mexico.

The geographies will teach you that Tennessee is 430 miles long, a little more than 100 miles broad, and that it is bounded on the north by Kentucky, on east by North Carolina, on the south by Alabama and Mississippi, and on the west by Arkansas, and so on, but I want to tell you that the State of Tennessee in reality is bounded on the north by Canada, on the east by the Atlantic Ocean, on the south by the Gulf, and on the west by the Rocky Mountains. In other words, we have within our State representatives of the fauna and the flora of that part of our country east of the Rocky Mountains and south of Canada.

I should like you to know our people. We have an almost 100 per cent native-born population in Tennessee, mostly of Anglo-Saxon descent. When you come to know these people you will appreciate the qualities that have made them great.

I want to make this statement with regard to certain individuals, and with respect to the qualities that characterize the people who have made Tennessee famous, and later refer to points that have been publicized which, in my judgment, are unfair to Tennessee. In the first place, I think our citizens believe in something. In the second place, I am sure they love to be independent, they love to be individuals, they don't want to be dictated to, or regimented by, anyone, and when you call the list of John Sevier, Andrew Jackson, President Polk, Meriwether Lewis, Nathan Bedford Forrest, David Crockett, Sam Houston, Bob Taylor, and in more modern times, Alvin York, Judge McReynolds, and Cordell Hull, you will realize that Tennessee has produced something besides the types of characters that have been publicized in certain current magazines.

I want to repeat that our people are rugged individualists; they don't want to be dictated to, and some of the unfavorable publicity, as I shall try to tell you in a moment, has arisen from the fact that, regrettably, perversions of this independence have occurred.

I want you not only to know Tennessee, its geography and its people, but I should like you to know something about our conservation set-up. Two years ago the Legislature passed a general bill creating a Conservation Commission. That Conservation Commission included within its scope six departments, which, we believe belong together. In the first place, we have fish and game, but also include forests, state parks, the division of geology, an office of information, and finally, the division of hotels and restaurants. This last was put into our department because the Department of Health said, "We can't do anything with them. There is too much politics. Won't you take over this orphan child?" We were glad to do it because we had a man in mind to take charge of it and who since doing so is really making progress.

These six divisions make up the Department of Conservation. We have a commission with staggered terms, and at the head of each is a Commissioner who looks after one of the divisions.

Thanks to our efforts in the past two years, we believe that the Legislature has confidence in our organization. We are not perfect; we have a long way to go yet, but the fact that the Legislature believes in us enough to do away with the formerly popular local bills and leave to us some of the decisions respecting the counties, and the fact that they gave into our hands that thorniest of all conservation problems in the State, Reel Foot Lake, shows that the members of the Legislature are willing to trust us.

We have a Governor who genuinely believes in conservation. Some of the things that have been said in the newspapers would not indicate that, but I had the pleasure of teaching Governor Cooper at Vanderbilt University, and at that time he was interested in birds, in trees, and nature, and when he was running for Governor he said to me, "If I get to be Governor I shall appoint you on a conservation commission." I thought that was just a tribute to an old teacher, but he kept his word, and I can tell you frankly, that in the two years' existence of this Commission he has stood back of us.

The other night he told the members of the Legislature that he didn't want any local bills and that he wanted to do an honest job for conservation in this State, and I want to report to all of you, this morning, that Tennessee is on the forward march, and that we expect to continue.

As for the unfavorable publicity, I mentioned, I wish to say that some of the things you have read could not have been written by people who know our State. Madam Perkins has suggested that if the people of Tennessee would wear more shoes it would help the International Shoe Corporation do bigger business. You have heard about our monkey law, and while it is true that it is still on the statute books, nobody pays any attention to it. You have heard of our night riders. They have defended their rights as they understood them at Reel Foot Lake, and have defended their rights as they understood them in the great tobacco farming areas of this State. You have heard of our child brides. You have also heard of the Ku Klux Klan, which was started at Pulaski, Tennessee. You have heard this area called the Bible Belt.

I want to say that if you will reflect upon the qualities of some of the men and women that are being talked about, you will realize that dominant in them is the desire to be rugged individualists; they don't want to be just like other folks, they don't want to be dictated to, and that spirit of independence and individuality and originality, in my judgment, is what makes this really the Volunteer State.

I am proud to be a citizen of Tennessee, I am proud to welcome you to this State, and I want you to know Tennessee better. I believe if you do, you will love us and understand us better, I believe that you will want to come back to this State, fish in our streams, hunt in our forests, and visit our parks and scenic places. We promise you a hearty welcome and assure you a good time. Ladies and gentlemen, again I welcome you to Tennessee, this lovely day that really makes it Sunny Tennessee, and I hope we will have a grand meeting and you will come to see us again.

GREETINGS FROM MEMPHIS

HONORABLE WALTER CHANDLER
Mayor of Memphis, Tenn.

CHAIRMAN MAYFIELD: *If you will look at your program you will find that we have not only an address of welcome from the State at large, but we also have the greetings of the great City of Memphis, and those greetings will be said by the Honorable Walter Chandler.*

MAYOR CHANDLER:

Now that you have been so propitiously welcomed to the State of Tennessee, we want you to know that Memphis is really a part of the State. We have been claimed by Mississippians and Arkansans and sometimes by Tennesseans, but we really belong to all three of these great states, because if the Mississippi River hadn't separated us from Arkansas we would be a part of that State, and if the surveyors hadn't made two or three mistakes in drawing the lines between Mississippi and Tennessee, we would probably be in Mississippi. In any event, Memphis is a sort of *sui generis* town, and we are naturally proud of it, because it is strategically located, and particularly so for a gathering of men who are interested in the great cause of wildlife conservation.

We are honored that you have come to Memphis for the first of your conferences in the South, and we have a feeling that your meeting here will be beneficial and profitable and pleasant.

The great Mississippi River is perhaps the stream through which, as it were, all of the problems of conservation run, and here on this fourth Chickasaw Bluff, I am sure you will be interested to know that when the first white people came, they found buffaloes in great abundance. Even in my own time, wild turkeys used to abound here, and you will find that there are still many of these birds in the lowlands of Arkansas, some in Mississippi, and a few remaining in Tennessee.

We are undertaking to meet the problem of restoration of the wildlife that made this country fascinating, and we are happy that you are here to stimulate the movement, so that the great program of the Conservation Commission, which the State of Tennessee has adopted, may be altogether successful.

Now just a word about Memphis. The city which you see here was established in the year 1821, four years after this country was taken over from the Chickasaw Nation by purchase. In 1826 it was incorporated, and in the year 1850 it was next to the fastest growing city in America; Brooklyn was first and Chicago third. But when the Civil War opened, Memphis fell into the hands of the Federal Government by being captured by the Federal Navy that came down the Mississippi

River, after a quite a battle right out here off the bluffs that you will see while you are here. From that time on the city remained in Federal hands, and following the war experienced a reconstruction that was perhaps worse than the war itself. Following reconstruction, the city was ravaged by several epidemics of cholera and yellow fever, and in the year 1879 Memphis was practically wiped out by yellow fever. Most of the leading merchants and other business men then left Memphis and went north to St. Louis and Chicago. Some of the great business houses and industries which thrive in St. Louis today had their beginnings in Memphis before the yellow fever pestilence of 1879.

This city was not only wiped out by disease, but it became insolvent. The State of Tennessee abolished the City of Memphis and took part of the land on which the city is now situated back under State control. The municipality that remained was governed by a commission appointed by the Governor. In the efforts to relieve the community of disease hazards, the city went bankrupt. Finally, however, people came back, bought in the bonds, and turned them over to the city; then in the year 1880 Memphis made a new start. The city that you see today is really the result of only sixty years of patriotic, indefatigable work on the part of the people who love this city because of its historic past and who believe in its future because of its strategic situation on the routes of trade.

We are proud of the record that the city has made; we are glad that you have come here; and we want you to know that we have, we believe, and we want you to feel it and to participate in it, a little different brand of hospitality. The latch-string is on the outside to you all the time you are here and the city government is at your disposal.

We have as fine an Audubon Society here in Memphis and as fine an organization of men interested in the conservation of wildlife as you will find anywhere. We are proud of them and of the work that they are doing.

If I may close with a little couplet, it expresses more fervently than any words of mine the degree of our welcome and our greetings to you:

Here is our heart, here is our hand,
Welcome to the promised land.

MESSAGE FROM CANADA

HOYES LLOYD
Superintendent of Wildlife Protection, National Parks of Canada, Ottawa

I quite agree with all the things that have been said about the rugged individualism of the people of Tennessee and particularly of Memphis, because Mrs. Lloyd, as quite a few of you know, happens to have been born in this city.

Although we meet in trying times, I am glad to visit again and renew acquaintances in the South where I have spent many happy hours afield in other years.

In Canada, in spite of war, no essential conservation service has been discontinued. We believe, as you do, that conservation is an important line of defense, although we have not yet put the declaration on our postage stamps as you have. We are maintaining protective services and are continuing and extending our system of sanctuaries for waterfowl and other migratory birds, for we agree in the belief that well-situated sanctuaries constitute one of the most effective means of conserving bird resources. While drought has continued to exert a strong adverse influence in some large regions, its effects on waterfowl are being offset, to some extent, by the establishment of many small reservoirs. About 12,000 of these reservoirs have been created in plains country under our Prairie Farm Rehabilitation program. In addition numerous larger projects are also under way, some of them in non-agricultural areas. The latter benefit not only the waterfowl but also beavers and muskrats. There is continued slow improvement in the supply of eel-grass on our Atlantic Coast that is so important to the brant and other wildfowl. All in all, present conditions appear to justify us in continuing to regard the waterfowl with Scottish optimisim—that is to say, optimism strongly tempered with thrift, or even with frugality.

The propagation of beavers and muskrats in large managed areas is making great strides in Canada. It is an outstanding example of a rational conservation development that has been carried forward in spite of the war. Areas established in recent years, covering thousands of square miles, are now coming into production, and new marsh and waterway areas are being added at frequent intervals. The vast delta of the Mackenzie River is now a beaver preserve. In another part of the Northwest Territories, south of the Liard and Mackenzie Rivers and Great Slave Lake, special protection has been given to the marten.

Last year at Washington I stressed the fact that hunters and fishermen from the United States are welcome in Canada. Eight thousand, eight hundred and one hunters accepted Canada's invitation, and I sincerely hope that all of them had successful trips. Already many of them will be completing plans for a return visit and may I repeat there is room for many more.

There are no restrictions upon citizens of the United States visiting Canada that will interfere in the slightest degree with ordinary tourist activities. Visitors might possibly be asked not to take photographs in certain military areas, but doubtless you have rules of that kind right here at home. Hunters who come to Canada need permits to bring in firearms but these are easily obtained by writing the Commissioner of the Royal Canadian Mounted Police, Ottawa, and furnishing him with a few particulars. He sends the permit to the Customs officer at the port through which the hunter plans to enter Canada. Therefore it is important that once having selected a port of entry, the visiting hunter should not change his mind and apply for entry at some other port. This is mentioned merely as a precaution to prevent delay in bringing the hunter and his firearm permit together.

When a United States tourist or sportsman spends money in Canada for his own entertainment he not only gets bargain rates because of the favorable exchange, but he also has the satisfaction of knowing that he is helping a worthy cause. All United States dollars spent in Canada go back to the United States to pay for needed war supplies or to meet our other obligations here.

It is a pleasure to come here and to bring assurances of continued friendship from your northern neighbors. I think, as the years go by, we gain a clearer and stronger idea of the blessings of being good neighbors. We are glad to join in the North American Wildlife Conference, and to add our bit to the discussions.

May I add in closing that we, in Canada, welcome inquiries at any time from anyone in this great country on Canadian wildlife problems. Write to us and our Travel Bureau, our National Parks Bureau, or the Provincial game departments concerned, will furnish complete information whether your interest be touring, hunting, fishing, or whether you are coming up just to visit us and to satisfy yourselves that we are still saying "thumbs up."

GREETINGS FROM MEXICO

SENOR JUAN ZINSER
Secretaria de la Economia Nacional, City of Mexico, Mexico

I come in the name of the Mexican Republic, to represent the President, General Manuel Avila Camacho; the Department of State, Lic. Ezequiel Padilla; and the Department of Economy, Lic. F. Javier Gaxiola. They send to you the best regards from your friend, the Republic of Mexico, that is going to help you in every way and to work with you as a friend and good neighbor. On this occasion when we are reviewing the work in conservation in Mexico, I trust that the two Republics may work together, as they have in former years. Last year we had a little trouble in Mexico and did not keep up the work as it should have been.

In January, 1940 the conservation of natural resources in Mexico was subjected to a change in administration and management, due to the fact that the Department of Forestry, Game, and Fisheries was closed by order of the President at that time, General Lazaro Cardenas. As in other periods, the Department of Agriculture was again appointed to take care of forestry and game, and the fisheries were assigned to the new Department of Navy.

This change involved also a certain number of the personnel who were in charge of the late Department of Forestry, placing a few of them in positions in other government departments where no conservation activities could be developed.

The Game Service was undertaken by a group of men who never before had had the slightest contact with wildlife problems, and due to their lack of knowledge and interest, intense persecution of the fauna was permitted. Armada or battery shooting of wildfowl was resumed in the Central Plateau where the Valley of Mexico is situated. It should be pointed out, however, that the number of ducks which wintered in Mexico last season was markedly smaller than in most years, due in part to the severe winter, but mainly, perhaps, to the drying out of a number of reservoirs that usually serve as resting and feeding grounds for ducks. The water was used for irrigation of the surrounding lands where corn and alfalfa are mainly cultivated.

The regulation prohibiting trading in deer hides, their parts or products, was virtually abolished by toleration of the commerce, which is positively destructive of these animals.

An interesting subject is the condition of the big-horned sheep and prong-horned antelopes, which require immediate attention in order to prevent their extermination in our territory. The first of these animals has already been extirpated from the region of Bahia Kino, that is Kino Bay, in Sonora, because the Totoaba fishermen combed the mountains until they got the very last specimen. They persecuted also the prong-horned antelope in that part of its habitat close to the coast. Not long ago, this region was famous for its abundance of wild animals, and particularly of these two which I have brought to your attention.

Farther south, in the States of Colima and Guerrero, we have another problem. the killing of hundreds of deer for their hides; in this pursuit they use spotlights at night. A few months ago, I learned of one hunter who shot four does in one night, and six the next. They pack the skins and send them over to Acapulco or Manzanillo. Part of them, they say, are going to the United States, but I think most of them are going to Japan, and in former years some were sent to Europe. I think it is very important that we stop this traffic.

WILDLIFE'S SHARE IN THE USE OF THE LAND

HONORABLE CLAUDE R. WICKARD
Secretary of the Department of Agriculture, Washington, D. C.

CHAIRMAN MAYFIELD: *The meeting this morning is favored by a representative from the new Secretary of Agriculture, the Honorable Claude R. Wickard. He has sent C. M. Granger, Assistant Chief of the Forest Service in the Department of Agriculture who will give us his message.*

MR. GRANGER for the Secretary of Agriculture:

Your invitation to me to address you today states that all of your discussions are to be thrown against the general background of national defense. Certainly, this consideration colors and animates most of what this Nation is doing today.

I think all the policies and programs of the Department of Agriculture are in accord with the pattern of national defense. For years we have been working to promote the conservation of our soil, our ranges, and our forests. In the realm of our farms and farm products, we are immensely better able to meet the defense emergency than we were in 1917. The action we have taken as a Nation to insure forest conservation has given us something measurable on the credit side. And certainly there is far more knowledge of the need and means of range conservation.

Our aim in natural resource conservation is to keep the Nation strong for both military defense and economic defense. The long wars are the economic wars; the winners in this field of battle must be fortified by unfailing good husbandry of the soil and its products.

Despite progress in all fields of agriculture, there is still an enormous task ahead in making ourselves secure for defense on the farm, in the forest, and on the range. Even if we could forget defense against military foes, we have a long way to go in making ourselves secure against economic and social ills at home which arise out of maladjustments and misuse in the field of natural resources.

All of this Nation's current activities of a military and economic nature in the interest of national defense are, of course, not ends in themselves. They are the means to insure that we may continue to possess the freedom to live as we choose to live. We have all decided that we have something very much worth while defending.

Probably none of us has attempted to set down a complete list of the principal things we are ready to make all sacrifices to defend. If we did make such a list, it would contain material things and things of the spirit; it would provide on the one hand for the necessities—the bread of life, so to speak—and on the other for the right to believe and think and play as we please.

If a successful national defense could guarantee us only the permanent right to work day in and day out at our chosen tasks, it is doubtful if we could put the requisite spirit into that defense. As man cannot live by bread alone, neither can be found all satisfactions in work alone; there must be the satisfaction of the things of the spirit; there must be the time and the material for diversions.

On the list of things worth defending, the satisfaction we get from wildlife would rank high. Wildlife has its economic values too, but I venture to say that few of you would be here to discuss it if you were not also interested in its intangible values—spiritual values, if you will.

What is wildlife's share in the use of the land? Once upon a time, game had the use of all of the land in this country. The story of how it came to be pushed around and crowded out is familiar to all of you. Much of that was necessary, and was compensated by the benefits of other uses. On the other hand, much of it was unnecessarily destructive to wildlife and its habitat. And so we have come to the place—in fact we have long been there, where wildlife must be definitely provided for in the orderly allotment of the use of our land.

In a way, I wish this were not so. I wish that the artificialities, which go with planning its habitat, with stocking and restocking areas with various forms of game, and with regulations, were not necessary. On the other hand, there is a satisfaction in planning and carrying out programs that will definitely assure wildlife of its place.

Most of you know of the activities of this Department and other agencies in land-use planning. All of those interested in rural land are trying to prevent misuse and waste of the soil resources, and to promote uses that will preserve the basic values of the soil, that it may continuously produce the most fruitful yields of products and services. The farmers and other land owners all over the Nation are cooperating in this planning effort and they are counseled and aided by all those groups having an interest in the use of our soil.

The Department of Agriculture has a responsibility for working with those who control the uses and the future of private lands, as well as the responsibility for the constructive use of the land that the Department directly administers. On the privately-owned lands—whether they be farm, or forest, or prairie—we are working with the owners in helping to plan and to carry out programs for improved land-use through the cooperative activities of the Soil Conservation Service, the Agricultural Adjustment Administration, the Forest Service, and other bureaus in the Department.

Of course you know that more than half of the game in this country is found on farms and other private lands. You know that a group of AAA conservation practices brings direct benefits to wildlife. I refer to those practices carried out by individual farmers on their own land which improve woodlots to better shelter and feed wildlife, which encourage woodlot planting, which increase the acreage and yield of permanent pastures, and which expand the acreage of cover crops. On the prairies and range lands, millions of acres of grass cover have been restored through AAA practices, thousands of ponds and water storage facilities have been constructed, and millions of trees have been planted in shelterbelts. All of these accomplishments are of decided benefit to wildlife.

The operations of the Soil Conservation Service also are contributing greatly to better wildlife conditions. Evidence shows that strip cropping in some cases has doubled the wildlife population of a farm; the development of water facilities has benefited wild fowl and other game; the development and care of hedgerows, woodlots, windbreaks, with provision for form and plant species which shelter and feed wildlife, has been an outstanding contribution. Erosion control is helping to clear up streams, making them suitable again for fishing. The formation, by farmers themselves, of 443 soil conservation districts, covering 271,457,520 acres, is a step toward the permanence of all these benefits.

The national forests, although primarily administered for the conservation of timber resources and for watershed protection, have enormous subsidiary resources, one of which is wildlife. National forests support nearly a third of the country's big game, and in the West 75 per cent of the big game is on the national forests for a part of the year. As an adjunct of the main job of the Department in the national forests we have long had a program of building up and maintaining wildlife as a subsidiary but permanent source. I was highly pleased, recently, to see a statement from one of the Southern States that the Forest Service had restored public deer hunting by bringing in deer to stock some of the national forest areas. This has been done in many places. I am delighted to know of the extent to which cooperative intensive management plans for wildlife have been developed by the states and the Forest Service working together in chosen areas in the National Forests. This is an ideal set-up—two agencies with mutual interests and complementary authorities and responsibilities getting together to do well by the wildlife and the public.

Of course, there are problems and conflicts. However much wildlife may appeal to us, we cannot give it the right-of-way over everything else. We in the Department not infrequently have to try to bring together those whose interests seem to conflict at times. For example, either the stockmen or wildlife people may seek preferences for their respective flocks. There are times when the Federal Government and the states have to develop joint measures to prevent game from increasing to the point where it hurts the forest, ruins its own range, and starves itself out, or on occasions leaps the farmer's fence and eats his winter supply of hay.

Handling all of these things adds up to good planning and good management. If wildlife is a natural feature and source of practical and spiritual values, it is also a crop. We must make the best provision we can for its accommodation in the pattern of land use, and we must then all work together in accomplishing a management program which will build up and maintain as much of a store of wildlife as can be accommodated, and by a systematic harvesting of the surplus, avoid overdevelopment, damage, and starvation.

I wish I might give you my greetings in person. But I am glad of this opportunity to urge in this message that we all join in assuring wildlife of its share in the use of our land in a way which will lend itself to orderly planning and management. In this way, we can maintain wildlife as one of the permanent economic and spiritual values which we shall forever defend.

AN END TO TRAFFIC IN WILD BIRD PLUMAGE

JOHN BAKER
Executive Director, National Audubon Society, New York, N. Y.

A great victory has been won for the wild birds of the world through the signing on February 6, 1941, of a joint declaration of policy and program by the National Audubon Society and Feather Industries of America, Inc. The members of the feather industry join with the Society in advocating federal and state legislation to bring about permanent cessation in the United States of all traffic in wild bird plumage of any kind from any source.

There is every likelihood that within a few weeks' time a bill will have been introduced and legislation enacted in New York State, the forerunner of similar federal and uniform state laws, which will write the final epitaph, within six years, to United States traffic in wild bird plumage.

All friends of wildlife everywhere will welcome termination of a period of inadequate protection of wild birds resulting from the existence of loopholes in plumage laws, federal and state, and of confusion induced by different interpretations of those laws. Moreover, many kinds of wild birds are not protected by existing state legislation. Some states have no plumage laws whatever. Nevertheless, the campaign that was won a generation ago marked a great advance and all credit is due to those who participated in it. Of course, that fight was led by Dr. T. Gilbert Pearson, our President Emeritus, who I hope is here, and if so will stand, perhaps, in order that you may applaud his performance. The legislative gains at that time were doubtless the best that could then be obtained.

Some of the wild bird plumage in current inventories of dealers, manufacturers, and jobbers was imported prior to the passage of the restrictive provisions of the Federal Tariff Act in 1913, and even prior to the restrictive New York State legislation in 1910. As to such inventories, the owners posses constitutional rights. Then, again, the Treasury Department has see-sawed in its decisions as to the rating of sundry birds as domestic, or domesticated, in character, so that consitutional rights are possessed with regard to considerable wild bird plumage of such birds imported as recently as 1933.

Portions of the existing inventories, however, have been illegally imported or offered for sale; some have already been seized by the Bureau of Customs and confiscated; and portions have been seized by other enforcement agencies. Well over a million albatross quills, we are informed, have been seized by the Bureau of Customs as the result of information given to it by the Audubon Society. These feathers came in as domestic goose feathers, and were offered for sale as "Chinese pelican."

In the Society's campaign pamphlet, "Massacred for Millinery," it was pointed out that a loophole in the Federal Tariff Act permits importation of wild bird plumage for tied fish flies and that this had opened an avenue for illegal diversion of such plumage to millinery use. Proof of such instances is now in the possession of the Bureau of Customs; the inventories involved have been confiscated and penalties assessed.

Feathers of bald and golden eagles, as well as magpies, have been found on sale in retail stores in all principal cities of the country where checks have recently been made by enforcement agents. These quills proved in all cases to have been purchased in New York City, where it is illegal to sell them; cases for prosecution are now in the hands of the District Attorney of New York County.

Reverting to the declaration of policy and program first mentioned, that document was drawn with great care, following extensive negotiations, and consultation with officers of the New York State Departments of Conservation and Law. Those members of the feather industry signing the declaration state that they believe that they constitute at least 90 per cent of all the manufacturers, dealers, and jobbers in wild bird plumage in the United States, and that they own, control, or possess at least 90 per cent of all current inventories of wild bird plumage in this country. All persons trafficking in wild bird plumage, whether or not they have signed the declaration of policy, will be bound by the provisions of the contemplated legislation.

All those who have steadfastly fought for more legal protection of wild birds, will be interested in an enumeration of the most important provisions of the declaration of policy. Among these are:

1. Members of the industry agree to deliver at once their entire current inventories of plumage of the bald eagle, golden eagle, egret, bird-of-paradise, and heron, to be held pending passage of new New York State plumage law. At that time these feathers are to be either destroyed or distributed to educational institutions for exhibit purposes.

2. Within one month of the signing of the declaration on February 6, 1941, and regardless of the passage of any new legislation, the members of the industry agree to file with the New York State Conservation Department complete certified inventories of all wild bird plumage owned, controlled, or possessed by them on February 6, 1941. Such inventories are to be audited and additionally verified by certified public accountants. Auditors of the Society shall have the right to par-

ticipate in the determination of methods of obtaining a uniform, complete, and understandable set of inventories.

3. Upon the passage of new plumage law in New York, annual inventories are to be taken in the same manner and filed with the State Conservation Department, which shall have the right at all times to check on their accuracy.

4. Members of the industry will also file sworn statements as to the truthfulness of its inventories, together with waivers of their constitutional rights in the wild bird plumage. To make that waiver more binding, there will also be a transfer of title in the merchandise as of the expiration date six years after enactment. The fact that such constitutional rights exist, and have been consistently upheld by courts in similar situations, has been at the bottom of resumption, in recent years, of traffic in wild bird plumage; thus the declaration's provision for the waiving of constitutional rights in the wild bird plumage inventories is essential to effecting a permanent cessation of traffic in the plumage of wild birds.

5. In seeking new protective legislation, the Society and the industry will jointly recommend that the industry be permitted to dispose of certain of its current inventories of wild bird plumage during a period of six years after date of passage of new plumage law in New York State. At the end of that period any remaining inventories would be delivered to the State Conservation Department for destruction or distribution to educational institutions for exhibit purposes. After that date all wild bird plumage, except that in actual use for personal adornment, would be contraband in the United States.

6. Members of the industry have approved of the provision in the declaration that on and after the date of signing thereof, February 6, 1941, no additions shall be made to their aggregate current inventory of wild bird plumage. Members of the industry will be permitted to buy and sell among themselves plumage listed in the filed inventories, but no member of the industry will be permitted to add to his stock of wild bird plumage from any other source for any purpose whatever.

7. The Society and the industry will urge that all new protective legislation shall include specific definitions of "wild birds" as including every kind of bird except "domestic fowl," which shall include only chickens, turkeys, guinea fowl, geese, ducks, pigeons, ostriches, rheas, English ring-necked pheasants and peafowl of actual domestic origin.

By reason of the concentration of the millinery industry in New York City, it is apparent that New York is the key state in the effort to end traffic in wild bird plumage. Although a considerable advance will have been made when new state law has been passed in New York, the feather industry and the Society are committed to a joint program that will seek similar comprehensive legislation in the other 47 states, as well as whatever federal legislation may be necessary.

Friends of wildlife conservation everywhere, without whose staunch support this victory for wild birds could not have been won, will be kept fully informed as the joint program of the Society and the feather industry proceeds. Copies of the declaration of policy and program are being sent to all agencies dealing with the enforcement of plumage laws, and to members of the feather industry signing the declaration; copies will be available also for any one requesting them.

We wish to express our appreciation to the Commissioners of Conservation and the Directors of Divisions of Fish and Game in many states, for their cooperation in this campaign, through instructing their agents to inspect the legality of offerings by retail stores of millinery trimmed with feathers.

Our thanks are due, also, to officials of the U. S. Fish and Wildlife Service and of the Bureau of Customs and the staff of the District Attorney of New York County. Special mention, we feel, should be accorded the personnel of the Department of Conservation of the State of New York and their counsel of the New York Law Department, who have been unfailing in energetic enforcement of the existing law, and in attempts to bring to successful conclusion the negotiations for new legislation.

Above all, the National Audubon Society expresses its thanks and appreciation to the thousands of men and women who, by their united voices, have so vigorously supported the campaign of the Society to achieve permanent and complete cessation of United States traffic in wild bird plumage.

THE STOCKMAN'S VIEWPOINT ON CONSERVATION

SYLVAN J. PAULY
Vice-President, National Wool Growers' Association, Deer Lodge, Mont.

It is a pleasure indeed for me to be here with you this morning. I consider it an honor and a privilege to address you in behalf of the National Wool Growers' Association of America, and to be asked to represent our President, C. B. Wardlaw, of Texas, who regrets that he could not be here personally.

I bring to you the greetings of the stockmen of the West; I bring to you a pledge of our hearty cooperation in your program. We respect-fully ask of you in return that you meet us part way in the attempt at solution of some of our mutual problems.

In the course of my remarks this morning, I shall talk to you primarily as a wool grower, but many of the questions involved apply equally to cattle producers. I shall talk to you primarily as a Montanan, as being a native of that State, I am more familiar with the problems there. I shall talk to you, however, as a representative of the livestock industry in the West, because with certain minor variations the problem is the same in all eleven Western States and the problem of the sheep and cattle man is that of the lovers of our big game animals, namely, the sane and proper use of our great range areas. I trust that I may, in the course of my remarks this morning, say something that will be of aid to the deliberations of this Conference. I hope that I may be considered qualified to talk on the range problem. I was born on a ranch in the West and in some capacity or other have devoted my entire life to the care and attention of livestock.

Sometimes I wonder if you who live in the eastern part of the United States fully realize the important part that the livestock industry has played in the development of our country. In the settlement of this western area, first came the missionary, spurred onward by a religious zeal; then came the trapper and the miner, who were lured on amid untold dangers by the hope of profit; but after them came the vast herds of cattle and droves of sheep, tended by men as brave as the world has ever known. They preceded their fellows into the wilderness; they went ahead of the railroad; they had one great advantage—they were, to use a present-day military term, mobile units; they could forge far into the trackless wilderness; these sheep and cattle, after they had grown fat and multiplied in number, could be brought back to a shipping point and sent to market.

Settlers followed the cattle trails, and built cabins and finally permanent homes; families flourished in the spots first visited by the herdsmen. In fact, today in the West, many a town stands on the spot where some lonesome cowboy or herder sat and watched the dying embers of a tiny fire beneath the open sky.

Even today the livestock industry of the West is an important part of our national life. It is an integral part of our very existence. More than 80,000,000 animals are required every year in order to feed the people of America. To translate this into terms that are perhaps a bit more graphic, I might say that to feed the American people requires 150 hogs per second. Of course, the western ranges do not enter into the production of hogs. I merely mention it as a basis of comparison. But we also require 50 beeves, 30 lambs, and an estimated 15 veals per second. Many of these animals start their lives in the West: they come to the great farm areas of the Corn Belt where they are fattened, and finally reach the markets of our densely populated industrial areas. Some 12 million dollars annually is spent for feed for these western animals in your farming area.

Just to refresh your memory, not all this livestock grazes on government owned areas. Perhaps some 12 million head are on the national forests. I will avoid discussion of the areas administered under the Taylor Act. There are 175,000,000 acres of national forests, of which about 132,000,000 are in the 11 western range states. Of these acres, about 80,000,000 are used by domestic livestock. Twenty per cent is grazed by sheep, 42 per cent by cattle, whole 38 per cent is reserved entirely for wildlife and recreational purposes.

Only recently I read that it requires 135 pounds of wool as it comes from the sheep's back to fully equip an American soldier or sailor. We of the West, who are engaged in the production of national necessities are proud of the part that we play in taking care of the American needs, in both peace and war.

It may be of interest to you to know that in spite of the growth of the livestock industry, the number of game animals in the mountainous regions of the West now is greater than it was a hundred years ago. In fact, the big game population in these range states has approximately trebled in the past fifteen years, and this has been accomplished without seriously interfering with the use of these federally-owned lands by sheep and cattle, and despite the fact that greater numbers than ever have been legally taken during the hunting season.

The grazing of livestock in the national forests is in itself a great protection against serious fire through removal of a portion of the undergrowth and the presence in these areas of numbers of cowboys, riders and camp tenders, who are familiar with the ways of the out-doors, often preventing fires, especially those started by lightning, from reaching serious proportions.

As I have stated in the beginning of my remarks, I have spent my life on the range and it is my opinion that the elimination of both sheep and cattle would not materially increase the number of deer and elk. It is my honest opinion, in fact, that removal of livestock might have the opposite effect. There is ample room in the national forests for all the sheep and all the cattle that now use them, in addition to two or three times as many big game animals as are there today. The crying need for these big animals is not for additional summer range, but rather for adequate, suitable, natural wintering areas where they may survive the months when snows are deep and temperatures are low. There is, of course, a reason for that. In the areas where these animals were formerly wont to winter we now find that there are railroads and highways; the civilization of the white man has taken possession. We find that there are ranches, and farms, homes, and towns. As an extreme example, I might mention that many deer used to winter on the site of the campus of our state university. I personally have observed large areas of big game range in the drainage of the Black Foot and Flathead and Swan Rivers in western Montana. where domestic livestock are never permitted at any time of the year, but where in winter when snow is deep, the twigs and the branches and the bark from all the trees have been stripped as far as the starving game could reach. while the grass, untouched by domestic animals during the summer, lay buried beyond the reach of the elk and deer beneath four or more feet of snow.

So I would urge upon you by every means at your disposal to provide better winter ranges for these animals; when that has been done you will have contributed greatly to the further increase in their number.

I would repeat that I am sure you can never accomplish that objective by adding to a strictly summer type of range, of which they already have a superabundance.

While I have this opportunity of addressing you, I would like very much to discuss with you for a moment the problem of predatory animal control. I know there are nature lovers, and I believe they are very sincere in their convictions, who are of the opinion that even our predatory animals should be protected in order not to destroy the balance of nature. This theory, ladies and gentlemen, may be applied with moderate success within our national parks, but I deplore it as being utterly unsound and impractical when applied to the great range areas where game abounds. I am talking to you now not as a livestock man, but rather as one who is sincerely interested in the welfare of our game.

I might add again, in passing, that many erroneous impressions have been given out to the public in the past about the stockmen. We have been referred to rather bitterly at times as "cattle kings" and "sheep barons." We ourselves have been referred to at times as predators. The fact is, however, that the large outfits are passing away. We believe that the average ownership in Montana today is probably less than 50 cattle, surely less than 300 sheep, and I believe that this is only representative of conditions in the West. It is sometimes claimed that we operate on the public ranges on a large scale at great profit and largely at government expense. This is not true. I stand before you and I can honestly say today that I have never personally killed an elk or a deer; I can assure you without fear of contradiction that there is no single group or class in the West that contributes more to the conservation of our game and wildlife and particularly our big game animals than the stockmen of the West, and they do so by the contribution of feed and forage in the winter months when the higher areas are unoccupiable; they contribute the grass on privately owned land, and they do so cheerfully within a reasonable extent. We contribute also in other ways to save the animals, and this, my friends, I consider true conservation, because, after all, it is impossible today, as it always has been, to increase our wildlife population solely by the use of fish hooks and bullets.

As I stated above, the predatory animals do take a terrific toll of our wildlife. It is almost impossible to estimate the number of birds that they kill. The coyotes in the winter time travel in packs; it is possible for them to kill deer and larger animals when they are floundering in heavy snow. Walking through the forest, time and again we have come upon the spot where a doe had tucked away her fawn in peace and hiding, only to return a little while later to find just a few bones, a few bits of skin, a few drops of blood not yet dried. It is just another tragedy upon this earthly scene.

Earlier I called your attention to the importance of the livestock industry in the West, and I should like to mention now the manner in which its income is derived. The livestock industry is not parasitical; by that I mean it does not exist at the expense of others. It takes some of the natural products of the West that would otherwise go to waste and converts them into useful articles of food and clothing. Out West, each year, we annually raise a most valuable crop of browse and of grass. The soil, some fertile, some barren, combined with the golden sunshine and refreshing rains each year covers the ranges with a blanket of green. Yet though one crop is harvested, the next year another one just as good will be waving in the breeze.

All this growth would profit no one if it were not for the sheep and the cattle that we raise. Whenever you cut a tree for lumber it takes nature a hundred years to replace it. If you take a ton of ore or coal out of the ground it is gone forever. The same applies to a barrel of oil. But every year a new crop of forage will again cover our Western ranges, and whenever we see a lock of wool or taste a tender morsel of lamb or of beef we can regard it, if we please, just so many blades of grass or flowers, or weeds or so many bits of moss that have been gathered from the prairie and from the mountain, from the meadow and from the crag, and converted into products that add to the comfort and health of the human hace, to the economic advantage of the West, and to that of the nation as a whole.

AGRICULTURE'S INTEREST IN CONSERVATION

H. W. HOCHBAUM
Extension Service, U. S. Dept. of Agriculture, Washington, D. C.

It is certainly stimulating to be here again with you and to rejoice with you over the advances that have been made in wildlife conservation. I have just read the report of the Select Committee of the House of Representatives on Wildlife Conservation, and there was only one term that came to me that expresses my own feeling. I was simply thrilled at the progress that has been made by the various agencies. with the aid, of course, of the many thousands like you who are supporting them.

I was much amused last night to hear Dr. Pearson's reference to the primitive state of conservation in the early days of his work, and it led me to reminiscing. So if I may be permitted, I will give here just a little note of humor out of my own experience.

I don't know just how far back my own interest in wildlife goes, but I remember that like Dr. Pearson I too was once an instructor in a college where the classes were entirely composed of women. During the summer my colleagues and I used to guide some of these students on field excursions. One of these colleagues, now Curator of the Museum of the University of Illinois, knew of a great heronry on the La Plata River in Colorado, and there he took his class and I took mine, of girls of assorted shapes, sizes, and ages. We had to have some support from other men, so we took with us two other colleagues, one now the Dean of the Teachers' College at Columbia University, and another who is now the head of the Department of Education at Iowa State University. When we got to the river near the heronry, we found that the bridge was out, and we did not know how to get our charges across. Finally, we volunteered to carry the girls over the river on our shoulders. I think there were about 50 of them. The river was up to our waists, and you never heard such shrieking and screaming in your life. This too, mind you, was in the day before people lived on a reduced starch and sugar diet—those were solid, corn-fed girls.

Returning to my allotted subject, I would begin by quoting the former Secretary of Agriculture, now Vice President, Henry A. Wallace, as to one of the keys to agriculture's interest in wildlife. In a radio talk given in 1939, he said, "Our economists estimated in 1935 that 55 per cent of the land in the United States was in private farms, and an additional 30 per cent was leased or controlled by agricultural interests. Certainly the future welfare of wildlife depends heavily on the way in which we manage this 85 per cent of our land, the extent to which we make the wild creatures welcome on our lands that are primarily needed for other purposes, especially agriculture. These considerations make me feel confident that farmers are potentially the most important group of wildlife conservers and restorers in the United States. In a very real sense the further improvement of wildlife conditions depends upon agriculture, upon what we do with our lands, and I feel that this improvement is being better planned than ever before through our coordinated land use programs, as well as by farmers who are actually doing something for wildlife throughout the country."

The Department of Agriculture's activities in this great endeavor have been sketched to you by Mr. Granger in the message from the present Secretary, covering the plans and the activities of the AAA, the SCS, the Forest Service, and newest development of all, the national land use planning endeavor, all in cooperation with the Fish and Wildlife Service, National Park Service, and other state and federal agencies. And I may add that all of these movements are gaining in momentum and in results as you and the many thousands of others like you lend your interest and support.

The needs and opportunities in wildlife conservation were emphasized in an address by the Secretary of Agriculture, Mr. Wickard, at Purdue University on January 15, 1941, when he called attention to the fact that we must look forward to a perhaps ever-decreasing foreign market for our agricultural products; and that the problem that faced agriculture as a whole here in this country was one of readjustment, not merely reduction, on such a scale as we have never known. The Secretary especially stressed the need for helping the two million-odd farm families who have incomes of less than five hundred dollars a year, to so readjust their farming and their living that better living and more all around enjoyment of life will be possible.

This is, of course, an enormous problem. In solving it, land use planning must necessarily play an increasing part because many of these people live on land which should be taken out of agriculture. They occupy some lands from which possibly increased income could be derived were it devoted to recreational purposes, as hunting.

I was in Texas last year and noted the hundreds of farms that displayed posters stating that they were game demonstration farms. I was very much interested in the report of Mr. Callender on the work that the Texas Extension Service in cooperation with the State Game, Fish, and Oyster Commission has done in encouraging farmers and helping people to enjoy the wildlife resources, make the most of them, and conserve them.

Some of you are perhaps familiar with the great movements that are going on in helping to make these readjustments. You may know that Wisconsin since 1928, with the aid of county land zoning ordinances, has taken out of agricultural uses some 5 million acres in 24 counties in the northern part of the State and restored them to forest and recreational purposes. You probably know that similar action is being taken in New York State, and that Michigan and Minnesota also have adopted land-zoning policies. In all these states, returning lands from agriculture to forestry is making greater opportunities for wildlife conservation.

In this great work I am proud to say that Extension is playing an ever-increasing part. We have some 9,000 full-time Extension agents, about 2,900 county agricultural agents, and recent reports show that wildlife conservation practices have been adopted on 35,000 farms. Our 1,400,000 Boys' and Girls' Club members are showing a growing interest in the problems of wildlife conservation.

Our efforts to increase the interest of farm people in wildlife conservation and restoration gives the Extension personnel a great opportunity for cooperating with all other conservation agencies. Extension occupies a unique place in its cooperation with the states, with the counties, and with the Federal Government. The Extension agent translates the national and state programs into terms of local significance and helps to apply them to local situations. This need of education is one great problem that will ever be with us in the field of wildlife conservation. I make a special plea that Extension be given every opportunity to help you and all of the wildlife agencies in teaching farm people to understand the conservation situation.

Our second great problem will always be coordination. The report of the Select Committee of the House of Representatives to which I referred, points out again and again the need for coordination. It is a word that has been used much in the last few years. Real coordination is something that is very difficult to bring about; I don't know why, except perhaps that too much of the effort to achieve it is restricted to the office desk. Real coordination comes only as people work together on the land where the problem is.

Let me say here that while we can't get along without specialists, sometimes it is awfully hard to get along with them, because the specialist sees things rather narrowly and we have difficulty in getting him to appreciate the points of view of other specialists and of the local people. Someone has said that in this age of specialization some specialists are not only unable to see the forest for the trees, but they can't even see the tree for the particular branch on which they are sitting.

In restoring some of the land now in agriculture to forest and wildlife conservation, we sometimes have a similar clash of specialties, because the forester looks at it from one angle, the landscape man from another, the wildlife specialist from still another, and the CCC workers from still others. That problem of what to do in the best way to help farm people and be of the greatest aid in wildlife conservation is ever present. I have no doubt, however, that we will solve it.

THE FUTURE FOR CONSERVATION

DR. IRA N. GABRIELSON
Director, U. S. Fish and Wildlife Service, Washington, D. C.

At the First North American Wildlife Conference, held in Washington, D. C., in 1936, I was asked to present my ideas on a national wildlife program. In response to that request I outlined a program based of what seemed to me to be the outstanding needs. There were seven: more land for wildlife . . . closer cooperation of federal and state agencies . . . closer coordination of federal activities . . . a wider recognition of wildlife values by those who manage lands . . . efforts to correct stream pollution . . . adequate research programs . . . and protective regulations based entirely on the needs of wildlife.

The five years that have passed since these needs were thus outlined have been years of strenuous effort on the part of conservation forces throughout the country. Most of us have been overwhelmed by the hurly-burly of every-day activities and have seldom had the chance of viewing our accomplishments in the light of basic requirements and general objectives. There have, indeed, been many accomplishments, some of them beyond our most optimistic expectations, and, of course, all the experience of these five years throws valuable light on the problems that must be met in the future. Accordingly, before discussing our future plans, I believe it will be helpful to review the needs that were apparent in 1936, consider them now in the light of our five years of experience, and appraise our accomplishments in relation to the basic requirements of conservation.

Considerable progress can certainly be reported in our programs to provide land for the restoration and use of wildlife, yet more land is still a basic need.

The federal *waterfowl* refuge system, for example, has been enlarged, and it is continuing to grow although more slowly than in the early part of the period under discussion. We still need about 3½ million acres, as a minimum, to provide adequately for the birds while they are in this country, and should add numerous smaller interstitial areas to the system. The more easily restored areas have already been dealt with, so we must anticipate increasing difficulties, as well as higher prices and more complicated land-purchase problems. At the same time, the funds available for continuing the waterfowl refuge program are now limited to those provided by duck-stamp sales.

The federal *upland* refuge system has been greatly extended. In a number of cases the President has withdrawn public lands in the West to form such refuges, and extensive areas purchased with Federal resettlement funds have been transferred to the Fish and Wildlife Service for wildlife uses.

Many states have made progress in providing land for wildlife. Their purchasing and developing programs have gone steadily ahead. They also have received a number of upland areas purchased with resettlement funds. Recently Pittman-Robertson funds have provided money for wildlife restoration in States where little was available before.

We still need to acquire many additional refuge areas and develop them in one way or another. It is imperative, for example, that a great many acres of marsh land pass into public ownership so that it can be protected from needless drainage and destruction, if we are to provide adequately for future populations of waterfowl. The extent to which this and other land programs succeed depends, of course, on public recognition of the need and support in meeting it. If we succeed in making the needs known, we have good reason for expecting this support and, through it, of realizing our hopes for more wildlife lands.

As to the second need outlined in 1936—that is, closer cooperation between federal and state agencies—we visualized two helpful measures. One was an extension of the cooperative research and demonstration projects then established in nine states. The other was financial aid to the states by the Federal Government. We have succeeded in both, though not to equal extents.

In 1936 we estimated that there should be 15—instead of 9—cooperative units to carry out basic research in major ecological regions. There are now 10 of these units—an increase of only 1—but I think that all who are familiar with their work will agree that they have met their assignment in fairly adequate measure. They certainly represent a close cooperation of federal, state, and local agencies.

The feasibility and benefits of close cooperation between federal and state agencies are most assuredly apparent in the Federal Aid program, which has been begun and well advanced in the past five years. The Pittman-Robertson Act, which provided federal financial aid to the states in their wildlife work, has been a law for only three years, yet 44 out of the 48 states are actively engaged in the program or have qualified for participation. I am frank to say that this program has been more successful than even the most enthusiastic supporter would have believed possible in the beginning.

The Congressional appropriation of a million dollars for this program in its first year was increased to 1½ million in the second year and 2½ million in the current, third year. The budget recommendation for next year is 3 million dollars. The appropriations are thus approaching the income derived from the sales tax on sporting arms and ammunition, or in other words the limit set by the basic act.

While there were, of course, some projects proposed that were not of a very high standard, the majority have been good, and there has been little difficulty in working out acceptable programs. Many of the states started off with survey projects designed to produce more adequate knowledge of their wildlife resources and of the needs for particular developments. By now many of these programs have passed from the survey phase to the acquisition and development of lands. Some of the hoped-for results are already apparent.

The federal-state program has met no major obstacles and is rapidly assuming a character that promises a future of solid accomplishment. The cooperation that this program has involved between the state conservation commissions and the Fish and Wildlife Service has been of great significance. It has resulted in an increased understanding by each agency of the other's problems and in the establishment of closer and better cooperative relations.

In general, but particularly as a result of the Pittman-Robertson program and the cooperative research and demonstration units, I think that the cooperation and mutual confidence of the various state agencies and the Fish and Wildlife Service are better today and on a more solid basis than ever before.

The third point mentioned in the program outlined in 1936 was the recognition of wildlife values by land management agencies, both public and private. Here again we can report considerable progress. Many of the public land management agencies are taking wildlife values and needs into account in formulating administrative programs. There has been a great demand upon the Fish and Wildlife Service for advice and counsel as well as for assistance in getting basic information for carrying out these policies. We are doing our best to comply, but there is a very noticeable gap between the demand and our ability to meet it. It is unfortunate that this condition exists, for the conservation program is weakened to whatever extent we are unable to stimulate and make permanent the interest in wildlife by cooperating more effectively in the increase and diffusion of fundamental information. Private agencies with which both the Fish and Wildlife Service and the state agencies have been working are slowly becoming conscious of wildlife values, although the progress in this field has not been so great as one could wish. The importance of the recognition of wildlife needs by owners of private lands cannot be overemphasized. More than 75 per cent of the land in this country is in private ownership. Nearly every state conservation agency finds this a dominant problem in its program, and they are trying to find ways to stimulate and develop the wildlife interest of private landowners. Some of the efforts are meeting with fair success, but I cannot say that we are anywhere near a solution for this very important problem. It is very apparent that it will be necessary to develop land management practices that not only will recognize wildlife values but which will be compatible with other land uses before we can succeed in getting widespread application of them by the hundreds of thousands of individual landowners in this country. It is a problem that should be kept to the fore because it is vital to the conservation program. If a way cannot be found to get this farm program across, wildlife conservation will fail throughout vast areas of the country.

Pollution was another topic discussed five years ago and it was pointed out that to achieve conservation, it must be stopped or reduced to a nondestructive point. Considerable progress can be reported in the reduction of pollution by municipalities and public agencies. Through the use of federal funds many hundreds of sewage disposal plants have been built. There is, however, need for tremendous efforts in this field, and no very encouraging statement can yet be made about industrial pollution of our waters. Very little, if any, progress has been made in this field, and the attitude of industrial organizations is still one of bitter opposition to any attempt which will cost them anything, to clean up the streams and other waters of this country. Not only that, but industrial plants are still being built that will bring about further pollution. In many cases local interest has not been great enough or well enough organized to prevent those developments. I cannot state too strongly that it is extremely short sighted to encourage or permit the development of new sources of such pollution or the continuation of those in existence purely on the ground that it is cheaper for some industry to operate by using a stream as a private sewage disposal plant when the stream can be a public resource of great value. It does not appear to me that any community is going to profit in the long run by the operation of such a plant. Pollution of the stream means elimination of a fish food supply and destruction of a recreational area potentially of much more value to the community than the advantage to one or a few individuals of easy disposal of wastes. I think that less progress has been made in this field than in any of the others. Certain interests continue to oppose effective legislation looking toward the cleaning up of streams or the prevention of future pollution and so far they have been successful in preventing even the consideration of anything approaching an adequate program.

Our 1936 program emphasized that research on wildlife should be expanded to meet the new problems that are continually being created by modern developments and that the results of this research should be freely available to all land administrative and wildlife management agencies. Here again I am able to report considerable progress—through the 10 federal-state cooperative units through universities and colleges, and through the surveys and the administrative research programs of the state game commissions aided by Pittman-Robertson funds. Altogether we have accumulated a tremendous body of up-to-date information about our wildlife population and its needs. I cannot as yet say that it is sufficient and probably it never will be as changing social and economic factors are constantly creating new problems. As I have stated before the solution of one problem often results in unexpectedly bringing to light various others. I cannot say that we have made as good progress in the field of aquatic biological research as we have made in that on land forms. This has been largely due to the fact that it has not yet been possible to finance research on fishes and other aquatic forms to an extent comparable with that dealing with game birds and mammals. There has been some increase in the research work of the former Bureau of Fisheries, now a part of the Fish and Wildlife Service, as well as in that of a number of state agencies, but its volume and the availability of men trained to do it are still far below what is required.

Closer coordination between activities of federal land administrative agencies was another need pointed out in 1936. In this direction also it is possible to report achievement. I believe there is more appreciation of conservation needs by public agencies in related fields than ever before. I know that readiness to cooperate and understanding of wildlife needs on the part of such agencies as the Public Health Service, the Army engineers, and the land agencies of the Federal Government in general are better and more effective than ever before. Although there is still room for improvement, I feel that very satisfactory progress has been made, and I hope that it can be maintained. There is very grave danger, however, in the movement for national defense that some of the progress in cooperation and coordination will be lost. There have been some disturbing evidences of that nature in the past few months. Only by continuous vigilance on the part of alert active conservation agencies can we avoid some injury to the wildlife program and loss of gains already achieved.

Final emphasis in the program outlined five years ago was on protective legislation and regulations based entirely on the needs of wildlife, not on the wishes of special groups or interests. Since 1936 there has been little change in federal protective legislation, except the addition, by special act of Congress, of the bald eagle to the list of creatures protected by national law. Federal migratory bird hunting regulations have continued to be drawn to meet the needs of wildlife. It has been found possible during the past year or two to relax slightly the restrictions on the hunting of ducks and geese because of the success of the waterfowl restoration program. On the other hand, the severe winter of two years ago had a very serious effect on certain forms, and it has been found necessary to put additional restrictions on the hunting of the woodcock and the mourning dove. The regulations relating to migratory game birds will continue to be drawn for the essential purpose of maintaining adequate breeding stocks. I am glad to be able to report also that more and more of the state conservation agencies are making their regulations so as to serve the basic needs of wildlife although there are still instances of the wishes of certain groups receiving too much consideration. Members of these groups are still somewhat vociferous, but it seems to me that in general they are declining in power and influence. More agencies are now getting into position, by state legislative enactment, to give adequate attention to the protective and regulatory features of game administration. I again urge that it is essential for state and other conservation authorities to have full power to change the regulations that govern hunting from season to season as conditions require.

It has long been the policy of this country to maintain game crops as a public resource, used by hunters, generally for nominal fees that encourage hunting by the multitude. As long as this policy remains, it is imperative that adequate authority be lodged in administrative groups to protect the wildlife population during emergencies and to permit increased utilization when the populations increase beyond the supporting capacity of the food supply. Such situations may sometimes arise very suddenly as a result of great storms, widespread disease epidemics, or other causes. Legislative machinery is too cumbersome and slow to meet such emergencies especially in states where the legislatures convene only once in two years. Although in the past four or five years a number of states have given to their game authorities the needed power, in many instances lack of freedom to act promptly and effectively is still a fundamental defect in our administrative machinery for handling wildlife problems. Those among you who live in states where that power has not yet been granted should make the demand for it a number one part of your conservation program.

To sum up: in the past five years wildlife conservationists in this country have certainly made great progress along many lines. There are still, however, many needs that have not yet been fully met and we may as well be frank and admit that we have failed in some respects. I am sure it will be helpful to emphasize our unmet needs and to consider our failures very carefully.

One phase of the wildlife program on which we have made little progress has been the restoration of fur animals. At one time the United States was one of the great fur-producing nations, and it could easily recover that status by proper management of its fur resource. At the present time it is estimated that we are producing 40 to 45 million dollars' worth of furs annually as against a former production of perhaps two or three times that amount. It is difficult to measure fur animal production in money returns alone because of fluctuations in the values of skins, but it is certain that both in numbers of animals taken and in the value of the fur, the harvest in this country is far below what it was a few years ago. Such animals as the beaver, muskrat, marten, fisher and mink, all producers of valuable fur, could be restored on many areas of publicly-owned and other wild lands with little or no interference with their present uses. It will be necessary, however, to improve methods for the management of these lands before we can make a great deal of progress. We know too little about the basic biology of some of these fur animals, although a research program now under way should usefully increase our information. We need more adequate financing for a fur restoration program, and a thorough revision of the laws and regulations governing the taking of fur animals. The fur laws of many of the states are antiquated and of very little effect in actually conserving the fur resource. Many state game commissions do not now have the authority and finances for handling this problem. I am glad to say that a number of states have undertaken fur-animal restoration projects in connection with the Federal Aid in Wildlife Restoration program and are also carrying on research in this field. But, as yet there is no adequate machinery for governing the take of fur bearers. The pressure of open competition encourages individual trappers to get all of the animals they can as early in the season as they can, and this results in undue depletion of the breeding stock and in harvesting the crop before the pelts are prime. Thus much of the potential value of the crop is lost.

It seems to me that there are also several defects in the fishery program. In too many cases we are still overemphasizing the planting of fishes in waters about which we know little or nothing. It would appear to be the first requirement of good management to determine beforehand, whether the fishes involved can survive in the waters proposed for stocking. We are planting increasing numbers of fish each year in constantly decreasing areas of inland waters. So far as the Federal program is concerned, we have too many hatcheries inadequately staffed and inadequately operated. This condition can be met in either of two ways: By disposing of some of the hatcheries in order to man properly those that are to be operated, or by increasing funds for operating all of the hatcheries.

It seems to me, however, that the most serious fishing problem is the loss of productive waters. The area of inland waters in this country for the production of fish life, as I pointed out a moment ago, has been constantly shrinking over a great many years. Four causes have contributed to this: Drainage of lakes; stream-straightening operations, that have destroyed much productive water and many spawning beds; pollution by municipalities, by public agencies, and by private industry; and accelerated soil erosion. The combination of all four of these factors has brought about a constant shrinkage in the amount of water available for the production of fishes for food and recreational purposes, while at the same time there has been a constantly increasing public demand for these resources. Until we tackle the basic problem of restoring our waters to productive capacity, whatever may have been the cause of their destruction, we are not going to make a great deal of progress in restoring the fisheries of this country.

The control of soil erosion on the headwaters of many of the now unproductive rivers is a first essential to restoration of the productivity of these waters. We should give all possible support and assistance to the agencies engaged in soil conservation. Their work is a basic requirement in many areas and must be done before our biological restoration programs will have any chance to succeed. Those of us who are interested in the wildlife resources of this country should also back every program to prevent the establishment of new sources of pollution, and we should demand the correction of present abuses. We should also question every drainage operation and every stream-straightening enterprise until it can be shown that resulting public benefit will counterbalance the losses occasioned through destruction of natural resources.

It is time for us to take an aggressive attitude in dealing with these problems. That, I pledge you, will be the attitude of the Fish and Wildlife Service. I might point out in this connection that this Service has no regulatory or police authority over fishes—nor, as a matter of fact over fur animals or any other forms of wildlife in the continental United States except waterfowl and other migratory birds. Usually it is impossible for us to take direct action, but we can and will encourage and sustain those agencies that can act. With adequate funds and enough men we can do research to get the facts upon which to base intelligent water restoration programs.

In addition to furnishing basic information the Fish and Wildlife Service can and will do its part in attempts to get the facts before the public regarding the destruction of these vital natural resources and the steps necessary for their restoration. Certain federal legislation in this connection, is desirable. The Buck Bill or similar legislation, should be enacted to put under way the same sort of constructive program in the field of aquatic biology as has been started in the bird and mammal domain. There should also be legislation and appropriations to give wildlife agencies the same advantages in the way of extension and educational services as are now available in agriculture and forestry. It has been proved conclusively that actual demonstration through personal contact between extension agencies and the people on the land is the most effective way of translating the results of agricultural research into action on the farms of the country. We cannot expect anything different in the field of wildlife conservation. Until we have some sort of medium for making our information fully available to those who are in position to use it, progress in carrying out our programs will be slow.

I should like to emphasize one danger to wildlife that may result from the great American tendency to turn attention from one thing to another, according to the headlines of the day. As a result of constant radio and newspaper publicity, national defense is now prominently before the public. National defense should, of course, be supported by every American citizen, but it should not be forgotten that there are forces and interests always ready to take advantage of any program that promises to divert attention from their own selfish activities. Already there has been a tendency to advocate as defense measures, drainage and dam construction projects that have never had enough intrinsic merit to receive public support. Unless conservationists oppose these moves, we can expect further damage to the wildlife resources of this country with no adequate compensation to the public in return. If the defense fever mounts we can expect increasing demands for all sorts of exceptions to sound conservation which in the long run will be harmful to the nation. In the last World War, for example, we stepped up the fisheries take far beyond what was prudent and, as a result, some of our important fisheries are still in a depleted condition. We can again expect the proposal of various schemes to promote personal gain at the expense of national resources. I believe that our conservation program is so vital to the future welfare of this country that there can be no excuse for a let-down in its progress. If this country is to continue to be a good place to live in, or one worth fighting for, we must treat the products of soil and water intelligently, not only in good times but in bad, in national emergencies as well as in peaceful periods. Only in this way can we be assured of an annual return capable of sustaining and feeding our population.

To sum up: It seems that we have good reason to be hopeful. We have made substantial progress in the past five years in many phases of the conservation field, more I believe than in any other five-year period in the history of this country. We have it in our power to solve most of the conservation problems, but it would be foolish for us to become over-optimistic or to lean back with a self-satisfied feeling that all is well and that we can now relax and enjoy a well-earned rest. We have still a tremendous job in restoring wildlife environment, in protecting essential breeding stocks, in cleaning up our streams and other waters, in restoring those that were needlessly destroyed, in reforesting our lands, in restoring our fur animals and bringing back an annual income from lands that are not now producing nearly what they might yield in returns of human value, and in providing recreation for the American people. We still have many obstacles to overcome and there will always be conservation battles to fight.

May I remind you, in closing, that in conservation we may win many contests but if we lose the last one we lose the war. An unwise project for the destruction of natural resources may be defeated fifty times, but if it wins the fifty-first time we might as well have lost on the first occasion. We who understand the value and the vital necessity of maintaining natural resources of soil and water and their products, face a continuous job of making other Americans understand the vital character of this program. We face a never-ending battle to hold off those who would sacrifice anything in the future for immediate gain. And make no mistake, there will always be people, many of them, ready to do this if they can see profit in it for themselves. The forces of conservation will always have such groups to fight. There are now, and always will be, many who would take the last fish, kill the last bird or the last deer, or cut down the last tree, if in so doing they could realize an immediate personal gain. It is our duty as American citizens concerned with the national welfare and the future of this country to see that these groups do not prevail.

SECOND GENERAL SESSION

Tuesday Morning—February 18—Mississippi Day

Chairman: W. F. Dearman

Director of Conservation, Game and Fish Commission,
Jackson, Mississippi

DEFENSE AND CONSERVATION

The second general session convened at 10:35 a. m.

Chairman Dearman: *Governor Johnson asked me to convey to you his best wishes for a successful meeting and to express his regrets at not being able to attend.*

Mississippi is the baby in the conservation field. We have had a statewide game and fish commission only since 1932. It has grown rapidly, however, and now has $225,000 revenue from 124,000 licensed hunters.

We have tried to conduct our department in a cooperative manner, and I want to acknowledge with thanks the cooperation of all the federal agencies. They have been very good to us and have aided us in enforcement, research, and other things.

Mississippi is the only state, as far as I am able to learn, that has a lady heading up a project in the Pittman-Robertson program. She has been outstanding in conservation work for several years and we are proud of the work she is doing. I refer to Miss Fannye A. Cook who will be on the program tomorrow.

Mr. Edge (moderator): *The purpose of this meeting is obvious to all. It concerns the relation of the national defense program to conservation. Can the defense program achieve its end without great detriment to conservation or will it be destructive as in the last war? Before we are through I sincerely hope that this panel will produce a definite message to the people of the United States, because certainly we are here for a vry important and most timely discussion. We will hear first from Congressman Collins.*

Honorable Ross A. Collins
U. S. Representative from Mississippi

I have been asked to talk to you on military defense, and to show its relation to the conservation of our natural resources.

I can realize the anxieties that you men and women have; I realize that you are fearful that any kind of military preparation will unduly and unnecessarily drain the natural resources of the country; I realize that in the past that has been true perhaps to a larger extent than was necessary.

It is my conception of military preparedness that it should be based upon a proper balance between personnel and materiel. Wars are always won or lost before they are begun. All of which means that the preparation we make for war is the equipment we must use on the field of battle. For about fifteen years I have insisted, in the Congress of the United States, that weapons with which we fight are vastly more important than the number of marching men that we assemble into what we call the Army. The thing that counts in warfare is fire power, and that means the shot and shell and gas and other missiles that you throw at the adversary. I can arm an individual with a Springfield rifle, and his unit of fire power, let us say, will be one; I can arm this same individual with a semi-automatic Garand rifle, the one recently adopted by the United States Army and the Marine Corps, and his fire power will go up to three; in other words, he will have three times the killing capacity of an individual with the Springfield. I can give him a machine gun and his fire power will be fifty times more than it would be if he used the Springfield rifle. I can give him a properly equipped tank and his fire power will be 250 times that of the rifleman; in addition he will have 360 degrees of maneuverability, and his hide is protected with something besides his khaki, for he is encased in armor. I can go still further and give him a fully armed four-motored bomber and his fire power will be 2,500 times that possessed by a soldier with the Springfield rifle.

Those more powerful types are the kinds of weapons that are going to count, that have been counting in the last few years, especially the tank and the airplane. The airplane is now used as artillery, and it has a flying radius of 2,500 miles in many instances, whereas a field piece has a range of fire of only a few miles. Why not have an implement that is capable of shooting 2,500 miles instead of one that will range only 1 or 2 miles? Moreover, the missile that it drops is infinitely more powerful than the projectile from a field piece.

From what you have read about modern armies in the last two years, you know they have used the airplane, the dive bomber, and have dropped bombs of destruction upon the heavy pieces of the adversary to put them out of commission, followed by the tank to disable whatever is left in the way of machine-guns and other artillery pieces. Those two instruments in cooperation with each other, step by step, have pushed fingers of steel throughout any area that they have attacked.

We know who is going to be our adversary if war comes, or at least our principal adversary and we know the methods employed by that adversary. In Poland, in the Low Countries, and in France, the same tactics prevailed. England has adopted these methods in Africa; in all of the recent campaigns in Africa, England has proceeded upon the same lines as Germany did in the Low Countries and in France.

I have always maintained that large or huge numbers of men minimize rather than increase the potentialities of an army. We plan an army of 4 or 5 million men that have to be paid and fed and clothed and housed. I am fearful if we have an army of such size, that we can't arm them with anything except inadequate weapons because the cost of maintenance will be so high as to prohibit the use of anything except obsolete equipment.

Let it be said in justification of what I have just stated that every nation that has rested its defense chiefly upon manpower has been defeated on the fields of battle. For that reason a few of us have been urging the new way, the new technic, for several years. Let me read from a speech that I made in 1932: "Mechanization implies the actual use of automotive machines in combat. Aircraft, tanks, armored cars are the outstanding examples of fighting machines. We have been accustomed to think of this line of development in connection with airplanes, but not as applied to the ground forces of an army. The purpose of a mechanized force is to provide a powerful, fast moving weapon, capable of maneuverability, which combines fire power, speed, and shock to a much higher degree than now exists in the older arms. It is ideally organized for mobility and surprise."

And again: "The scheme is simply this. Substitute the mile and a half an hour infantry masses or the sixteen mile an hour cavalry, lacking fire power, with a fast moving armored force capable of striking suddenly in one direction, disappearing, and then repeating the blows from another, and this is the technic: Visualize the mechanized force consisting of units of light tanks, supported, when desirable, by companies of medium tanks, with artillery support on tank mounts; there must be help from the air, both for protection against enemy planes and as assistance for the supporting artillery."

Those excerpts are taken from a speech made by me on the floor of the House of Representatives nearly ten years ago, and give a fair outline of what has happened on the battlefields of Europe during the last two years.

We especially need mechanized forces including armored tanks for the protection and conservation of the youth of the country, which, in my opinion, is the one type of protection and conservation in which the fathers and mothers of America should be most interested.

We are all agreed that we must make every sort of sacrifice in order to protect our country and our ways of life, but in doing it we ought to so arm as to give to every individual in our armed forces the maximum degree of fire power and all possible protection from enemy guns and other weapons.

I can't see how such a defense program is going to take very much of a toll from the natural resources of the country. We are particularly fortunate in this country that we have an abundance of cotton.

I know that the farmers have not felt that they were especially blessed, because a surplus always means low prices, but while they have suffered because of abundance, the country as a whole has been benefitted by that abundance. We have on hand more than enough cotton to last us for the next twelve months or longer, even though we do not raise a single bale. The same is true of corn and wheat and to a lesser extent of the other crops.

The timber resources of the country should not be taxed to any large extent, because timber, except for housing, is not going to play much of a part in modern war.

I don't see why wildlife and fish should be punished as it has been in the past. To be a little bit more specific, I may say that besides being on a committee of military appropriations, I likewise am on the agricultural subcommittee, and I know you won't tell on me if I let you know that a bill has been agreed upon including the same sort of soil conservation program that has been carried on heretofore and substantially the same amount as before for forests. I know that the fish that swim in the sea and the fresh waters are going to be protected, even in times of emergency. There are just too many fishermen, or would-be fishermen, in Congress, for anything else to happen. There are also many friends of wildlife. I don't believe that the public forests are going to be depleted; I believe they are going to be held. I do not see the necessity for the cutting of very much timber except what the Forest Service believes should be cut.

Naturally, our mineral resources are going to be taxed, perhaps more than they should be. With that single exception, I don't see very much of a conservation problem in this country. I believe that our outstanding problem is the conservation of the youth of the country, and I think we can do much to protect and conserve our sons by providing them with the kind of weapons that are most effective in warfare.

MODERATOR EDGE: *And now we will proceed with the conservation side of the picture.*

KENNETH A. REID
Executive Secretary, Izaak Walton League of America, Chicago, Ill.

So that there may be no misunderstanding of the conservation viewpoint, I want to say very plainly that there is no intent on the part of any of us who are vitally interested in the conservation of natural resources in any way to impede valid national defense measures. We are for them one hundred per cent, and we will cooperate in them to the best of our ability. We do insist, however, that the nation take the long-time view of the situation and we insist also that the mere label of national defense on a measure shall not be sufficient to let it pass unquestioned. That is one of the greatest dangers that confronts conservation today. Undoubtedly more wood, more spruce, for instance, will be cut for airplanes, more coal will be mined for industries, more metals of various kinds will be used, and all of these things will create conservation problems. If we follow out the same course that has prevailed for many years, we will have a tremendous increase in pollution of the nation's waterways, some of it by industries that are not connected with national defense, but which will use the emergency as an excuse for doing nothing about treating their wastes before they are discharged into the public waters.

Furthermore, on the pollution front we will have to consider the numerous army cantonments. It is unthinkable that Uncle Sam himself would add to the pollution of American waters, yet that is something we shall have to watch very carefully, because unless a demand to correct raw discharges is really made, I am afraid some of these cantonments will, and I have been advised some of them have, put no provision in their plans for treating sewage.

With regard to new factories that are vitally needed for the national defense, often a great deal can be accomplished if consideration is given to placing them where the least damage will be done. If the haste is so great that proper treatment plants cannot be erected, a factory might be located on a clean and valuable stream when it might just as well be built near a stream that is already so badly polluted that it is unusable, or it might be equipped with holding basins that would eliminate or greatly reduce the seriousness of the pollution load before it reached a stream. I think we should urge that these matters be given careful consideration in the locating of new factories that are needed in national defense.

I wish to give you an impression from pollution studies as to the military vulnerability of some of America's largest cities. You know that for many years the practice in this country has been for every city and every industry to get rid of its waste by the most convenient method, namely, dumping it into the nearest waterway. The next town or the next industry downstream has to go to the trouble and expense of taking that pollution out of the whole river before they can use the water, and so the unsocial practice goes on down the river. Everybody dumps everything into it and passes the buck to the next fellow; the next fellow has to work on a sort of soup going between the banks of the river in order to make bacteriologically safe fluid out of it. I sincerely believe that we are paying today as much, yes, even more, for this backhand method of handling pollution than we would pay if we corrected it at the source. We are treating it at the wrong end.

Take the City of Cincinnati as an example. Every city and every industry, with very, very few exceptions, on the Ohio River from its important source, the Monongahela way up in West Virginia, all the way down, dumps its municipal sewage and its wastes into the river. The great majority of the river cities are obliged to use the river as a source of water, and each one has to erect an elaborate treatment plant that is very expensive to operate, in order to make out of that goo—I wouldn't call it water—a bacteriologically safe fluid for delivery through the water faucets to the citizens.

Now just think of the vulnerability of a city like Cincinnati in time of war. A few well-placed bombs on the city water treatment plant would render the whole populace of that metropolitan area helpless. Even if a bombing plane never reached Cincinnati, there would still remain danger from saboteurs on the ground, and they could readily put the people in the same position. The same applies to Pittsburgh, Philadelphia, Washington, and other large cities that are located on vilely polluted streams, yet are obliged to use them as a source of water supply.

When we hear people get up and say that you can't do anything now, you can't retard national defense, if you talk about pollution now you cripple vitally important national defense industries, I believe it is time to look at the other side of the matter and realize how vulnerable we are with our present system of treating pollution at the wrong end.

I wish to call your attention to another danger also—that of drainage. Undoubtedly more land will be farmed, more land will be put under the plow to feed not only our own people, but the armies of our friends. That will be accomplished in several different ways. It is likely, among other things, to give encouragement to the drainage promoters, banes of central United States in the past—drainage syndicates that have made money at the expense of vital national resources and in many cases at the expense also of the poor farmers who were induced to go in and take up former lake and swamp bottoms, that proved worthless for agriculture after all.

Incidentally, drainage throughout the Central and Lake States has probably done more to create floods in the Mississippi Valley than any other single factor. It has also contributed to drouth by destroying natural reservoirs, the lakes and swamps of the river system. By rushing the rainfall quickly down to the sea it causes floods in time of rain, and much lower water stages during dry periods.

Probably much more land will be put under cultivation by irrigation also. There, again, our river systems may be seriously interfered with, and unless all values are considered, the public will suffer the loss of valuable aquatic resources and recreational facilities. All we ask in this matter is that all values be given consideration and not just one value that some particular interest may put forward.

I see another danger on the farming side. There will be more beef and mutton needed and consumed; that will require more livestock. There probably will be attempts to put more grazing animals on our national forests and public lands than these ranges can support on a sustained yield basis.

Do not think I am an alarmist; these and other mistakes were actually made during the last war. The increased demand for wheat for European armies caused hundreds of thousands of acres of natural range land to be plowed in order to raise grain. Then, relieved of the binding sod cover, yielding two or three crops of grain, that light, friable soil pulverized, and winds came along and blew it away. I was in Connecticut one day and saw some of the dust from the far distant plains going over the State of Connecticut and into the Atlantic Ocean.

Producing food, regardless of the consequences, was considered wonderfully patriotic work twenty-odd years ago; the romance of putting this range land under the plow and feeding the hordes of Europe was written about. Don't forget that a few people made a lot of money out of that patriotic work, but that the nation as a whole suffered severely and a large part of our natural resources were irreparably lost. Man can't replace soil; it takes nature centuries to do it. But that was not the only loss. Thousands of families that went out into that country were rendered destitute when the top soil blew away, and they have moved into other sections where in many cases they have made living conditions more difficult for all.

There was still another aftermath of that mismanagement of land. This wartime farming was done on natural range land that had supported thousands of livestock. The livestock was pushed westward into the forests and mountains and seriously aggravated grazing problems there. So let's not have another dust bowl through lack of foresight in the use of our natural resources.

I fear another hazard to conservation and that is from roads. There are probably a good many people in this room who resent the indiscriminate extension of highways into roadless areas. It has been a hard job to keep roads for one excuse or another from being extended into every nook and corner of the United States. Some of the road projects have been stopped and others have been retarded, but many more have gone through, so that this intangible wilderness value that is so precious to many of us and has had so large a part in the moulding of America's character from pioneer days, has, year by year, been gradually diminished by the invasion of roads and other developments, usually prompted by some selfish interest rather than serving the broad public good.

Some of the road proposals that have failed on their own merits are now being revamped under the national defense plan and recommended to Congress as having military value. There is a real danger here. Sometime ago I read of a road to go down the Snake River Canyon as a national defense highway. It would be a tremendously expensive road to build and would parallel a road only a few miles distant. The project smacks of the pork barrel, from which we may expect numerous others will be resurrected.

I understand that recently the much contested U. S. Highway 61 up in the Arrowhead country, in Minnesota, is now reclassified as a national defense highway. That road has been successfully opposed for a number of years but is now coming in under the national defense plan. And so it goes; all over the country, roads and various other projects that could not succeed on their own merits are now being masqueraded under the national defense banner.

Some of you will recall that toward the end of the last Congress a bill was introduced that would authorize the use of any federal lands, including national parks and national monuments, for undefined military purposes. I want to repeat, as I did in the beginning, that conservationists are certainly not going to do anything that will obstruct vitally needed national defense measures, but we believe that this bill certainly needs more consideration. I can conceive very easily how a national park would provide delightful environment for a military training camp, but we do not believe that it is necessary to put an army camp in a national park, considering the tremendous amount of federal land that is not in national parks. So we took the position that if it was proved that some natural resource of a national park is vitally needed for national defense and cannot be obtained elsewhere, bring in a specific bill for that particular national park and let's look it over, rather than pass any blanket proposal that would throw down the bars for all national parks and would be just the sort of thing that a lot of chiselers have wanted and have sought every year in an effort to get a toe-hold or a foothold in our national parks for commercial purposes.

Congress is being flooded with bills providing for the construction of high dams for various purposes. In one place they will be for water power, in another for irrigation, and in another for navigation, and if none of those reasons suffice, they will be for flood control. Some of these also are being called national defense measures. Let's be reasonable about these things. I don't believe anybody expects this present situation to be still an emergency ten years from now, and yet some of these projects would not be finished within ten years. I think it is safe to say that practically none of them could be completed in two or three years. So their contribution to national defense couldn't possibly help in the present emergency, which most of us expect to last only a few years, and certainly hope will not last longer.

We must not let war hysteria blind us to the fact that the natural resources of America are the very foundation of its strength and of its wealth. I feel that conservation of natural resources is the most important long-time problem before this nation. War scares, labor wars, the condition of the budget, and other front-page news may be more immediately pressing, but in another decade they will be history. That is not the case, however, with the problem of intelligent husbandry or our natural resources. That will be with us ten years hence, and as long as civilization lasts, and it will become increasingly important as time goes on. Let the money-minded, those who scoff at the value of a few fish, or deer, or trees, not forget this fundamental fact, that the natural resources of America are the only source of all wealth. I want to repeat that: Our natural resources are the only source of all wealth, and on the way we husband those resources will be determined the economic strength and wealth of this nation and the standard of living that future generations of Americans will enjoy. Let's have real national defense, but let's not be blinded to the future of America, and let's be very sure that after the present period is over, America will be worth defending.

MODERATOR EDGE: *Our next speaker also is for conservation.*

EDWARD W. ALLEN
Secretary, International Fisheries Commission, Seattle, Wash.

As Mr. Reid has indicated to you, every loyal American is not only in favor of adequate defense, but insists upon it, and we of the Pacific Coast are particularly gratified that the Army and the Navy have extended their operations to Alaska.

One speaker the other day intimated that there was an incompatibility between business and conservation, yet when you consider conservation as merely the application of common sense to our natural resources, one would think that it would appeal as much to the hard-headed business man as to the academic theorist, and there are reasons why conservation should appeal even to the gentlemen of the Army and the Navy.

Let me give you one illustration of cooperation in the field which might interest you. I do so because my friend Charlie Jackson of the Fish and Wildlife Service and I have the honor of representing this country on the International Fisheries Commission. This is a committee consisting of two Canadians and two Americans. All the members from the time of its creation down to date have been loyal, patriotic citizens of their respective countries, yet in the seventeen years of that commission's existence, every decision has been unanimous. Why? Because each member has been ready and willing to listen to the other person's point of view and finally to make his decision upon the basis of facts.

The dangers to conservation from failure to consider the other fellow's point of view are illustrated by the plans for that great project, the Bonneville Dam, a very large dam across the Columbia River, which is one of the most important rivers of this nation. This dam is just a few miles above the City of Portland, Oregon. Supervision of its construction was assigned to the Army Engineers. Now those gentlemen are unquestioned in their integrity, their sincerity, and their ability, and yet they planned to erect the dam without consideration of any other element than power, because it was called a power dam.

It happens, however, that in the Columbia River there is a great fishery, one that for many years averaged approximately 10 million dollars in its annual revenue; if you will capitalize an annual income of 10 million dollars you will see that the resource amounts to something. The salmon are migrating fish, they go out to sea and come back to the headwaters in which they were hatched. The dam was so planned that it would have absolutely ended their migration up that river and would have annihilated an enormous industry giving employment to thousands of people and producing a nationally important food product.

What did the Army Engineers say? They said, "We have nothing to do with fish."

Now it happened that the people of the Northwest were aroused over this matter. They appealed to Washington, and they put up a real battle, with the result that the Army Engineers were compelled to think about fish and to put into that dam ladders or fishways that have saved that enormous resource. I wish to say this, however, to the credit of the Army Engineers: that once their eyes were opened to the necessity of considering other things than the mere construction of a dam, they have cooperated most heartily. But I point this out to you to show you how a thing can be undertaken with just one object in mind, and in a way that might be very destructive to other interests, but that it can also be done with proper attention to all of the elements that are involved. So in the matter of national defense, the forces of conservation are not in opposition, but they do insist, when a national defense project is under consideration, that every aspect of the matter should be given full consideration.

Turning to an activity, mentioned by Mr. Reid, that of bombing; we know that our young airplane flyers have to be trained in the use of bombs; they can't get it out of a book; they must have practice, and the only way to get it is actually to drop bombs. It is essential that both the Army and the Navy in the training of their men must drop bombs. All right, but where shall they do it? Shall they do it where it will destroy a valuable forest? Shall they do it in a part of the sea where it will destroy a valuable fishery? Shall they do it where people have their farms and where they must be moved out unnecessarily? Or are there not areas, bleak or waste, on land and waters where there is a fish population of little value, that can be used for that bombing practice? In other words, it seems to us that when they are selecting those areas they should not merely think of the single question of how we are going to give the boys practice in bombing, but that it is equally important that they should consider how little damage they can do and still get needed experience.

In the matter of the erection of dams, I referred to the Bonneville case, and Mr. Reid very appropriately called your attention to the fact that people who have some private interest to serve try to take advantage of the words "national defense" as a cover for advancing their personal interests. A dam of sufficient size to be of any consequence in the cause of national defense cannot be an emergency matter; because a dam of that kind takes years to build. If there are dams that seem to be justified, they should be considered not merely from the standpoint of power production, but their effects upon fisheries and upon flood control, or other interests should receive due attention.

A great deal that has been very damaging, as Mr. Reid has indicated to you, has been done in the name of flood control. I referred to getting the salmon fish up and down the Columbia River, but there is another factor affecting fisheries. Some of our rivers, in the name of flood control, have been made into veritable flumes that shoot the water right out to sea and make fish life impossible. Moreover, they are not accomplishing the purpose for which they were modified. Let this be a warning, and in conection with all so-called new improvements let us not be beguiled by the word "emergency."

In the field of commercial fisheries, we learned in the World War that the same insistence on production that was so disastrous, as Mr. Reid has pointed out, to the Mississippi Valley in creating the dust bowl, was equally disastrous in the case of the fishing industry. There has long been a great salmon fishery on the Pacific Coast founded on the sock-eye salmon of the Fraser River. Without going too deeply into its biological history, I may say that this particular salmon is what we know as a 4-year fish; that is, it will spawn one year, go out to sea, and in the fourth year return to the stream in which it was born, there to spawn and die. These four-year periods are the population cycles of that fish. A run of the sock-eye in 1913 was very severely injured by a great rock slide in the Fraser River, and that depleted brood returned in 1917, just at the height of the demand for food production, and there was such overfishing of the salmon in that year that on the next return of the cycle, the sock-eye run had been reduced to less than a quarter of its magnitude in 1917.

Such short-sightedness, it seems to us, can be avoided. We can safely increase production, only if it is done in a rational manner, and we have a Department of Fish and Wildlife in our Federal Government that is qualified to determine what increase in take can safely be allowed. We finely believe that those who demand increased production, in fisheries, for instance, should be obliged to consult that department of the Government which is expert in the matter of fisheries, and not go ahead blindly in total disregard of the future.

And so, it does seem to me that while we all wish and demand national defense, we have a right to call upon those who are in charge of that work to take a broad-minded attitude in their approach to each problem as it arises, and at all times to keep in mind the future of this country. We also have a right to expect our natural resources to be so used that we may get the maximum benefit out of them, but at the same time preserve them from year to year indefinitely in the future.

COL. WILLIAM J. BACON
United States Army Retired, Memphis, Tenn.

Listening to these discussions this morning, I have concluded that there is no difference about this problem at all between the Army and the conservationists of the United States. The Army has got a job to do and it is a big job. It is more than a man-sized job; it may be an impossible one. No one can tell. But on the outcome of how that job is done is going to depend the entire future history of the United States, if not of the world.

We are fortunate in having men in Congress like Mr. Collins, who have studied defense problems, who have worked over them, and we are fortunate in having men in the Army of the United States who have given the best of their lives to them. We are also fortunate in having public-spirited citizens like the membership of these organizations who are meeting here today, who have studied the problem of conservation and are willing at this time to give all of their thought, all of their knowledge, all of their ability, and all of their effort, in teamwork with the Army, with the Navy, and with the governing authorities of the United States to try to get the job done, and done satisfactorily.

War and even preparations for national defense on the scale we are attempting necessarily involve great economic losses. Not only financial loss but if war comes there will be loss of human lives, and destruction of natural resources, buildings, monuments, and of everything that the nation possesses. But at the end of the struggle, it is consoling to think that there are men and women in the United States who have given their thought to conserving the natural resources of the country, and that we can again join in trying to bring the country back to normal, so that we can pursue again our accustomed avocations in peace and happiness.

But even in the struggle, in all the efforts that are being made, and in all the planning, it is highly important and imperative, I believe, that the Army should consult with the conservation authorities of the country, so that through counsel and careful consideration of the problems that confront the nation, some scheme should be worked out by which the defense of the country can be carried on with prospects of ultimate victory, and yet carried on without irreparable destruction of the natural resources that have made this country what it is today.

Primarily there are two kinds of natural resources, those that are exhaustible and those that are replaceable. You can't put back in the earth, oil and mineral rocks. You can, however, restore a great deal of the grass, you can restore ordinary wastage, if not severe erosion, of the top soil. You can restore the purity of streams, you can restock the streams with fish, and the suitable lands with game and birds and mammals.

Just what toll is going to be taken of our resources no man can figure. If the emergency is prolonged, it is going to be stupendous. I thoroughly agree with the gentlemen who have said that some projects camouflaged under the name of national defense and preparedness are not such in fact. I realize that many of these projects also will require years to finish, they can't be done over night. But you must take probabilities into consideration. This war is going to be a long-drawn-out war; it will go on, I hope for three or four years. That may seem an unpatriotic statement to make, but I can't envision any quick wind-up without utter destruction of Great Bratain, and then God only knows what penalty we here in the United States will have to pay. For the war to end quickly, Britain must go down, and if Britain is destroyed, we are left alone in the world to fight for the things that we hold sacred, that our forefathers fought and bled and died for, for the things that have made our nation what it is today. They are entirely worth fighting for, they are worth making any sacrifice for, and I know that you men of the conservation organizations realizing the seriousness of the situation that confronts the world today, agree that we all must make sacrifices as individuals, as organizations, as a nation, that we must forget, for a while, our hobbies and must sacrifice for the good of the nation and the security of the world.

The Army is not unreasonable. The Army is a one-idea organization, and that idea is to win, and sometimes in its determination to win, in the effort it puts forth for ultimate results, it loses sight of some of the things that you men consider precious, as it did the fish stairways in the Bonneville Dam, but the men who control the Army, the high ranking officers, and, as a matter of fact, most of the officers in it, are men of judgment, of vision, of education, and ability, and they are quick to realize the justice and the fairness and the necessity of conservation measures when pointed out to them. They have not been thinking along the same lines that you have, and your patriotic duty is to guide them and advise them on matters on which you are posted and on which the Army is not informed. By combining your effort, your thought, your experience and your study, with those of the men who control the Army, I believe it will be possible to carry this emergency through to its ultimate end with less destruction of the natural resources and the wildlife of the United States than if that cooperation is not exercised and the experience and thought and knowledge of both elements are not combined in working out the ultimate plan.

The health of the Army is a very important matter. A sick man cannot fight, in fact he is a great handicap to an Army. An Army in an active campaign is more handicapped by those who are wounded and those who are sick than by those who are killed. You can leave the dead on the battlefield, you can come back and bury them if there is a lull in the fighting; but you can't leave a wounded or a sick man there.

Necessarily, there will be some destruction of water resources to prevent malaria. Where the big camps are located, the medical authorities will be quick to make a survey of the stagnant water and marsh where malaria mosquitoes can breed and get rid of them. It may be possible to do that without permanent injury; it may be possible to do it in such a way that when the danger of infection among the soldiers is over and they go back to their homes and the big camps are dismantled, the water can be restored as it was before the emergency.

There will be some increased pollution of streams, necessarily; there is no way to avoid it. You can't erect expensive reduction plants to take the waste from all the factories that are going to be put under 24-hour production, and deleterious chemicals no doubt will be turned into the streams of the country. That will be bad for the fishes, and as was so well pointed out here today, it is going to put an extra burden on the cities further downstream when they try to make the water supply suitable for human consumption. It is a serious, almost a desperate problem.

Nobody knows when the war will end, but I believe that the American people, whether they are in the Army, whether they belong to the wildlife organizations or the fisheries organizations or the Methodist Church or the Baptist Church, whether they are lawyers, doctors, farmers, or what-not, realize, as a whole, the seriousness of the situation that confronts us today, and that they are willing to make any sacrifice that is necessary. But I further believe that they will require of the men who control the Army and the Government that common sense and judgment shall be used in the defense program, and that as little damage shall be done to our natural resources as is possible to do and carry through the job to a successful conclusion.

DISCUSSION

MR. GUTERMUTH (Indiana): I would like to inject two other thoughts into this panel discussion, and to hear the opinions of others upon them.

First, a time-worn and often-defeated bill has recently been presented to the National Congress, as well as to a number of the state legislatures, to further restrict traffic in guns and ammunition and to require the registration of firearms. I believe that the sportsmen of this country should give serious consideration to this move and should present their views, not only here, but to the different law-making bodies.

One of the responses to an appeal from Great Britain has been the donation in the Bundles for Britain of many firearms that the sportsmen of this country could spare; they are now on their way to the British Isles to help protect the people from parachute troops. It seems to me if we continue to make it more difficult for our people to have firearms and ammunition, we may some day find ourselves in that same deplorable condition.

The second thought is this. One of our leading national sporting magazines has been publishing editorials and circularizing the country with letters and I believe even has gone as far as to present bills to some of the state legislatures, asking that free hunting and fishing licenses be given to conscriptees. This is one of those proposals masquerading as national defense that have nothing to do with it. I think it would be a mistake to divert any of the money that comes from the sale of hunting and fishing licenses and which is used to carry on wildlife wark, to provide free permits for any particular group of people in this country.

MR. COLLINS: I do not believe there is any possibility of the passage of national legislation for the restriction of ownership of sporting firearms.

MR. GUTERMUTH: The bill for free hunting licenses that is being advocated by a national magazine would make it mandatory on a state to give free permits to all conscriptees. In Indiana at the present time, we give a permanent free permit to all of the soldiers, sailors, marines, and nurses who served in the four major wars of this country. Probably 235,000 permits, to those groups, are in force in our state. We have another bill presented to give free permits to all persons over 60, and the bill being advocated by this national magazine is to give permits gratuitously to all of the conscriptees. Where, I ask you, is the money coming from to carry on the fish and game work in the several states if we are going to give free permits to everyone?

MR. REID: I think the move, Mr. Gutermuth calls to our attention, would be definitely unwise. Not being on a state commission at the present time, I am not so much concerned about the loss of revenue, but the proposal considered as a feature of the management of wildlife that we are trying to establish is unsound. I know of one place where such action would be tragic, and that is in Alaska. There has been a desire on the port of the Army personnel there to hunt the big game of Alaska on a resident license, and Lord help the big game if such a thing should go through, not to speak of the proposal for no license at all. It is perfectly obvious, if the bars are let down to that extent, that game management and fish management would cease to exist in areas overrun by large numbers of conscriptees many of whom would be interested in hunting and fishing. After all, the favor would be small, for the license is the smallest part of the average sportsman's expense. I think the suggestion is just a little more hysteria, perhaps seized upon by someone as means of getting publicity and a little popularity with people who want to get something for nothing. I don't believe that the American sportsmen, as a whole, want to get something for nothing or would be in favor of such legislation.

MR. EDGE: Now is a good time to ask what the sportsman has in the way of constructive suggestions to offer as to national defense. Mr. Reid, would you care to go into that a little bit?

MR. REID: I think America is extremely fortunate in having some 17,000,000 sportsmen. The fact that we have a large land area, and, compared with some

European countries, a less dense population makes the pursuit of hunting and fishing by the average citizen of the United States a possibility such as does not exist over there, and the fact that the American sportsman regularly goes out each year with his gun in the pursuit of game gives this country not only men partially trained for the Army, but a splendid force for home defense. Many of the sportsmen's groups all over the country, our own and others, are regularly on skeet fields, rifle ranges, and pistol ranges, constantly using the different types of firearms. They are training themselves in marksmanship and I believe constitute a very valuable auxiliary of the Army.

I think it would be very unwise to attempt to disarm the whole American citizenry on the plea of better control of criminal individuals and subversive groups, for I believe that America is extremely fortunate in having this great army of sportsmen who have guns and who know how to use them.

MR. EDGE: I think it would be in order to ask the Congressman a question. He made a statement to the effect that he saw no possibility of the upsetting of existing federal agencies dealing with forestry, fisheries, and so forth, that look after our natural resources. It is my understanding that in a state of national emergency the Army and the Navy have a right to commandeer any resources. What assurance have the people who want to husband and guard the natural resources of the country, and what provision, if any, in that direction is going to be made in legislation for national defense?

MR. COLLINS: Mr. Chairman, before I answer that question, let me add this to what has already been said by my friend Mr. Reid, with reference to the things that are being done by the sportsmen of this country and the good that is to be accomplished by the conservation particularly of game.

I am for you people, and I want to see you carry on. You are doing much more than the conservation of game and natural resources; you buy a tremendous amount of ammunition, and thus keep the munitions companies of this country in existence. The sportsmen of this country are responsible for the development of the semi-automatic rifles and automatic rifles and other weapons that are being used. So you people are making a large contribution, a much larger one than some of you probably realize, to the military defense of this country.

What is Washington going to do for the conservation of natural resources of the country? You need not be in the least worried about the conservation of the soil, because, for one reason, and I say it to you emphatically, we have more food and fiber crops on hand now than we know what to do with. In this year's agricultural appropriation bill we are providing for a further reduction in the crop acreage of the country. We can't possibly use for ourselves more than 8 or 9 milllion bales of cotton; we can't possibly sell foreign countries more than a million bales; yet we are going to raise 12 million bales and we already have about 12 million bales on hand. Similar surpluses exist of other crops.

With reference to dams for the generation of electricity, for flood control, navigation, and so on, we don't propose to do any more than authorize surveys. We couldn't get by, as the saying goes, with more than that if we wanted to, because there is a tremendous urge on the part of everybody, including members of Congress, to keep appropriations for all activities of the government, other than for military and naval defense, down to a minimum. So there is no reason, friends, for anxiety on that particular matter.

Of course, some of the forests are going to be depleted to get lumber for the construction of camps and some of the low places are going to be drained, but I believe that we can face the present emergency with the assurance that the natural resources of this country are going to be conserved to a very much greater extent than they ever have been under similar circumstances in the past.

MR. EDGE: The Congressman answers the question in one way, but I still haven't the answer I want. I may add that it is my understanding that there has been brought before the Secretary of the Interior a proposal for a national advisory board on conservation, and that this proposal has been brought to the attention of the President. There it rests. I do not know what disposition is going to be made of it. But I believe that the meeting on national defense and conservation such as this should certainly go on record as favoring that proposal.

I might ask Mr. Allen, who is a member of the International Commission, how he feels about the suggestion that the existing conservation groups in the United States, representing all of the people who have anything to do with our natural resources should form an advisory council to the United States Government on this matter of the correlation of conservation and national defense.

MR. ALLEN: That sounds like a good thing. Some of you may know that the Department of Commerce, at the time that it included the Bureau of Fisheries, established an advisory board consisting of representatives from all parts of the country to meet once a year in Washington, review the entire national situation, and submit suggestions and advice to that Department. The Department of the Interior, which has now taken over the national fisheries, continued that advisory board, which held a meeting in Washington only about two or three weeks ago. It is composed of representatives of the industry from all parts of the United States who come, without compensation of any kind, to present their local problems, discuss the situation, and submit their views to the Department. If such a committee is good for a department, why should not one on a larger scale be good in advising the national government generally with reference to conservation problems? It seems to me such an advisory council to the Government would be highly desirable.

MR. WALCOTT (Connecticut): I have only a word to add, and it is this: At a meeting of the Maryland State Game and Fish Protective Association on December 7 I spoke on this subject of the threat to our national natural resources, and suggested, at the end of that speech, a resolution, which the Maryland Association adopted unanimously, and which the Outdoor Writers adopted unanimously at a later meeting, the purport of which was that a national advisory board for the protection of our natural resources be appointed by the President. It caught the ear or the eye of Secretary Ickes, and he wrote me quite an enthusiastic letter about it and said he thought it was a very wise thing and if we didn't object, that is, if the sportsmen or the conservation associations didn't object, he would like to present it to the President himself, which he did. The President was very much interested in it and sent word back to me that we must keep our eyes and ears wide open and be on the alert; that he did not feel like adding to the number of boards just at the moment, but if there was any real threat to our natural resources he would respond at once and take such steps as were necessary to check it.

That is as far as the matter has gone. Whether other resolutions of a similar sort, or whether the backing of other associations, such as this, will bring further progress, I don't know. I feel that the President knows a great deal about the situation; he appreciates the danger, and I think he and Secretary Ickes would be the first to set up some board for the protection of our natural resources if they though they were seriously threatened. It certainly devolves upon us at least to see that if they are threatened we get promptly to Secretary Ickes and the President, or to both of them.

MR. EDGE: We have just a few moments remaining for discussion and I would like to call on William L. Finley, of Oregon, for a contribution from his section of the country.

MR. FINLEY (Oregon): We who live on the Pacific Coast have felt that the national Government has certainly allotted a great deal of money to building power dams there. The dam on the Sacramento River is a 500-foot dam that will cost anywhere from 200 million to 300 million dollars. They had to spend 20 million dollars to get the Southern Pacific Railroad line out of the way. At Bonneville Dam they have already spent over 100 million, and the Grand Coulee project, as estimated by the authorities, will cost 400 million dollars.

Local interests in the West expressed definitely, years ago, the opinion that the President should not spend too much, that he should balance the budget, but later they took the stand that since he was going to spend any way we ought to grab all we possibly could for our region. So they brought up the plan of building seven additional dams on the Upper Columbia River, but they couldn't quite put that through even though they worked upon it for about two years. Then they suggested seven dams in the Upper Willamette River. They got the Army Engineers to study this project and received a very thorough report upon it. That report stated that if the objective was flood control, it could be achieved in two ways: In the first place, by revetments or by levees and revetments at a cost of 33 millions, or by the high dams at a cost of sixty-two million, seventy-five thousand dollars. Immediately the pressure groups decided that they would rather have the larger amount of money. It was put through Congress on the theory that flood control should be the purpose of the Willamette River, although the report of the Army Engineers stated very clearly that under the Flood Control Act of 1936: "Local interests be required to bear the cost of land and damages, including the cost of railroad relocations and the facilities for the propagation of fish and related works, and be required to maintain and operate the reservoirs on completion." The cost, therefore, would be, to the local interests, $18,645,000, and to the Government, $43,430,000.

That was a poser. The local interests didn't like to pay that amount, so they combined with lobbyists representing different parts of the country and procured a change from the Flood Control Act of 1936 to the Flood Control Act of 1938, the latter providing that local interests would not have to pay a thing, that all expenses would be borne by the Government. I think that was against the best judgment of the Army Engineers, and of the National Resources Committee, because they had stated very carefully: "If projects deserve federal contributions, they certainly also deserve local contributions, and unless local interests are prepared to make appropriate contributions on their own behalf, the Federal Government normally should not participate in the improvements they seek." And they said, "Do not permit pressure groups and special local interests to obtain unfair advantages at the expense of Federal taxpayers."

Now just one moment in regard to flood control in the Willamette. That river rises in the high mountains where there are vast forest areas, so there is no flood control problem there at all comparable with that of rivers with great tributaries flowing through cultivated regions, such as have been created for flood control elsewhere.

The main thing that the flood control interests could bring up was that in 1861 there was a big flood and that another is likely to come and cause us a good deal of trouble. Even the need for irrigation was suggested as a reason for this project. Yet in the Willamette Valley we have 41 or 42 inches of rain during the summer and in the headwaters in the Cascade Range we have 100 inches. The facts are that along the Willamette we are not in need of either flood control or irrigation.

Now I should like to present a resolution on this subject, which I think will be approved by the Army Engineers and by all here.

Whereas, The basis of wealth of this nation is in the public resources of land and water, the conservation of these resources means their wise use for the benefit of our people and not their misuse. Over-exploitation by individuals, special interests, and pressure groups, in many cases, results in destruction and loss to our people as a whole.

Whereas, The rivers that rise in the mountains and flow down the valleys toward the sea have different public values that should be recognized, studied, and carefully conserved for the benefit of all the people of this nation; and

Whereas, The damming of many rivers, like the Columbia, has followed the studies and reports of engineers and the proposed damming of many others, like the Wilamette, has been outlined only by engineers; and

Whereas, These proposed projects have not been studied by other experts, now therefore be it

Resolved, That none of the other rivers of this nation be blocked by dams until studies of such projects be made and their value determined by economists and scientists whose reports shall be published; and be it also

Resolved, That copies of this resolution be sent to President Roosevelt, Secretary Ickes, the Chief of the Army Engineers, and any others that should have it.

The resolution was approved.

THIRD GENERAL SESSION

Wednesday Morning—February 19—Arkansas Day

Chairman: D. N. GRAVES

Secretary, Game and Fish Commission, Little Rock, Ark.

CHAIRMAN GRAVES: *The Governor of Arkansas, the Honorable Homer N. Adkins, has asked me to express his sincere regrets that he cannot attend the Conference. The Governor has asked that I read the address that he intended to deliver.*

AN ADDRESS READ FOR THE HONORABLE HOMER M. ADKINS, GOVERNOR OF ARKANSAS

As Governor of Arkansas, I wish to express my appreciation of the fact that this great annual wildlife conference is being held here.

At this particular time, this conference is impressively significant for two reasons. The fact that a national conference of this nature can be so well attended, at a period when so much of the world is desperately involved in war, is significant of the soundness of our democratic form of government. Possibly even more important is that a conference of wildlife conservationists, state and federal wildlife administrators, technicians, and many persons who are not officially connected with wildlife conservation have, by their presence at this conference, demonstrated our realization, as a nation, of the vital importance of conserving and developing our natural resources.

It has often been said that the effects of each of our several periods of economic depression that have followed great wars have been softened and, to some extent, absorbed by mass movements of our people to new frontiers and by further exploitation of our natural resources. We sincerely trust that our nation will not be drawn into the whirlpool of world strife but, even so, our efforts to rearm the nation and to build up our national defense will make it vitally important for us to maintain and preserve a cushion of natural and renewable resources to soften the after effects of emergency by preparations. We must conserve and develop our wildlife resources for our use and enjoyment when the present emergency shall have passed—and pass it will. Though we no longer have new frontiers, the resources of which

I speak are renewable and will serve our great nation as a back log in whatever the future may hold for us.

I think of myself as I speak to you today, not as the Governor of Arkansas, but as one of her citizens who is sincerely interested in the future resources of my state and nation and as one who is also interested in the wildlife resources as a sportsman. I appreciate the recreation and enjoyment of a day in the field with dog and gun and some friend. The thrill of a deer hunt and the fellowship and friendliness of a campfire are imprinted indelibly on my mind. All these things go to make up what we term the "American way of life." We love and cherish these things; we must make effective our stewardship of the resources upon which they depend if our future citizens also are to enjoy them.

Our national defense program, in all its ramifications, must of course, take precedence over all other governmental activities. But none other than the President recently said, in his message to Congress, that our national program of conservation is vitally important as a national defense measure and must not be permitted to suffer. I shall see to it that wildlife conservation shall not lag or suffer in my state throughout my tenure of office as Governor and I sincerely hope and trust that this important work will continue at an accelerated rate in Arkansas and in all of the other states of our nation.

Wildlife conservation, development, and management is "big business" for any state government; it is also "good business." I have observed that today there is much more interest in wildlife conservation all over our nation, and in Arkansas particularly, than ever before. This aroused interest is due to a variety of causes. Among them is the influence of the so-called "New Deal" agencies, which directly reflect the sincere desire, on the part of the President, to further the conservation of our natural and renewable resources. The greatly increased demand for better hunting and fishing is one of the results of a national economy that has provided our people with better roads, greatly improved transportation facilities, improved sporting equipment, and, above all, a higher standard of living that includes more time for leisure, relaxation, and recreation. This increased interest has been made articulate by such national organizations as the American Wildlife Institute, the National Wildlife Federation, and the Izaak Walton League. Local chapters of these organizations, together with many other sportsmen's clubs, have been established in our state. I have observed that invariably the men in any community who assume the duties and obligations of such organizations are the leaders of that community, leaders in business, in citizenship, and in community life. In Arkansas much credit for this increased interest is also due to the

Game and Fish Commission and its employees. Through their efforts our laws relating to wildlife have been made more effective and the efficiency of departmental administration has been definitely improved.

Our Commission consists of seven members appointed by the Governor who serve without remuneration. All appointments that are to be made to this Commission will be leaders of their respective communities; men who have a statewide interest and viewpoint and, above all, men who are sincerely interested in and informed concerning wildlife conservation and management.

We shall retain the employees of the department who have been doing a good job and who have gained invaluable training and experience in wildlife work—no matter who they voted for last August—and when we find an unsatisfactory employee, a dead-head on the pay roll, we shall fire him—no matter for whom he voted.

The Commission will be held responsible for the operation and administration of the department. They, in turn, will hold their executive secretary responsible. He will be authorized to fire unsatisfactory and unfit employees—no matter who recommended their appointment. I have assured the National Wildlife Federation and the sportsmen's organizations of our state that their recommendations regarding appointments will be most carefully considered. This procedure will, to a great extent, remove the department from political influence.

Now, a word about finances. For the biennium ending July 1, 1937, the annual appropriation for the department was only $116,800. A request to increase the resident license fee for hunting and fishing was granted by the Assembly. These fees were increased from $1.10 to $1.50. This slight increase together with more effective and improved enforcement and greater public interest enabled the department to build up its revenues to a point that justified an annual appropriation of $200,000 for the current biennium. In the General Assembly of 1939 increases were levied on certain commercial fishing operations and other existing license fees were applied to wider bases generally. These increases, again with more adequate enforcement, have enabled the department to justify an annual budget for the ensuing biennium of $333,580, an increase of $133,580 annually.

This appropriation will enable the department to add eight technically trained full-time employees to its staff, two additional district supervisors, four special investigators, and to establish six district offices. Approximately $70,000 annually will be available from this appropriation for matching federal funds available to our state and for acquisition and development of game refuges, public shooting grounds, fish rearing facilities, fish rescue, drainage to eliminate hazardous conditions, control of gar fish and other predators. Ten thousand dollars has been ear-marked for the purchase of game for restocking refuge areas.

Heretofore, the work of the department has been handicapped by lack of funds and, as a result, it has not been able to cooperate fully with the Federal Government. This handicap has now been removed.

I find, upon inquiry, that Arkansas has a high standing, with the various departments of our Federal Government that deal with wildlife and I shall lend my efforts and influence to see this relationship further improved.

In conclusion, let me repeat that—I shall personally see to it that wildlife conservation shall not lag or suffer in Arkansas throughout my tenure of office as Governor.

FISH REFUSE TO RECOGNIZE MAN'S BOUNDARY LINES

CHARLES E. JACKSON
Assistant Director, U. S. Fish and Wildlife Service, Washington, D. C.

Protection of fishes that migrate from one state to another or from one nation to another is one of the most difficult problems facing fishery administrators of the State and Federal Governments today.

The general public does not understand that the Fish and Wildlife Service has no regulatory jurisdiction over the fisheries of the several states. The fact that the Service does have regulatory control over all migratory waterfowl, through an international treaty, makes the situation all the more confusing.

Unfortunately there is no similar international treaty affecting all migratory fishes. However, there are two separate treaties with Canada, each providing for a single species of fish—the halibut of the North Pacific and the sockeye salmon of the Fraser River. Although fisheries would benefit immensely by them, there are no treaties pertaining to the fishes of the Great Lakes, the lobster fishery of the North Atlantic, the shrimp fishery of the Gulf, nor the pilchard and tuna fisheries of the West Coast.

Even if we had treaties between the United States, Canada, and Mexico to conserve the migratory fishes that cross national borders there would still remain unsolved problems relating to adequate protection for the fishes that move across state borders, like the shad, striped bass, bluefish, sea trout, sea bass, and many game fishes that abound in interstate waters. I list these species for illustrative purposes, recognizing that some of them may technically be international, but their abundance beyond our national borders is insignificant.

The power of the Fish and Wildlife Service to regulate fisheries, therefore, is limited to the Territory of Alaska. Every state has jurisdiction over its own fisheries, even though the fishes are in interstate waters. For instance, Tennessee has authority over the fisheries of the Mississippi River within the state lines of Tennessee, but adjoining states control the fisheries in the same Mississippi within the borders of their states. Furthermore, the coastal states have jurisdiction over the salt-water fisheries within 3 miles of their shores. Since the Federal Government has always recognized the 3-mile limit in international law, neither the state nor the Federal Government claims jurisdiction over the fisheries beyond it. Hence, a salt-water fish, when it leaves the 3-mile zone, enters into "No Man's Land" and passes beyond the sphere of protection of either the State or Federal Government. Thus our own citizens, and foreigners as well, under this 3-mile doctrine, may take these fishes without any regulatory control whatever.

Much has been said and written about this state of affairs, particularly with regard to the Japanese fishing off the coast of Alaska for salmon and crabs. In fact, there are bills pending in Congress proposing to extend the jurisdiction of the United States over waters to the end of the Continental Shelf.

Conflicts between conservation laws of the states, such as exist with respect to minimum size limits for certain species of fishes, often result in disregard for any size limit, or at least the shortest limit comes to be recognized as the *de facto* law. Seasons also sometimes conflict. The States of Virginia and Maryland have different black bass seasons on the tidal waters of the Potomac River, Virginia opening on June 15 and Maryland on August 1, an interval of 46 days. The seasons presumably are designed to allow black bass to spawn in the spring and summer months before being subject to capture, yet all the bass in this section of the Potomac River and its tributaries spawn at the same time. An angler, therefore, can start fishing for black bass on the Virginia shore 46 days before he can fish on the Maryland shore. Since the State of Maryland does not have as many wardens as anglers, it has a difficult task to prove whether bass have been taken in the open waters on the Virginia side or in the closed waters of the Maryland side.

So much for an illustration among fresh-water fishes. Now let us turn to the Northwest Pacific Coast, where we find commercial trolling for chinook salmon in the coastal waters of California, Oregon, Washington, British Columbia, and the Southeastern part of Alaska. These areas have fairly adequate laws protecting the salmon fisheries, but the trolling takes place largely in waters beyond the 3-mile limit, where, as stated before, neither the state nor Federal Governments have jurisdiction. The result is that fishermen working the inshore waters in conformance with the laws of the jurisdictions involved, are penalized by those fishermen who operate 3 miles offshore and have no limitation as to season, size or any other restriction. Scientists have found that the chinook fishery is facing a serious situation; great quantities of immature salmon are being taken and the total production is falling off rapidly. If not corrected this trend inevitably means loss to all concerned.

We are familiar with the construction of the great dams on the Columbia River, and the whole nation is interested in the efforts being made to perpetuate the salmon runs despite the handicap of the dams. The Federal Government has spent millions in providing ladders to aid the fishes over the obstructions, and the Fish and Wildlife Service is now engaged in introducing salmon to new streams in order to make up for the loss of spawning grounds in the upper Columbia River that will be shut off by the construction of the Grand Coulee Dam. How inconsistent it is on one hand, to spend these millions to protect the valuable fisheries of the Columbia and, on the other, to permit unregulated fishing just 3 miles off the mouth of the river.

Pollution also is involved in the Northwestern fisheries problem. Laws regulating pollution in the States of Idaho, Washington, and Oregon, are inadequate and there being no federal jurisdiction, if Idaho pours polluted matter into the Snake River and destroys the salmon spawn in the headwaters of the Columbia system, there is nothing that either the national government or the States of Washington and Oregon can do about it. Under present divided control, the problem of conserving the Columbia River salmon is only partially solved. Under existing conditions, what have we accomplished if a chinook salmon succeeds in eluding the troll fishermen in outside waters; escapes the nets and fishing apparatus in the lower Columbia River; climbs the ladders of the Bonneville Dam; avoids the dip nets of the Indians in the Upper Columbia; and finally arrives on the spawing grounds in Snake River or its tributaries, only to have its spawn destroyed by Idaho mine wastes. The vital need is for unified control between the states, provinces, and nations involved, so as to give full protection to the valuable Columbia River salmon. It appears that the best thing to do would be to negotiate a new treaty or to extend the existing salmon treaty to include the Columbia River chinook.

Now let us discuss the conflict of laws that apply to other fishes migrating between the United States and Canada, such as the sockeye salmon of the Fraser River. This valuable fish, in order to reach its spawning grounds, must swim through the waters of Puget Sound in the State of Washington, and then proceed to the headwaters of the Fraser far into the northern part of British Columbia. Ever since the establishment of the salmon industry, the fishermen of Washington and British Columbia have competed to exploit this rich resource and as a result of this competition this valuable fishery became seriously depleted. The Canadians complained that they could only take a portion of the salmon reaching the Fraser if any were to be spared for spawning, yet they had full responsibility for protecting the salmon en route to, and on, the spawning grounds.

After some forty years of controversy, a treaty was finally ratified between the two nations in 1937, and the International Pacific Salmon Fisheries Commission was created. Because of fear on the part of some of the U. S. fishermen, it was necessary to make an agreement that no regulatory authority would be granted the Commission until two complete cycles of sockeye salmon had passed. In other words, the Commission has no authority to regulate the fishery for a period of eight years that will terminate in 1945. If the scientific investigation should indicate that the sockeye salmon of the Fraser will be entirely depleted in 1943, there is no power in the Commission to prevent the catastrophe, and it would be necessary immediately to seek an amendment. We are now completing the third year of investigation. By 1945 the Commission expects to have data upon which to base adequate regulations. Over a period of years, we hope gradually to rebuild this resource to its former abundance, normally worth approximately 35 million dollars but now yielding only 4 million dollars annually.

The only ocean fishery in the world controlled by international regulation is the halibut fishery off the coast of Washington, British Columbia, and Alaska. The treaty relating to it was ratified by the United States and Canada in 1930, and the International Fisheries Commission was established. This latter Commission was given regulatory authority and the fishery is now being protected. The halibut fishery was in a sad state of depletion in 1930, but under control of the Commission is rapidly being restored. This work is recognized throughout the world as the first successful restoration of a depleted ocean fishery. It is a demonstration of what can be done between friendly nations. We anticipate equal success with the sockeye salmon.

Again and again efforts have been made to obtain a treaty with Canada to protect the fisheries of the Great Lakes. Eight American states and one Canadian province border the Lakes. The principal difficulty has been in getting the eight states on the American side to agree. For many years the fisheries branch of the Service has maintained a small corps of biologists on the Great Lakes and we now have information to show how the fisheries may be restored. In fact, some years back, we succeeded in convincing the Lake States that they should have uniform regulations. The program started off fine, but soon New York accused Ohio of "not playing the game," and the agreement between the states came to an end.

Some of the more progressive of the Lake States have greatly improved their regulations by raising size limits, and prohibiting certain types of destructive fishing gear. The Fish and Wildlife Service has exerted its influence with the other states to follow these good examples, but frankly, little has been accomplished, primarily because of the objections of the fishermen themselves. State conservation commissioners fully appreciate the situation and are anxious to bring about uniform regulations, but if one state fails to promulgate adequate regulations and enforce them, the effectiveness of the whole plan is destroyed. Fishes that escape the fishing gear of Michigan are subject to capture in Wisconsin. That fact is not lost on Michigan fishermen and wholesale law violations follow. When proof is submitted in court that a neighbor state permits the taking of undersized fish, it is most difficult to convince a judge or jury that a fish legal in Wisconsin is illegal in Michigan, and it is practically impossible to obtain a conviction.

Sportsmen are particularly interested in the striped bass that ranges along the Atlantic Coast from Connecticut to North Carolina. Here only state lines are involved, yet there is a sad lack of uniformity of protective regulations between the states. The problem is further complicated by a bitter feud that has raged for the past several years between the sport and commercial fishermen, particularly in New York and New Jersey. New Jersey adopted an 18-inch minimum size limit, but New York, Maryland, Virginia, and North Carolina still retained a 12-inch or lower minimum. The sportsmen and commercial fishermen of New York agreed to ask the Fisheries Branch of the Service to recommend a minimum size limit for striped bass, and to abide by our decision. The Service compiled all existing scientific data on the subject, admitted frankly that the work was not completed, but set up a minimum size length of 16 inches measured from the snout to the fork of the tail or 17½-inch overall length, expressing the opinion that at least a majority of striped bass attaining a length of 16 inches will have spawned at least once. The commercial fishermen accepted the verdict and took the initiative in having the New York Legislature increase the minimum from 12 to 16 inches. The fishermen and dealers in New York City told me recently that they have benefited by this legislation and that their previous objections have been overcome. Now they are receiving a better price for their fish. Two years ago, the

Service recommended a 16-inch minimum to all the striped bass states along the Atlantic Coast, but Maryland, Virginia, and North Carolina still retain a 12-inch or lower minimum, thus permitting the taking of striped bass that have had no opportunity to reproduce. I think you will agree with me that there is an urgent need to place these striped bass under a uniform set of fishery regulations. The problem is how to bring this about before it is too late.

To adequately protect migratory fishes in the United States we are confronted with two problems: First, how can we conserve those species migrating between the United States, Canada, and Mexico and second, how can we conserve other species that range between two or more states but do not migrate across national borders?

Obviously a single international treaty like the Migratory Bird Treaty, covering all migratory fishes, would be a simple answer to the first problem. However, Canada and Mexico are not concerned with those species whose range is entirely within the boundaries of the United States, and these species cannot be aided by international action.

Efforts in the past have failed to obtain an international fishery treaty between the United States and Canada covering all species, but we now have successfully operating two treaties, each dealing with a single species. It is better to make some progress, even though it be a step-by-step process, than to leave all species out of control. The problems are so varied by species and geography that a single treaty does not seem practical at the present time. A commission established by treaty, or some method of single regulatory control, is necessary if the fishes of the Great Lakes are to be of the greatest economic benefit to the eight American states and the Canadian Province of Ontario. If an international treaty to solve the Great Lakes problem is not possible, then a compact or treaty between the eight states alone, would go a long way toward a solution, and this plan of state compacts is the best answer we have for the second problem.

The Constitution of the United States lodges power in the Federal Government to negotiate treaties with foreign governments but it also provides for compacts or treaties between the states. A few years back representatives of several states recognizing the need to use this power of compacts, formed an organization known as the Council of State Governments. Headquarters are located in Chicago and much has been done to bring about uniformity between the states on laws relative to taxation, sanitation, transportation, and public parks. The Council, aware of these difficult fishery problems, has appointed conservation committees, and conducted a number of public hearings in various parts of the country with a view to finding a solution.

Those of us engaged in fisheries administration have high hopes that the Council on State Governments may succeed in bringing about uniform fishery regulations. It matters not what machinery is utilized so long as the fisheries are conserved, so we are lending every possible aid and encouragement to the Council on State Governments.

The Service is convinced that if migratory fishes are to be conserved they must be subject to single or uniform control. Fisheries cannot be protected as long as there are conflicts as to size limits, seasons, and conservation factors in general. If the several states concerned with migratory fisheries will through compacts set up single commissions and grant sufficient authority to protect the fisheries, in the end conservation and wise utilization will be attained. We have for guidance the very splendid results achieved by the International Fisheries Commission in protecting and restoring the halibut fishery. If the plan works between two great nations, there is certainly no reason why it should not work between two or more states.

If we could only erect signs and indicate boundaries between states and nations on the highways of the seas, rivers, and lakes, which the fish themselves could understand, we could save all this worry about conflicting laws, but unfortunately fishes refuse to recognize man's boundary lines.

DISCUSSION

MR. WILLIAM L. FINLEY (Oregon): May I ask a question? What has been said is very important in regard to fish resources on the Pacific Coast. I can't see any reason why a bill cannot be put in Congress at the present time to have them protected by international law. Is there any bill in Congress?

MR. JACKSON: Not so far as I know.

MR. FINLEY: How can we get it? Can't we get somebody to put one in?

MR. JACKSON: Mr. Finley, Dr. Gabrielson has taken this matter up with the State Department.

MR. FINLEY: I hope it can be done, because that is the only way we can control the fisheries of the Pacific Coast.

LAW ENFORCEMENT

R. G. TURNER
Director, Division of Game and Fish, Nashville, Tenn.

I shall deal chiefly with the historical background and present day practices of game law enforcement, together with the philosophy developed in this field.

Our first problem is a fruit of the family tree. We are the descendants of courageous, independent, and self-reliant forefathers. The spirit of freedom still boils over when restraint is applied—especially when the restraint is an enforced game law.

Daniel Boone's rights and freedom extended just as far into Kentucky and Tennessee as he could go without losing his scalp. That limitation proves that even in those days it was necessary to practice some restraint.

Tennessee and Kentucky were endowed with a rich soil and many mineral resources to attract the white man. In addition the early settlers found an abundance of game. However, the working of that unrestrained spirit of freedom handed down through the years has practically destroyed all species of big game, and has seriously threatened the supply of small game. Moreover, our streams have been polluted and fish life destroyed without regard for a future supply.

In the light of these facts, one must classify man as nature's worst *predator*. When you deal with predators, eradication is one method, but no predator exterminates itself, and this one continued to raise large families and teach them the principles of individualistic freedom. As a result, our game and fish supply went down and down. Near this city the now extinct passenger pigeon collected in such numbers that they darkened the sky as they flew over but now the only local reminder we have of this bird is the Pigeon Roost Road.

This history does not mean that we had no far-sighted individuals; we did have them; our first governor advocated conservation, but the people of his day, no doubt, thought he did it because he was governor.

Our first game laws were county laws, and it was many years before general game and fish laws were enacted. As the general laws came into force, county laws degenerated into exemptions from their provisions. Again the pendulum swung, and the number of exempted counties has gradually decreased until on February 15 of this year our Legislature wiped out the last ones. The conservation laws now apply to the whole state.

This review of the past brings to mind the basic principles and philosophies of the enforcement program. The kind of game laws you have depends entirely upon what you can get the legislators to pass, and that in turn depends upon the sentiment of the people they represent. Despite attempts to educate the people, only a limited few ever give a thought to game and fish conservation until the supply falls to the point where it is no longer available. In other words, people "Never miss the water till the well runs dry." Scarcity of game and fish, and not reasoning, is the greatest single factor in building public sentiment for the enactment and enforcement of game laws.

When the law enactment stage has been reached, the type and kind of enforcement then becomes very important. What of the personnel? It is not a dogmatic statement to say that enforcement officers are born not made.

Each of us are endowed with one or more talents; if you are not mechanically inclined you would never succeed as a mechanic, and if you do not have a talent for enforcement work, you will never make a good enforcement officer.

A good enforcement officer must be very versatile.

He must be very high in native intelligence with an educational background sufficient to enable him to acquire the facts and figures necessary for this work.

He must possess diplomatic qualities, be physically fit, and a hard worker.

He must develop into a good game law lawyer, and learn to assemble evidence acceptable in any court.

He needs practical knowledge about the agricultural sciences, forestry, ornithology, ichthyology, mammalogy, and botany.

The game law enforcement program in some areas has to a large degree and over a period of years been seriously retarded by placing it in charge of an incompetent, uninterested, and dishonest personnel.

As a result of failures based on these three factors, and inability to recognize their importance, some administrators have been lured into expensive educational programs of no immediate, and of highly theoretical future, value.

A law enforcement program honestly and intelligently administered is educational in itself, in that it builds public sentiment for game law enforcement—the objective of education.

To care for the future we must through intelligent enforcement show the present fishing and hunting generation that game laws are formulas by which we measure the put and take, so that we may wisely use a part of our present supply and perpetuate and dedicate a part for future use.

The selection of enforcement personnel has been by patronage, and civil service.

Each has its advantages and disadvantages. Neither gives a 100 per cent guarantee that the right man has been placed on the right job —and neither affords immediate relief when a mistake is made.

Regardless of the method of selection, officers should be trained in schools requiring strict attendance and intensive study. Such schools pay big dividends in efficiency, build good public relations, and will raise the revenue of departments operating under license fees.

Good law enforcement like everything else that permanently succeeds must be based on honesty, industry, efficiency, and courtesy.

THE IMPORTANCE OF FUR RESOURCES IN WILDLIFE ADMINISTRATION

ALEXANDER T. MACLEOD
Executive Director, American Fur Merchants' Association Inc., New York, N. Y.

I hope to convey to you the importance of fur animals in the economic life of our country and to get your assistance so that in any general plan for the conservation of wildlife, whether state or federal, fur animals will receive equal consideration with fish and game.

When the early explorers from Europe commenced to tap the apparently inexhaustible supply of fur animals of the New World, the fur trade of the Old World came into a great heritage. During the 300 years that have elapsed, the quest for furs in North America has covered the continent. Untold wealth has come to peoples and nations from this great natural resource, and since the supply has always appeared to remain abundant, little or no thought has been given to the possibility of its exhaustion.

Today, so great is the demand for fur garments in our country, that the United States imports many more furs than it produces. However, I must admit that many of the pelts imported are used in the manufacture of garments in the lower price range and therefore, do not come into direct competition with American furs. In fact these imports tend to lessen the drain on our domestic supplies.

For many years our American earth and water, our forests and our wildlife were used with little thought of tomorrow.

Now the citizens realize that they must conserve these resources, and keep them from wasting away because of man's thoughtlessness and greed. Conservation is the wise planning for, and the prudent use of, our natural resources.

Unfortunately the trappers, farmers, and landowners who are interested in fur as a natural resource are not organized like the hunters and the fishermen and hence cannot influence federal and state legislators to become interested in fur animal problems.

Trappers and fur tradesmen are interested in conservation of the fur supply, for it is upon the raw-fur catch that their livelihood depends. The annual take of fur animals in the United States is estimated to be worth about 40 to 45 million dollars, and the sales of fur products at retail in the United States reaches approximately 275 million dollars.

Fur is an important commercial commodity and more of it is consumed in the United States than in any other country in the world. The fur industry employs many thousands of men and women and contributes to the comfort of a great many people. An industry, the finished product of which is so much in demand, scarcely needs an apology for its existence. As far as members of the fur trade are concerned, it is unreasonable to believe that they are not interested in perpetuating a natural resource which is the backbone of their business.

The crying need is for a uniform policy for the conservation of fur animals. They should be adequately recognized in state and federal administration. National and state organizations fostering wildlife conservation should take cognizance of fur bearers and a national plan should be devised to maintain and preserve these animals as a valuable natural resource.

A large majority of those who trap fur animals and produce them in captivity include farmers and their sons who depend upon this source of revenue to increase the farm income. The employment it furnishes, and the income it supplies, to those rural folks would appear to be sufficient justification to arouse public sentiment for immediate action in order to save what is left of our fur resources.

Because they have squandered an originally bounteous natural supply of furs, the people of the United States now face the alternative of becoming more active in fur-animal conservation and restoration or becoming still further dependent on furs of foreign origin.

It is difficult to conceive that in a civilized country so valuable a resource as fur animals has been so sadly neglected and atrociously wasted. You can't go on killing millions of fur animals forever without eventually threatening their extermination. How long must the present situation continue before we realize that there is something fundamentally wrong with our policy? Fur animals are the property of the people and should be managed for the benefit of all the people instead of permitting selfish interests to exploit them.

It is generally believed by those who are struggling with our federal land policies that too much agricultural land has been developed, yet they have failed to see that a considerable part of our public and private land could well be utilized for the production and conservation of fur animals.

There are those who think of a swamp or marsh only as a place to be drained. Others believe that such areas serve their best purpose as a dump for defunct automobiles. Yet many such places are havens for muskrats and other valuable fur animals, as well as for migratory waterfowl. Some of our tidal and inland marsh areas are capable of producing five, sometimes more, muskrats annually per acre, not to mention other wildlife. At present market prices, the returns on an acre from that number of muskrat pelts alone would furnish an income of from $7 to $14 each season. Why then is serious consideration not given to fur animals as an annual crop? Animals are a product of the land; they are fed, sheltered, clothed, and warmed out of the soil. Land can produce something more than cotton, corn, or pork. Wildlife, one of our greatest natural heritages, deserves serious consideration in any general policy for land management.

Every year millions of acres are being injured for wildlife production by forest fires and soil erosion and by the plowing of large sections of land that never should be cultivated.

The same factors that caused the extermination of the passenger pigeon and the decimation of the buffalo herds, and that brought the migratory waterfowl population to a crisis, are bringing fur animals there just as fast.

If demands for certain species grows, naturally the catch is increased; and if some furs are neglected in the trade, the reverse is true. A strong demand for a particular kind of fur causes continued trapping, which if pursued long enough will reduce the number below commercial quantities and may eventually exterminate the animal. Continued increase in the number of a fur animal trapped does not mean that the species has increased in numbers. On the contrary it most likely is an indication that the fur bearer in question is being threatened with extermination.

The marten, fisher, and otter, our three most valuable fur animals, individually, are now in a precarious state. The price obtained for their pelts has always remained high enough to cause close trapping. The animals, although never abundant anywhere, have now entirely disappeared from much of their former range. Of the three, the otter is perhaps most plentiful because more skill and patience are required to locate its haunts and capture it.

At this point I would like to quote from an article on the American Fur Trade by Thomas J. Biggins of the textile division of the Bureau of Foreign and Domestic Commerce that appeared in the January

2, 1941, weekly bulletin of the U. S. Department of Commerce under the sub-heading—"*Conservation Measures Necessary.*"

"The fur-garment manufacturing industry has expanded to such an extent that grave concern is felt as to the availability of raw furs. The appearance of lumbering and agricultural settlements, together with the drainage of swamps and improved methods of capture, has driven fur-bearing animals farther and farther afield and has caused serious depletion in their numbers. The stoppage of fur importation from various sections of Europe and Asia will put an added burden on the American wildlife; and because of these and other factors, the conservation of this natural resource is of paramount importance. A recent study by the Fish and Wildlife Service of the Department of Interior states that if the demand for furs in the United States continues, then unless protective measures prevent, a larger number of fur animals will be trapped to meet that demand. In view of the already precarious condition of many fur species, trapping must be limited and shorter seasons promulgated to maintain the supply.

"According to the Fish and Wildlife Service, one of the most important features of the present-day legislation on fur animals is that requiring trappers to make annual reports on the number of each species taken. The year-to-year renewal of the license is conditioned upon the filing of satisfactory returns on the catch of the previous season. The data to be obtained from these reports would provide the material for a factual survey of the annual take and of its relation to the breeding supply. Protective or conservation measures may be based on these surveys."

The American Fur Merchants' Association, Inc., which I represent, is a trade association of fur importers and dealers located in New York City. True, they are all in business for profit and as individual firms they do not give enough consideration to the source of supply of their product other than its country of origin. In cooperation with the Fish and Wildlife Service of the Department of the Interior and the various state game, fish and conservation commissioners, however, we have been gradually educating our members to the importance of a sound conservation program based on that old economic law of supply and demand. The dollar turnover in the fur industry from trapper and farmer to the consumer runs close to $500,000,000 annually. As an industry, it is a far from negligible factor in the economic life of our country. A better understanding and a closer cooperation is necessary between all factions that are connected with the industry if we are to derive the full benefit of the valuable fur resource.

In closing, I appeal to you, who are so well organized, to adopt a broad view of the problem of fur conservation and to lend your support to a national plan to maintain and preserve fur animals. The Fish and Wildlife Service of the Department of the Interior is familiar with the problem and the American Fur Merchants' Association, Inc., is cooperating with that Bureau to establish a closer relationship with the states to assist in developing the conservation and production of fur animals.

ADMINISTRATION OF PUBLIC LANDS

JUSTUS H. CLINE
Stuart's Draft, Va.

CHAIRMAN GRAVES: *I feel that it is particularly pertinent for me to mention at this time that the Big Levels Game Reservation in Virginia has just recently been dedicated to Justus H. Cline, a distinguished citizen of that State—an honor that should be brought to the attention of this conference.*

The basic essential in wildlife conservation is a dependable place to do it. It is not a short-time enterprise but is a task that will always be with us. It is an essential part of the efforts to preserve the well-being and life of the nation, and to prolong tenure of the earth by the human race itself.

To many of us the expression "Where wildlife cannot live man cannot live" has become a platitude, but not so to the millions in the streets and byways of this great continent. While there is born in every individual an interest in wild creatures, the habits that civilization imposes upon us have so specialized our thoughts and activities that only a relatively few persons seem to grasp the broad picture of conservation. As a result of this specialization we have created many agencies: For instance, one to look after our forests, another soils, another wildlife, and so on. These agencies have the same general objective and operate in the same broad environment but, it seems to me, with too little consideration for the common end, which is after all nothing but the preservation and improvement of mankind's environment as a whole.

It is of great benefit to the officials of this conference that wildlife is about the only thing in the entire environmental picture that has an appeal to everybody. A group of about 20 men, representing practically every major division of science, met in Richmond recently. The purpose of the conference was to focus as many branches of science as possible, both pure and applied, upon some specific enterprise or investigation that would appeal to the imagination of Virginians as a whole and result in long-time benefit to the welfare of the people of

Virginia and the nation. During the course of the meeting one of the leaders, pointing at me, said, "Cline there has the only thing we are all interested in—wildlife."

What has brought so many disasters in the history of wildlife is not that the human race did not have a basic interest in it, but because, in everybody's desire to be a specialist, wildlife has been treated entirely too much apart from its environment, with the result that environment has been the subject of one activity and wildlife of another, without adequate correlation.

Not long ago I took about 20 high school students to the Big Levels Refuge, where the George Washington National Forest, with the advice of the Wildlife Service, is carrying on important experiments in wildlife husbandry on a large scale. Numerous small clearings have been made in what was an unbroken forest and planted to various things of value to wildlife. In one of the fields some persimmon trees, dogwoods, haw bushes, grape vines, and other fruit-bearing trees and shrubs had been left uncut and they were mostly laden with fruit. I asked the youngsters why the Forest Service left these trees and shrubs standing in a plot that was otherwise completely cleared. Although most of the boys were busy filling their stomachs and pockets with the delicious wild fruits, it did not occur to one of them that these things constituted a necessary part of the wildlife environment, which the Forest Service was trying to preserve and improve. In their minds a concept of the dependence of wildlife upon habitat did not exist. Lack of this basic understanding is not peculiar to youngsters of school age but is widespread among adults. More demonstration projects such as that at Big Levels are needed to show in a concrete way the essential relations between habitat and wildlife and also human life. One great weakness in the administration of things pertaining to our organic environment is that the wildlife is under one jurisdiction and the habitat under another with too little correlation between the two.

Some years ago a friend and myself were sitting by a brook in the Blue Ridge Mountains watching the antics of a squirrel. A United States Forest Ranger, unknown to me at that time but now one of my esteemed friends, came by. I asked him why the Forest Service in looking after the tree did not also look after the squirrel, the turkey that was roosting in it, and the deer that browsed under it. He told me promptly that the squirrel belonged to the state and that the Forest Service had no authority over it. If I had gone to the State Game Department or to the wildlife service and suggested that certain modifications of the forest were essential for the well-being of the squirrel, the turkey, and the deer, the answer certainly would have been very like that of the ranger—we have no authority over the forest.

Now that illustrates the position of wildlife in almost the entire United States; it is like the man without a country. The landowner owns the land, the habitat, the food supply. The state, according to legal theory, owns the wildlife. If the landowner cuts down the trees that bear the nuts so necessary to squirrels, trees in which these animals den and rear their young, the poor creatures do not have a legal protector in the world to whom they can appeal. So with wildlife in general—it is in an utterly impractical and impossible situation as far as effective conservation is concerned.

This accidental meeting with the forest ranger in 1928 and the conversation mentioned led to the establishment seven years later of the Big Levels Wildlife Refuge in the George Washington National Forest of Virginia by Presidential proclamation.

At that time the idea of eliminating conflict of jurisdiction between the landowner and the wildlife owner by a system of joint management of wildlife was not controlling, although it was recognized that a centralized comprehensive authority was necessary in order to carry out satisfactory, unhampered experiments in wildlife husbandry in a national forest.

The General Assembly of Virginia, after vigorous persuasion by numerous citizens interested in the experiment, passed an Act granting to the Federal Government all wildlife rights in an area of marked boundaries embracing about 32,000 acres in the George Washington National Forest. Under an agreement between federal agencies the development program was carried on by the Forest Service with the cooperation of the Biological Survey and the Bureau of Fisheries—organizations that have since been united in the Fish and Wildlife Service. With the aid of a CCC Camp and relief labor, the work of environmental improvement was vigorously undertaken by the Forest Service. Almost 200 small fields were cleared and planted with a variety of grasses, grains, and fruits. The plants included both food and cover types. Hundreds of slashings were made and many other acts of wildlife husbandry were performed. Deer and beavers, which had long been extinct in the region were restored and they thrived. Grouse, wild turkeys, and raccoons which were on the verge of extinction began to increase notably without restocking. Predators were reduced in numbers where found excessive. Bears are now numerous and many signs marking boundaries and trails suffer from their curiosity to the no small annoyance of the Ranger. The Refuge is becoming the mecca of a large region for school children and all who are interested in wildlife conservation and nature study.

The establishment and success of the Big Levels Refuge began a new era in the wildlife history of the Old Dominion. It supplied the only real model that we have of the management of upland wildlife and habitat together and it has become in the few years since its establishment an outstanding example of the value and results of practical wildlife husbandry under a unified and comprehensive jurisdiction on public lands.

The showing of the Big Levels area created a widespread desire for more and the two large National Forests in Virginia, the George Washington and the Jefferson, now containing about 1½ million acres but which will ultimately embrace more than 3 million acres supplied the next great opportunities. It was discovered by experience of the Big Levels that it was entirely unnecessary for the state to surrender any of its wildlife rights on federally owned land administered by the Forest Service. It seemed better and proper for the State of Virginia to retain its basic rights so that citizens, who are after all the chief beneficiaries, should remain in a position of just responsibility in looking after the wildlife resources in the national forests which from time immemorial they had considered their own but had little opportunity to administer.

With little difficulty a cooperative plan of wildlife management in the two national forests of Virginia, as nearly as possible on an equal basis, was agreed upon by the State Game Department and the U. S. Forest Service and approved by the General Assembly. The additional funds necessary to carry out the program of cooperation are raised by the sale of a special stamp known as the forest stamp. This stamp is required of all who hunt, fish, or trap in the national forests of the state. It costs one dollar and is required in addition to the regular state hunting license. This dollar is used entirely for conservation of wildlife in the national forests, and I have never heard a complaint on its account. It seems to be universally accepted as a wise and just provision.

The practices of wildlife husbandry and environmental improvement started on the relatively small area of the Big Levels are being expanded as rapidly as possible over the entire national forest area of the State. Studies are being made from time to time by various agencies, including the Fish and Wildlife Service, the Forest Service, the State Game Department, the Wildlife Research Unit, the Virginia Polytechnic Institute, and private individuals, with confidence and assurance of permanency guaranteed by both State and Federal agencies and supported by the almost universal will of the people.

At last in Virginia we feel that we have found a place to do wildlife management on lands that belong to all of us and which will some day embrace more than a tenth of the land area of the State in a vast scientifically managed public hunting ground that we are striving to make into a grand ideal for the nation. The poor squirrel is no longer a "man without a country." The people of Virginia are conscious of a responsibility as well as the great opportunity that is offered to them by the publicly owned lands in the State.

Your farm belongs to you. Public lands belong to all of us. Your farm is a potential wildlife habitat, but whether there is any wildlife on it is up to you, because its destiny is entirely in your hands. Our public lands are also potential wildlife habitats but whether there is any wildlife on them is up to all of us. Its destiny is entirely in our hands. The state, the Forest Service, the Wildlife Service also belong to us, they are our agents and capable. Perhaps some day you may be willing to surrender some part of your proprietary rights even on your farm to a conservation ideal but as yet you are unwilling. The conservation ideal as far as you are concerned can only be set up by some cooperative jurisdiction under which the profits and losses are society's and not the individual's.

SUMMARY AND ANALYSIS OF THE CONFERENCE

FRANK THONE
Science Service, Washington, D. C.

I wondered a bit when the headquarters in Washington called me up to ask me if I would accept this rather impossible assignment, why they had picked on me, except for the fact that I have spent a good many years as a reporter of Congresses and have, I hope, a certain skill in rapid ingestion and digestion of their doings. Certainly there are a good many persons who are more familiar with the field of wildlife than I am, and who have closer connection with various organizations in it. Then it occurred to me that perhaps that was the very reason they hadn't asked some of these more competent persons, but had picked on me, because I am, in the ancient Greek and early English sense of the word, an idiot. In Elizabethan literature the word isn't used very often but where it is used it means an individual who stands apart. I have no official connections and am not related very closely with any of the unofficial organizations that join in this conference. Therefore, you may expect to hear, for the next few minutes the impressions of an independent observer.

The need for these conferences will go on long after we have gone. As long as there is wildlife and as long as there are people eager to exploit it, there will have to be better than a corporal's guard, there will have to be divisions and army corps of earnest workers continuing to put forth their best efforts to baffle the exploiters and to make life more pleasant for what my patron saint, Francis of Assisi, used to call his "little brethren," the wild things of the woods.

In the course of this Conference I have been much impressed with the earnestness of the quest for information on the part of executives in wildlife work. I have been impressed also with the high quality of research indicated by the papers presented in the sectional meetings. The men in the research work have been trying to supply the executive's need for better information on which they may base their plans for immediate action. Here, it seems to me, the wildlife work has shown the dilemma in which it exists and in which possibly it may always exist, for the need for information probably will always outrun the ability of researchers to supply it. At present the imperfect fit between the need for information and the ability of researchers to supply it is responsible for a good many errors, or, to be a little bit more discreet about it, the presentation of imperfect questions, implying lack of complete understanding of what is needed to be done, and the presentation also of incomplete information, implying a lack of advance in research.

One of the features of this Conference that has impressed me rather unfavorably as against the earnestness and competence of the papers that have been presented in both the general and the sectional meetings, has been the thin attendance at the general sessions. The meeting we had yesterday morning at which defense questions were considered was one for which every seat in this room should have been filled, but a great many of the six or seven hundred-odd persons who are registered and of others, registered, continued to hang around outside and didn't come in and take part in the discussion. There should have been much more discussion than there was. The subject was certainly one that concerns all of us very vitally, and while everybody here was talking on the same side (even the people who were here theoretically representing the defense activities), nevertheless, there should have been freer and perhaps more specific and exact discussion, particularly on the part of the research workers; they could have supplied some of the specific information that perhaps the defense people could profitably have taken away with them.

Similarly, although there was a full meeting on Sunday when the proposed Lundy educational plan was presented, there was relatively little discussion and yesterday morning when a special meeting was called for further consideration of the subject at 9:00 o'clock, an audience failed to materialize. I went to the designated place where I found Mr. Lundy and two or three other people. The proposed meeting failed although a full hour had been allowed for further discussion, and a considerable number of persons had expressed themselves rather vehemently in disapproval of the Lundy plan. A number of my most respected friends who are very much entitled to have their opinions heard don't like some of the aspects of this plan and have told me so, yet they didn't stand up in meeting and say so.

The Lundy plan requires a threshing out in full meeting but the opportunity will not come again for another year. In the meantime, the plan will doubtless have been advanced, retaining such imperfections as it may contain, which might have been avoided if we had had the discussion that we should have had here with the full opportunities that were offered to us.

In respect to the defense needs, this unanimity against exploitation has allayed my fears somewhat, at least as far as the persons here present represent interest and authority in that field. However, I do not think that we should allow ourselves to be lulled into a feeling of security by that unanimity, because naturally people who are interested in exploitation, who are interested in using defense needs as an excuse to go into nefarious activities, or what we certainly regard as nefarious, aren't here and aren't saying anything publicly. Nevertheless they are continuing to exert pressure in places where it may do themselves some good and do the country a great deal of harm. Without cessation, that has gone on, of course, for generations. It began with the Republic and to some extent probably will go on forever. Yet if permitted to go unchecked, it will hasten our decline and downfall. So despite our unanimity here we should not relax our vigilance.

Even legitimate defense needs, sometimes, as in the last war, have brought about some rather regrettable situations, as were ably outlined to you in a number of the papers that you have already heard, especially in the general sessions. Despite the fact that some of my time has been providentially taken away, I want to digress a little and relate an anecdote, that is my favorite conservation story. It implies no compliment to the white man but is a compliment to the savage, to the Indian, to the ignorant redskin. It was told to me by a friend of mine in Washington, Dr. John M. Cooper, who is Professor of Anthropology at the Catholic University of America. He is interested in cultural anthropology and spends his summers among various Indian tribes. Several years ago he put in three or four seasons among the Cree and Montagnais Indians around James Bay, that southern extension of Hudson Bay. There are some interesting Indians there; they are primitive and live entirely by hunting. They don't carry on any agriculture at all. They are woodland Indians, among the most primitive of Indians on this continent. Of course, they have a superficial civilization now; they have rifles, steel traps, and other equipment provided by the white man, but basically they continue to make their living by killing game animals for meat. Their staple food is baribou, their cash crop is beaver.

Their system of trapping beavers has always been on a family holdings basis; a little group, a family or sub-clan, held a certain tract of land with recognizable boundaries for trapping. Nobody else trespassed on it. They are very poor Indians, but they got along, after a fashion, with the beavers they had. During the World War at the instance of certain groups of white men, they abandoned the old family holding system and everybody trapped wherever he wanted to trap. The result was a large immediate yield of beaver skins that were needed for defense purposes, partly for direct use as warm clothing for soldiers, and partly to increase the dollar resources of Canada. The immediate effect, as far as the white man's economy was concerned, was good. The effect in a very short time on the Indian's economy, however, was close to disaster. The beavers were trapped out almost to the disappearing point, and the Indians faced starvation, because if they had no beaver skins they could buy no cartridges; if they could buy no cartridges they couldn't get caribou, and they starved.

Well, they held a council, to which they invited my friend. After discussing the problem gravely, they ended by passing a sort of resolution somewhat to this effect: If we spare the beaver now we will always be poor and always live in want, but the beaver will come back and there will be something for our children. We will accept the poverty that is our lot for the rest of our lives and leave the beaver so that our tribe may continue.

I think it would be a healthy thing if this nation could always be as simple and direct in facing its problems of conservation and face them as intelligently as did these Indians.

To get back to the main thread of my discourse, there is one thing that struck me during the discussion, both in and out of meeting, of the educational plan. I have not seen the publications that are being offered under the Lundy plan, so I may do them some injustice. I heard a number of persons representing various states declare that they had already adopted educational plans for conservation training in their own states that they were loath to give up. The Lundy plan is a general thing that undertakes to cover the entire country. The state plans may subdivide the country too much. One of the speakers held that the State of Missouri has a well-worked-out, and apparently satisfactory, educational system in conservation. However the State of Missouri is not a uniform area. It is comprised of a good deal of territory that has problems in common with those of eastern Tennessee and eastern Arkansas. Thus, it strikes me that perhaps instead of there being a separate conservation text book for each state, they might be prepared on a regional basis, one for the Delta region, for example, another for the Ozark region, overlooking the fact that it overlaps Missouri, Arkansas, and a bit of Oklahoma, and even runs off into southern Illinois. Or, exemplifying the idea from the single state of Tennessee, it has a Delta region in the west; at the eastern end of the state there are the mountainous uplands the conservation problems of which have very little in common with those of the Mississippi flood plain; and in between them is the great central section of the state, a rolling, hilly country that is not exactly like either of the others. So for the State of Tennessee you might need three text books in conservation instead of one.

One way to handle such problems might be by collaboration among the states, and another through an effort by a national organization like this one to provide conservation books for the schools dealing with ecological regions and disregarding state boundaries.

I want to add a few congratulatory remarks. Two sincere compliments for the National Audubon Society, one on the announcement of the imminent end of commercial traffic in plumage of wild birds, and the other on a thing I was very happy to hear from Dr. Pearson, the development of wildlife organizations, perhaps of a federated wildlife movement, in South America to match what we are doing here. I hope it may speed and prosper. I shall not be discouraged if it doesn't speed too fast, because we had to make fools of ourselves up here and pretty nearly kill off the last buffalo and the last pronghorn before we decided that they were worth saving, so I suppose, human nature being what it is, the South Americans also may delay until they find themselves near the bottom of the barrel before they take really effective steps in conservation, but perhaps they may profit a little by our ill example. At any rate, I am happy to know that there is a wildlife movement afoot in South America.

RESOLUTION

CHAIRMAN GRAVES: I shall now introduce E. J. Meeman, Editor of the *Press-Scimitar*, Memphis, Tennessee, who desires to offer a resolution for the consideration of this Conference.

MR. MEEMAN: I am about to propose to you an objective that cannot be immediately attained, but which is possible of attainment, and once achieved will be with us for a very long time and will bear perpetual fruit.

I propose a resolution asking for observance of the four hundredth anniversary of the discovery of the Mississippi River by the creation of a Discovery Forest.

The four hundredth anniversary of the discovery of the Mississippi River by

Hernando De Soto occurs in 1941. The four centuries since the white man first came to the Mississippi Valley have been marked mainly by reckless waste and wanton destruction of its natural resources.

Let us make this four hundredth anniversary the turning point into a new era of restoration and conservation. Let us make this great national observance one that looks not to the past, but to the future. Let us begin, in this four hundredth anniversary year of 1941, the rediscovery of the Mississippi Valley, a third of our land, and the restoration and conservation of its resources.

Let us mark this anniversary not by a dead monument of bronze and stone, but by a living monument of eternal growth, a great Discovery Forest on the banks of the Mississippi River, so named for the double reason that it will commemorate the anniversary and because, as John Burroughs has told us, man's every visit to the woods may be a journey of discovery.

Let this Discovery Forest be useful in all the ways that a forest may be useful, in the saving of soil and water, the growth of timber, and the provision of hunting and fishing and other recreation.

Let it contain as its central feature and climax a Grove of Repentence, an area to be restored to primitive conditions, where those conditions, once having been achieved as nearly as possible, will remain forever undisturbed. This grove to be a symbol of the nation's solemn resolve to turn from waste to conservation, and a perpetual shrine of the nation's respect for nature.

Because of the immediate pressing needs of national defense, we do not ask that this project be undertaken at once, but that this nation mark this four hundredth anniversary year by putting into the Federal Government's program the creation of this Discovery Forest with Grove of Repentence, to be realized as soon as our economy will permit.

Thus we shall celebrate history by making new history. Our observance of a great national anniversary shall be marked by a service to our country that will make it better and stronger.

So declares the North American Wildlife Conference, meeting in Memphis, Tennessee, near the site of the discovery of the Mississippi River, in the four hundredth year after that discovery.

We commend this declaration to the President of the United States, the Congress, the Department of Agriculture, the Department of the Interior, and the National Resources Board.

Thus we may create a new tradition in this country—a tradition that will, through the years, grow and increase in power. Thank you.

CHAIRMAN GRAVES: It occurs to the Chair that Mrs. W. T. Michie, of Memphis, who has served the Conference as Chairman of the Ladies' Committee, might add a few words upon this resolution.

MRS. W. T. MICHIE (Tennessee): Thank you, Mr. Chairman, for allowing me the opportunity of speaking for this resolution. We in Memphis are tremendously interested in the proposed forest, because it will be, as Mr. Meeman has said, a living monument. We know by experience with Shelby Forest what can be done and also how much work it takes to do it.

I now believe that almost anything can be done by faith, but it must be militant faith, and I hope that all of us are going to have that.

CHAIRMAN GRAVES: Senator Walcott, would you like to give us your thoughts on this resolution?

FORMER SENATOR FREDERIC C. WALCOTT (Connecticut): It would be difficult for me to add anything to the proposed resolution, but I am very much in sympathy with the underlying idea. I think it may be one that will catch, and I hope, become epidemic. I can't imagine a better excuse for a forest than as a reminder of our sins of omission and commission. I am heartily in favor of the resolution.

My only misgiving, as the resolution was shown to me last evening, was that it might possibly conflict in some way or encroach upon the Shelby Forest, in which I am very much interested, but having heard Mrs. Michie, who is the Chairman of that project, express herself in favor of this, and having satisfied myself that there is no encroachment, that the two forests meet with the approval of not only Memphis, but all of Tennessee, I hope the Conference will vote unanimously in favor of the resolution.

CHAIRMAN GRAVES: Thank you very much, Senator. I feel that the proposition has been sufficiently explained. I think all of us here are in complete sympathy with the thought behind this resolution, and the Chair will now entertain a motion for the adoption of this resolution by this Conference.

MR. FRED EVERETT (New York): I so move.

. . . The motion was seconded by Frank Thone, put to a vote, and carried by a rising vote. . . .

CHAIRMAN GRAVES: The Chair declares that the resolution is unanimously adopted.

PART II

SPECIAL SESSIONS

SPECIAL SESSION

MONDAY AFTERNOON—FEBRUARY 17

Chairman: J. Hammond Brown

Vice President, Outdoor Writers' Association of America, Baltimore, Md.

Assistant Chairman: Cecil F. de la Barre

Treasurer, National Wildlife Federation, Blacksburg, Va.

CONSERVATION EDUCATION AND PUBLICITY

Chairman Brown: *I believe this is about the first effort made to correlate or to coordinate three of the most important things that we as conservationists have in mind, into a single conference, approaching it from every possible angle. This is to be an open forum on conservation education and publicity.*

We are going to approach these subjects from every possible angle. I do not believe that you can go through Mr. Webster's best seller, and pick out three words that have so many different meanings, but are so little understood as conservation, education and publicity, and especially conservation. If I should ask each one in this room to write me a twenty-five word definition of conservation, I would possibly get an astounding array of replies.

To my mind, and I believe to those who study it, conservation is nothing more or less than the preservation of the wildlife resources, to keep them at a point where they can keep up reproduction—never allowing them to go below a point where they can keep up their level by their own reproduction. It is true of the soil, and it is true of the water. Without going into any more explanation I will set the text. This conference is to discover and coordinate and correlate the subjects, of conservation education and publicity. Our first speaker will represent the United States Government. He is Walton Onslow, Chief of the Press Service, U. S. Department of the Interior, Washington, D. C., who will set the text for the United States Government, Mr. Onslow:

Mr. Onslow: Well, in the first place, representing the United States Government is a pretty big order for a press man from one department. I cannot speak comprehensively for the whole government, because it is not my field. There are competent and qualified men representing departments other than the Department of the Interior, who can speak for themselves. I can, however, give you some idea of a few of the fundamental concepts that most of us in federal work follow and recognize.

I was interested in hearing our Chairman confine conservation pretty closely to wildlife. I have noticed a very broad tendency in this whole meeting, to talk about wildlife as the principal item in conservation. Of course, we all know that it isn't, that it is one of the most important areas in conservation, but we all recognize that conservation takes into account a great deal more than the restoration and preservation of our forms of wildlife. Consequently, I think it is fair to say that the fundamental concept of any successful government program of information, or you might call it publicity, is to carry out an aggressive program of broad information on conservation to the people—or to the particular field at which you are aiming.

The distinction is that it does no good to carry on a defensive operation. If you conduct an offensive, aggressive type of information, you won't have the situation arising that our friend from Tennessee was talking about this morning.

It always has seemed to us in the Department of the Interior that it is much better to carry aggressive information out to the people, than to sit back and take it on the chin from the critics. It is a stock speech in Congress to criticise the extent of government information activities. But what is the background for government press and information work? How did it come into existence? In the first place, I think it is fair to say that government information work has paralleled similar development in private industry, in social affairs of all kinds. We have information and publicity, of course, going on in all walks of life in all of our daily affairs. That has accompanied, according to some people, a general rise of literacy. People are better educated. They read more. They are beginning to demand more information. A corollary to this has been the development of the various media such as magazines, newspapers, radio, motion pictures, and all that sort of thing. So, along with that general social development you have had the same sort of thing going on in the government.

There is another reason for government development. The relationship between the average citizen and his Federal Government has increased in intimacy tremendously in the last few years. For instance, there is the matter of social security, old age pensions, and these programs of the Federal Government that affect very directly the lives and affairs of the citizens. The citizen is in more contact and in closer contact with the Federal Government than ever before, consequently, he is demanding more information. He wants to know how he does this, why he does this, which is a desirable and proper thing. I think that the more people know about the Federal Government, the more they will demand a more efficient administration of the government, and that is probably all to the good.

Now, to get down to practical cases, in the Department of the Interior: What is the relationship between our Department and the average citizen? For one thing, our program affects the lives of practically all citizens either directly or indirectly. For example, we administer vast areas of land in the West, public lands, forest lands, all that sort of thing. I looked up the record, the other day, to find out how much land in the Western States is under the jurisdiction of the Department of the Interior. I found, for instance that 84.5 per cent of all the land in Nevada is federal land administered by the Department; 57.5 per cent of all the land in Arizona is federal land; 56.5 per cent of all the land in Utah is owned by the Federal Government; 30 per cent of the land of New Mexico, and so on. We operate big grazing ranges in the West that produce the wool for your clothes and the leather for your shoes. We have forest lands, 130 million acres of forest and woodlands, under the jurisdiction of the Department. Consequently, the Department of the Interior is in pretty close touch with large numbers of our citizens. They have a direct interest in the affairs of the Department and they want to know how it is being operated, what we are doing, and they are certainly entitled to that information.

As far as conservation is concerned, in what way does the Department of the Interior participate in conservation? For one thing, it is engaged in soil conservation on the public lands I was talking about. It is engaged in wildlife work through the Fish and Wildlife Service. It is engaged in the preservation of natural areas such as national parks. It conducts range management, forest management, water conservation, restoration and use. It is in charge of the mineral resources, and issues permits for mineral prospecting. It is engaged in the development of hydro-electric power sites. Consequently we have a problem of reaching the people with information about these affairs. In the first place, we have an obligation to the public to let it know what we are doing with the public money allotted to the Department by the Congress. We had appropriated a budget of 160 million dollars last year. The public is entitled to know how efficiently we are using the money. We try to get the information out.

What are the various avenues? Mr. Brown talked about an effort to find out what are the best ways of educating the public. I won't presume to tell you how to do it. I can only report to you on the methods we are using.

In the first place, there are several different types of government information. There is for example, the persuasive type. That is called for in such programs as require the active participation of the citizen. The Agricultural Adjustment Administration program, for instance, is trying to get people to participate in a particular program. The same thing is true for social security and certain types of conservation. Consequently, we use the persuasive type of statement. Another type is the straight expository type of information. An explanation of projects, programs and the sort of thing that is going on. And then there is the out and out progress report that will tell the status of things going on, as, for instance, Grand Coulee Dam. Then we have general reports on the situation in regard to some programs of activity, such as might be issued by the Fish and Wildlife Service on the progress of its restoration, or refuge programs. Then, of course, we have the formal reports which are the printed documents, available to all.

What are the media that the government uses to get all this stuff across? It is quite obvious that we have to stick to established media. We go to the media in existence. What are they? In the first place, I think I would put newspapers. Newspapers represent the best, most substantial, and most economical method for giving out a news story. The newspapers are in the news business and want this stuff. Consequently, I think that is the best media that the government could use to get any messages across. A newspaper has this advantage, too. It is independent; it is able to pass upon what the government puts out—to make up its mind whether or not it is propaganda, if it is straight, or whether there is something behind it that should be stated in addition. In a sense, it is a test tube. The newspaper doesn't have to print what the government puts out. It can print it, or discard it, or go back of it, if it wants to.

The second media would be radio, which is a good medium requiring or utilizing several types in itself. Mr. Allen will tell you, I suppose, about the various kinds of radio programs. You have all heard them.

Then, the third media is motion pictures, which I think is one of the most difficult, complex, expensive, and involved methods of putting across a public statement. I think they are extremely difficult to work with, expensive, elaborate, and they are hard to use after you have them.

Then, of course, we have personal contacts, attendance at meetings, graphic materials, and demonstrations, and cooperation with existing organizations such as that we enjoy with the American Wildlife Institute.

There have been a good many challenges raised to government information work. It is said it is irregular. It isn't irregular. It is said it shouldn't be engaged in. That is a question of philosophy. The only thing I want to point out is that information work on the part of the government is required by law, and if you don't believe that, read the basic Acts of a good many of the federal agencies such as the National Park Service, the Fish and Wildlife Service, and the Soil Conservation Service, wherein Congress directed the agencies in charge to make information public, to report to the public, and carry on a program of dissemination of information. It is also legitimatized annually by Act of Congress in approving budgets for carrying out that type of work.

I haven't touched many of the major issues in this field, but the gentlemen who will follow me probably will speak on some of those in more detail. I think it would be very healthy if at the close of the period we could have a question and answer session.

CHAIRMAN BROWN: *The next gentleman who will speak for the Federal Government, taking up the subject as related to the Forest Service, Charles E. Randall, Chief of the Section of Information, Forest Service, U. S. Department of Agriculture, Washington, D. C., is not quite himself. Mr. Randall, would you like to read your paper or would you like some one to read it for you?*

MR. RANDALL: Feeling still a little shaky from a touch of the flu, I have asked Mr. Ovid Butler to read my paper.

MR. BUTLER (Washington, D. C.): Mr. Chairman, I feel I should apologize because I have just been handed this paper and I have not read it. I don't know what is in it and I probably won't agree with what is in it but I am going to read it.

"Everybody is for conservation, but apparently no two people have the same idea of what it means. To some, conservation means preservation of scenic values, to others it means 'down with the timber barons,' and to others it means feeding songbirds, or planting trees, or shooting crows. It has, indeed, happened more than once that two different groups were advocating diametrically opposed and conflicting ideas, both in the name of conservation.

"Apparently we don't all speak the same language. With conservation thus at the Tower of Babel, it isn't surprising that the general public, whose support conservation needs, gets a little confused.

"Conservation, of course, covers a wide field—so wide that I wouldn't have the temerity to attempt to define what it does cover. However, I can at least attempt to explain what the conservation program of the Forest Service aims at, in the hope that it might help us to understand each other a little better.

"One-third of the United States is forest land and the broad objective of the Forest Service is to promote the best, permanent use of that land, through direct administration of the publicly owned national forests, and through cooperation with the states and private owners for privately owned forest lands. There are two basic principles in the forest conservation program. One is what foresters call 'sustained yield,' which means producing continuous crops from the same land. For timber, it means harvesting the crop at a rate no faster than the growth—in other words, eating your cake and having it too. The sustained yield principle is applicable alike to timber and to wild game and to other products and services of the forest. Its full achievement would assure the permanent and continuing productiveness of our forest resources.

"The other basic principles is called 'multiple use,' and it looks to having every tree, rock and rill serve its highest purpose. A given forest may have within it some spots particularly suited to recreation, some spots of outstanding scenic value, some areas capable of growing high quality lumber, some good livestock range, water-power sites and fishing streams. All of it may be important watershed land and wildlife habitat. Multiple use management seeks to develop all of these uses and coordinate them in a unified management pattern for the whole area.

"Sometimes determining the highest use of a given area involves making difficult decisions, as for instance when the esthetic and sentimental values of a given area must be weighed against its importance in contributing to the support and permanent stability of a community of people. Fortunately, however, most of our forest land is adapted to a combination of uses, and under careful multiple use management can be made to produce timber, water, wildlife, recreation, scenery, and other goods and services, without serious conflict.

"In its last annual report, the Forest Service recommended a broad program of forest conservation built around these basic principles, which it believes would go farther toward stopping forest depletion and building up a permanent forest economy. I believe all conservationists would be interested in studying these recommendations.

"One of the big problems in conservation education, I believe, is to get people to see conservation problems in their broad aspects—to see the forest instead of the trees. Most people can quickly grasp the idea of stopping forest fires, or of roadside planting, but these are only parts of the whole conservation problem, and no one of them is the final answer. All such activities are interrelated and need to be coordinated in a broad approach.

"Perhaps if conservationists could get together on certain fundamental principles that we could all get behind, it would help conservation to move forward on all fronts. I wouldn't attempt to suggest specifically what those principles should be, but in a general way perhaps they might include the idea that the whole is the sum of its parts, and that the ultimate objective of all conservation work should be the permanent welfare of the nation and its people.

"The Forest Service has a motto that has been its guiding principle for thirty-five years, that might be applicable here. The motto is: 'For the greatest good to the greatest number of people in the long run'."

CHAIRMAN BROWN: *The next speaker we will hear from will be Howard Zahniser, Section of Current and Visual Information, Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C. Mr. Zahniser will now address you.*

MR. ZAHNISER: Of course, a conference like this is, itself, an educational device. Those of us who are engaged in information work, I imagine, know better than any other kind of people what hurly-burly really is, and for most of *us* a conference is the dizziest time in the whole round year. Even here it is difficult for *us* to get away from our urgent responsibilities and activities long enough to consider calmly what our basic objectives and requirements are and what progress we are making. Yet I think this is about as important as it is hard. So what I would like to do, in my few minutes, is to make some suggestions along these lines based on my observations and experiences in working for the Biological Survey and the Fish and Wildlife Service—some suggestions that I feel will be applicable to any conservation agency, federal, state, or local.

It seems to me that the basic objectives in our information work—no matter what sort of organization we are working with in dealing with conservation—are: First, to disseminate the data and interpretations of data that specialists have gathered and made; and, second, to keep the public informed, currently informed, of what we are doing—and why.

I do not include as an appropriate objective the advertising of an agency or simple name publicizing of an agency to call it to the attention of the people. I recognize that it is important for the public in general to know all the agencies there are that are available for help, and I recognize that all of us need public good-will to get along, but I think that a straight information program with a current report of activities will, in the long run, get a conservation agency the best good-will and support from the public.

Now, in carrying out these basic objectives, it seems to me that we have to employ all the techniques that we have available for communicating ideas to the people. Perfectly marvelous means of communication have been developed in this country, and we must use all of them. If we neglect or slight any of them, I feel that we fall just that far short in doing a good job in our educational work.

That leads me to another suggestion based on experience and observation, and that is this: The very fact that our marvelous means of communication have been so highly perfected in this country and, the fact that our public is accustomed to this perfection make it necessary, in my opinion, to employ special skills in using the various mediums—the press, the radio, the motion picture, the still photograph, the public address, and public discussion. We must employ special skills. We have developed our social and economic life so highly that we can not expect a good biologist, for example, to be a good radio script writer, or scenario writer, or good newspaper reporter.

I feel that all of us must finally face this fact that we must employ specially qualified people to carry on information work. Furthermore, it is necessary to have good organization within an agency and cooperation with other agencies in order to use the various experts that *are* available in the best coordinated manner. Finally, when we can not ourselves employ the experts we need, we should—and can—enlist the support of the many experts that are already engaged in publicity —the newspaper and radio men, for example. By helping them do their job we can get our own done well.

CHAIRMAN BROWN: *One more angle from the point of view of the Federal Government and that is the soil conservation angle by George Barnes of the Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C.*

MR. BARNES: As the chairman and others have said already, the word "conservation" has so many meanings nowadays that it scarcely means anything at all. I want to indicate, however, how the Service I represent defines the term.

We think that conservation is a *process*—a positive course of action —to be followed in the use of our resources. Conservation certainly is not a state of being—no resource will ever "be conserved," because resources are things that people need, and need implies use. Conservation, we feel, is a kind of use, or a process of using, our resources.

Conservation education, then, is the work of creating an informed attitude of mind toward the use of natural resources—a point of view that will lead the people of this country to reap the benefits of those resources through the process of conservation.

The Soil Conservation Service is interested in forestry and in wildlife, as well as in soil, because we believe these resources all are of a piece—part of the same picture—and that they must be dealt with as a whole and not singly. What is done with one directly affects the others.

The common denominator of these surface resources—soil, water, forests, and wildlife—moreover, is the fact that they are all affected by man's need to use the land.

The way land is used, for one purpose or another is the factor which determines, more than any other, the welfare of those resources.

The great bulk of our land, of course, is used for agriculture—regardless of jurisdiction, ownership, administrative prerogative and all other considerations, the primary use of land is for agriculture. It is the purpose of the Soil Conservation Service, to help insure that agriculture will follow the pattern of the conservation process.

Through demonstration projects and in soil conservation districts, the Service gives direct assistance to farmers for this purpose. In addition, it employs methods of mass communication to point out the advantage of using land in accordance with the principles of conservation. That is the work of the Information Division of the Service—to employ mass communication methods effectively in a general educational effort.

CHAIRMAN BROWN: *I will ask Mr. DeLaBarre to take charge for a few minutes.*

ASSISTANT CHAIRMAN DELABARRE: *Mr. George Lundy, Director of the National Wildlife Federation's Conservation Education Plan.*

MR. LUNDY: I suspect most of you know what the Conservation Education program of the National Wildlife Federation is, and I shall not take the time to explain it in detail. The program is the result of a survey made over a period of months and has as its principal purpose the placing of a series of educational units, which are to be distributed to the pupils of the elementary grades, throughout the nation.

A particular part of the program that I should like to discuss with you for a few minutes this afternoon is the manner of the distribution of those booklets. It is proposed that they be purchased by citizens of the communities and presented to the pupils in the schools. In order to get the cooperation of the people to buy the booklets and present them to the schools, we must, of course, interest them in the cause. These men and women must think it needs to be done. In other words, we must sell the idea of conservation to the people and particularly the need of educating our children with regard to conservation before they will put up money or make any effort to see that it is done. To do that, we are engaged in an attempt to organize several communities in every state or almost every state in the country this year. We think it would take us some six or seven years to have a national organization as it ought to be, to put the program across. We are starting out slowly, with only a few communities in each of the states in which we plan to operate.

We are setting up definite organizations of men and women who will undertake the responsibility of seeing that these materials are purchased by individuals or groups or by business—commercial organizations—stores and so on—or industrial organizations.

We are using this program as a double barrel shotgun, if you please. We want first to see that the material is placed in the hands of the student, but in the second place we want to come as nearly as we can to producing a course in adult education adequate to the needs of conservation. We know that when any American gives any money or effort towards promoting the program he begins to believe in it. When he begins to believe in that program, he begins to tell his friends. We sincerely believe that within the next four, five or six years as the program develops all over the nation we will have made new friends for the needs of conservation literally by the hundreds of thousands.

Since nocn I have received a letter enclosing copies of several letters that I want to read to you which will, I think, illustrate to you just how this thing does move when really it is understood. Two weeks ago next Wednesday, we held in the City of Cleveland a dinner meeting to which we invited about two hundred of the leading citizens of that city. About one hundred of them were present. In Cuyahoga County there are about 130,000 or 140,000 pupils in the elementary grades. There were some people in the audience who could easily have purchased the whole 130,000 booklets. We would much rather have 1,300 people buy the booklets instead of three or four or even one. Out of that meeting have come these letters. First, a letter from the Cuyahoga County Counsel of Natural Resources.

"You will be interested to know of the interest created here in Cuyahoga County as the result of our meeting at which the National Wildlife Federation program was explained. Since the meeting I have had about 30 calls from people who were unable to attend, asking for details of the meeting. The Educational Committee of the Cleveland Chamber of Commerce has approved the entire program and asked what they can do to help."

Now let me say that the Superintendent of the Elementary Schools of the City of Cleveland was present at the meeting. The last paragraph of his letter reads as follows:

"We are busy here with organization plans, and expect to place an educational unit in the hands of every elementary, public, and parochial school in the County. Figures show there are over one hundred thousand children in the elementary schools of the county. We realize that is a real job, and realize it is a job that must be done and done this year."

I will read extracts from a letter from the secretary of the Cleveland Kiwanis Club:

"I had the pleasure of attending that meeting, which I very much enjoyed and I wish to say that the Kiwanis Club is anxious to cooperate in every way it can with your organization."

Here is a letter from the President of the American Legion Club:

"I have your letter of January 29, and you may be sure that the American Legion Club will be happy to go on with the program in a substantial way."

Here is a letter from the Secretary of the Board of Managers of the Cleveland Museum of Natural History and he signs it "B. P. Bole, Jr., for the Board of Managers." I want to read quite a bit of this letter:

"Specifically, it seems to me that the apathy, or shall we say, lack of energy of conservationists the country over about conservation programs, is due to the magnitude of the problem. Conservation it seems to me is a 'Way of Life' and might easily become a religion in itself, and every phase of conservation as we have it interpreted to us currently, is but a very small part of the problem. It is a drop in the bucket, because the average conservationist cannot see the horizons of the movement. He doesn't know where to begin. I believe that we are all in this same boat and if there is any way to remedy this situation it is at least to discover the horizons. We must know the areas and our activities-to-be. Obviously, the first step is one of education and since the program is so vast, the time to begin the education is when one is very young. If the groundwork, the broad aspects of conservation, are well-learned by children, how much better will their background be for understanding the specific problems that interest us as adults!

"You have about a dozen of my votes for your Wildlife Federation program. If there is any way I can stuff the ballot box, I will certainly do it. It's a great step in the great direction, and to my mind the ONLY one that will pay dividends."

This is just one city. I could take the time to give you the same sort of reactions from dozens of other cities. We think it is a great program of publicity of interest to thousands of men and women who are not now interested in conservation—in this great problem getting them to do something about it. Thank you very much.

CHAIRMAN DELABARRE: *Mr. Shannon Allen, Chief, Radio Section, United States Department of the Interior, Washington, D. C.*

MR. ALLEN: I think I will give a very quick brush-off to two or three generalities, and come quickly to the consideration of a practical problem and the probability of some solution of that problem. The first generality that we will brush-off is that radio is a very good medium. We all know that! We know that it lends itself to the dissemination of information concerning conservation and that it is probably the greatest potential medium. It is a big wide open field. We have all been assured of the cooperation and help of the nation's broadcasters. That isn't the problem. We all have material—information and reports, plenty of them, that we would like to give to the public. That isn't the problem—sometimes a little bit of a problem is determining how we should use radio to make the report, whether it should be a spontaneous interview, or a remote pick-up from some point or on dramatization—but that is entirely too complicated to discuss here.

Let's take up the real bottle-neck in the use of radio for conservation and then see if we can do something about it. That bottle-neck is script. Radio eats up material at a rate that is not known to any other medium. You can spend a week on research, and then hours writing a good radio script, and put it on the air and the people who *happen* to be listening in that particular area are benefited. But for the rest of the country it just never existed. Good material should be given the opportunity of wider and longer life than that. I think it is probable that something can be done about that. I am asking a question and I would like more than anything else an opinion and discussion afterwards as to what can be done about it. Three years ago in the Office of Education they had a comparable problem in connection with educational scripts. They found colleges in Florida and Oregon and Wisconsin—colleges all over the country—producing excellent scripts but presented only to local audiences. A Script Exchange was organized. The scripts were sent into Washington; scripts that the local educators thought worthy of wider hearing. Some editing was done, but practically none. The scripts were catalogued—a very complete little catalogue. It described the scripts in enough detail so that a person would have a pretty good idea of what he was asking for. In the last three years over two hundred thousand scripts have been requested from this script exchange and the great majority of them have been used. Use was in two ways: on radio stations and through the use of script material produced in school assemblies. I am sure a great many of you in this room work in radio—have written for radio. How many people in this room have radio material, stuffed away in a file, that they have written which they know is worthy of more use than has been made of it? Are there some hands on that? Look at that, there is enough to keep half a dozen stations running two weeks. Here is the question: Is there a practical method by which good sound radio material can be shipped in to some central point, where it can be—not edited, but just classified? Then an inexpensive mimeographed catalog might go to each one of you to let you know what the other fellow is doing, something that might be useful to us all in some way or other.

There is a tradition about conventions to the effect that a lot of practical things are done in smoke filled rooms. Jim Stuber and C. A. Paquin were sitting in a room last night, one of them from Michigan and the other from Ohio. Both use radio and both were wishing they had more time to write material and get material together. And it turned out that Stuber had some material that was just what Paquin wanted and that Paquin had some that Jim wanted. They made a swap. Why can't we make swaps like that all over the country? The Department of the Interior is one of the principal conservation agencies. We have a radio section and a few people. We would try to do that, if you think it has any practical value at all. I think that is all I have to say to just plant an idea and see if anything develops.

ASSISTANT CHAIRMAN DELABARRE: *I know a number of you have made mental notes concerning this suggestion of Mr. Allen's. The next speaker will be Nash Buckingham, of Memphis, Tennessee, who will discuss "The Problems of Sportsmen's Organizations." Mr. Buckingham.*

MR. BUCKINGHAM: It occurs to me that from an epic of tragedy and saga of destruction in war-torn Europe and China have come words that will some day adorn imperishable granite and bronze. Like Abraham Lincoln's Gettysburg address, these two sayings will dwell forever there, and upon the lips and hearts of the ages, and their free peoples. Said Mr. Winston Churchill—"Never in history have so many owed so much to so few." And only recently General Sir Archibald Wavell, Chief of the British Empire's African Forces, remarked—"What a world we could build, if we put into our efforts for peace all the energy, courage and self-sacrifice that we WASTE in WAR."

This country may some day see a Utopian conservation; times like some very, very old sportsmen knew. A resurgent conservation, engendered by the efforts of the so very few to whom so many will owe so much. A Utopian restoration replete with game and fish and clean, pure, living waters; lands where one may hunt and angle without restrictions or fear of some game management agent's hand falling heavily upon one's shoulder. A land without sportsmen's problems. A land where precious time is saved by getting the bigger jobs done—and not wasted in exploitation, greed, commercialism, lost political motion and the personal jealousies and bickerings of so-called conservationists.

True sportsmen are, always have been and ever shall be, the backbone of restorational endeavor and conservational progress in this country. Being a hunter and fisherman myself, I rise or fall by that loyal acknowledgment; for I know that examination of practically every piece of nation-wide outdoor salvage through the years, will reveal some individual sportsman or group of idealistic sportsmen working for it undauntedly and, in the end, successfully. Sportsmen's organizations find themselves confronted by many tasks, but they have only one real problem—unification of interests. Where do the tasks and accomplishments of sportsmanship begin? They may well start among little negro Boy-Scout organizations such as a delegation from this conference saw receiving awards for building bird-boxes. Thence, we travel up the line to the hundreds upon hundreds of sportsmen's groups constituting the very backbone of American conservation. The average American sportsman is a pretty fair-minded fellow, who will, when aroused and convinced, drop whatever he happens to be doing and give the best that's in him to further a saner and healthier and happier course for this nation. He will stand just so much and no more from polluters and politicians. He is a bit lazy, however. But who wouldn't be, raised as we of this country have been, in the lap of wildlife luxury and amid untold freedoms and blessings?

It was Genghis Khan, who said—"No city's wall is any stronger than the hearts of those defending it." Our sportsmen's real problem is to go all-out for whatever objective, local, district, regional, or national they set themselves. Equally important, as to unification of purpose, is to find an objective and stick to it until the job is done; to capture and hold ground gained, at all cost. It is a source of pride to me as evidence of what I speak to read in Dr. Gabrielson's annual report on enforcement activities of the Fish and Wildlife Service, that 2,700 convictions were had out of 2,900 cases of violation of the Migratory Bird Treaty Act's regulations. Nearly 500 of those cases were the result of an objective by the Tri-States Game and Fish Association—sportsmen with a vital problem—game bootlegging—in Arkansas, Mississippi, and Tennessee. That objective could be copied with profit by many a sportsmen's association.

The sportsmen's problem is the most tremendously personal problem confronting national existence today—an existence now under direct challenge, incidentally. Any moment may find us defending with our lives and fortunes those basic resources, organic and inorganic—about which and for which, we of conservation, have for so long been sincerely concerned. Now is the rallying time for the honest shock-troops of conservation; to the end that shooting and fishing and the joys of living in an America reborn "shall not perish from the land."

ASSISTANT CHAIRMAN DELABARRE: *After that fine contribution concerning the sportsman by Mr. Buckingham I think it would be very much in order to turn the chair back to the President of the Maryland Game and Fish Protective Association who lists among his other accomplishments that of running the Baltimore News-Post outdoor column. Mr. J. Hammond Brown.*

CHAIRMAN BROWN: *We next take up the problem from the view of* *the outdoor writer. What is an outdoor writer? He is a comparatively new member of the fourth estate. Because of its newness, a lot of publishers do not appreciate the importance of outdoor writing. Get a man, woman, or child interested in the outdoors and he is bound, sooner or later to become what we call a conservationist. Leading the discussion from the outdoor writers' standpoint will be the President of the Outdoor Writers' Association of America, Dave Roberts, who writes for the Cincinnati Inquirer.*

MR. ROBERTS: The outdoor writer on the average American daily handles two types of material. First, he has outdoor stories of spot news or features value; second, he has a column under his own name in which a certain amount of editorial leeway is permissible. Surveys conducted in various parts of the nation show that material coming under either of these heads attracts a tremendous reading public. As this realization grows gradually on publishers and editors, the number of men assigned to outdoor writing increases.

In handling conservation material, newspapers and their writers are in a place of distinct responsibility, since so much of any conservation program must be based upon public approval or disapproval of the issues involved. Therefore, it is unfortunate that more men, with background and training in conservation matters, are not available for positions as outdoor writers.

But facts are facts, and it must be admitted that many of us who are entrusted with this type of newspaper work even on the largest newspapers, lack certain essential information relative to basic wildlife necessities. This, it seems to me, is one of the most important problems facing the outdoor writers' craft; the problem of our own education in the matters which we must treat.

Contrary to the general idea, fish and game are technical subjects. We realize more and more that a solution of wildlife needs cannot come through comparatively simple processes of artificial propagation and restocking. The outdoor writer who knows his subject must admit that a knowledge of soil, forest and water needs are of primary importance in any wildlife program worthy of its salt. Outdoor writers who do not know that are not keeping up with the best and most progressive findings in their chosen field.

It would seem to me that the newspaper man who wants to bring to his paper a following of outdoor-minded folk, should strive always to keep abreast of technical discoveries in the field of biology, forestry, water and soil conservation, and kindred subjects. I don't mean to imply that his material should deal directly with the rather dry details of scientific findings, but I do believe that his writings should reflect these findings, if only in the writer's own familiarity with them.

I realize fully the temptation to play up such spot news stories as the number of fish released from a certain hatchery or a group of hatcheries, or the number of game birds released by a state fish and game division during a certain period of time. I realize fully the news value of a fish hatchery project or a game farm proposal. Here are tangible facts into which a news writer can set his teeth, and which he knows will be perused with enthusiasm by a great number of his readers. I know that such stories, because they are news, must have their place in any outdoor page or column.

But I'm wondering if these same writers, under their own names, might not do well, for themselves, their newspapers and the sportsmen to whom their items are law, in many cases—if they might not act wisely in questioning, editorially, the policy of basing a wildlife program primarily on restocking efforts. We know that a great part of our annual state appropriations each year have gone for restocking, for fish hatcheries and game farms. We know, too, that there is pretty definite proof that most of this money has been wasted. But, since the average sportsman who pays the fish and game bill has had no opportunity to learn of the real failure of these efforts, the programs continue. As long as we of the newspaper craft continue to feed him chiefly a diet which certainly tends to foster the idea that all restocking is good and desirable, just that long will the general public continue to set its heart on increasing expenditures for artificial propagation and restocking.

Only a little study is enough to convince the average writer that wildlife welfare is much more deeply rooted in soil, water, and woods than in the releasing of numbers of half-tame pheasants, quail, bass or trout. I feel that the writer of outdoor material owes an obligation to his readers, just as the publisher of his newspaper owes an obligation to the public. Certainly it is the duty of a newspaper, in its editorial columns, to foster projects which are to the advantage of those individuals who make up the community in which the newspaper lives. It is just as certain a duty of the outdoor editor to foster in his own editorial expressions, projects which are to the advantage of wildlife and to those individuals in his community who are dependent, more than they ever will realize, upon the welfare of that wildlife.

My references to propagation and restocking are not the only examples which might be cited in this connection. There are many others. We may be spending too much of our wildlife budgets for law enforcement, and not enough for what I hesitate to refer to as "education." We may be tossing lots of money away in programs of dam construction, when improvement of actual stream beds is what we need. I'm not attempting to tell you what your studies into the technical side of conservation will bring to your minds. But I am attempting to impress upon you the need for careful and detailed studies of the more or less technical sides of the subject if your columns are to do the job they should be doing.

Let me urge, then, a greater use of outdoor columns, in an editorial way, in order to influence thought toward worthwhile outdoor efforts. Let me urge, too, that these editorial expressions be based in sound knowledge of the problems with which you deal. Let me tell you again that wildlife's existence will depend, in the end, upon plans evolved after careful and complete scientific study, whether that study be done in the field or in the laboratory; that it is no hit-or-miss proposition, but a serious, complicated field with factors which are eternally in evolution.

To keep abreast of those changes we of the writing fraternity must study and observe as well as write; we must do more than cast a good line or shoot a good gun.

In the last analysis, the success of most conservation programs during the next few years, at least, will depend upon proper cooperation; and that cooperation can come only through a full understanding, on the part of Old Man Public, of the problems at hand.

And Old Man Public, his uncles and his cousins and aunts, still depend upon the newspaper for a large amount of the stuff upon which his decisions are based.

CHAIRMAN BROWN: *The next speaker from the group of outdoor writers was formerly a newspaper man. He is First Vice-President of the Outdoor Writers of America. I refer to Ray Osborne, of the Texas Game, Fish, and Oyster Commission. Mr. Osborne.*

MR. OSBORNE: I am always unfortunate in meetings to appear just after Dave Roberts. He is quite a comedian as well as an expert in his line. Three years ago I was on Dave's side of the fence. I jumped over the fence to the publicity man's side. You don't hear the word "press agent" applied to public relations men any more. We are all propagandists. I don't care whether you are on the state game department side of the fence or writing for newspapers, we are all propagandists. We may write straight news, and that is propaganda of a sort. When a man writes in his own column his own editorial thoughts, that is direct propaganda either for or against a subject. There is not a great deal of difference between the press agent of a state game department and an agent of the Department of the Interior or a federal wildlife organization—any organization like that except that the state man has more things to do—he is more of a jack of all trades than anyone can possibly imagine except a man who is in the field. One minute he may be editing a motion picture story and the next minute he may be answering correspondence, or writing a news story or magazine article. Newspapermen are specializing more than the press agent because they have only to write. The press agent has to know his field, that of the motion picture, radio, newspaper, and magazine writing. I find, as Mr. Roberts told you, wildlife writing is comparatively new.

A biologist asked me last night concerning biologists and their tendency to be too technical. And that is where a press agent steps in. He is the go-between for all these biologists and technicians we now have and the public. In other words, your technician is so scientifically trained that he does not know the language of the person interested in the ordinary magazine, newspaper, and motion picture—The press agent takes a hand. He has studied all phases of wildlife conservation, has a smattering knowledge of soil, water, and forestry. He can interpret the technical, scientific paper of those men who are doing work upon which our conservation and restoration are based. This biologist also asked me last night how many men in the newspaper game are technically trained to prepare the constructive information that is needed. I said 20. Probably 12 or 15 of those men are here today, and there are a few more scattered around over the United States. Again your press agent comes in handy. In Texas we have some seven hundred newspapers. We have two outdoor writers in the entire state who know our problems. Your press agent, if he is the right type, is not cramming the state game department down the throats of the newspaper readers. We are doing enough in Texas that I could write three or four columns every week and give facts, information, without prevaricating a single phrase, or a single term. These newspaper writers do not have the technical training of outdoor writers. That is where the press agent is extremely handy.

Newspaper surveys show there are more hunters and fishermen than football fans in the United States. That is surprising, but true. The Southern Newspaper Publishers Association found that out. I think you will find the press agent is a good go-between, bringing about cooperation between the newspapers and the men employed in the game departments. They can still be called propagandists, but they are very necessary and I do not believe there should be any differences between the press agents and the newspaper men.

CHAIRMAN BROWN: *Now, we will approach the problem from the view of the state organizations. Practically every state in the United States has some form of conservation setup. Some are better than others, and some are still experimenting. There is no set formula that* *will answer for all states. I think that is the first thing we did find out. What will work in Ohio will not work in Maryland—what will work in Michigan won't work in Ohio. We are all trying to get a specialized setup that will work according to our problem. We will approach the thing from the view of the state. Each state has two very important men, one the Director of Education, and the other they send out as the Director of Public Relations—which is a five-dollar word for publicity. We will open that phase of the discussion with Townsend Godsey, of the Missouri Conservation Commission, who will start the discussion from the viewpoint of the states.*

MR. GODSEY: Scratch the next three races on your program and we will run this part of the program as a relay. C. A. Paquin, of the Michigan Commission of Conservation, and John C. Caldwell, Educational Assistant, of the Tennessee Department of Conservation, will help me out in a panel discussion of the subject.

There is an organization known as the National Conference of Conservation Education and Publicity Directors in which some eighteen states are participating and have been participating for three years. This conference meets once each year in one of the member states and discusses, very informally, the various conservation problems pertaining to the particular states. These meetings are very informal and we will now take you back stage at one of our meetings. We will keep our feet off the table here but will discuss all phases of the problem and want you to participate in the discussion, if you have a question.

Now, I do want to thank the Institute for permitting us to participate in their first official discussion of education and publicity. And in deciding what we were going to talk about, we consulted the program and found that the various phases of education through radio and newspaper were being well covered and therefore, we decided that we would discuss the educational phases of conservation as pertaining to schools. So we took the subject of: "How Conservation Concepts Can Be Projected in the School Systems Through the Cooperation of Curricular Planning." That will be the topic of our discussion. We feel that if there is ever to be an effective conservation program, it is to come through the youth of today. While it is true that quite a bit of conservation leadership has been taken in certain parts of the country through sportsmen's groups and other conservation groups, the sportsman hasn't always measured up very high in direct accomplishments to the conservation program. It is the exceptional sportsmen's groups that can show proof of measurable results to the benefit of conservation. Such a group is an exception—not a rule. By and large throughout the country, on a basis of measurable results, the real conservation work is being done by the rural youth. The salvation of wildlife lies with the boys and girls of today. While others are talikng, the rural youth is doing. We have analyzed what has been going on in the way of conservation education in the states and find that some states have conservation education programs under way. We have found that some states are successfully injecting conservation work through the schools in cooperation with the curriculum planners and we will base our little discussion today on that phase of how can we participate and cooperate with the curriculum planners to get the conservation education job done? In order to begin the discussion, John, I will ask you to start out with an explanation of how Tennessee projects conservation concepts in the schools.

MR. CALDWELL: Well, Town, we started out wrong, I will say. About six years ago, we started in our present conservation educational work. We thought at first that it was necessary, in order to get conservation into the schools, to get a strong pressure group to push it and hammer on the department of education, and try to make them teach conservation. We also thought that it was necessary to get some new organization through which we would project conservation, and so we organized a Junior Outdoor Club throughout the schools of the State. We had thousands upon thousands of members, and after about a year of that, we recognized that we weren't getting anywhere; that we were using the wrong technique, trying to use a new organization when the State is full of good organizations. We were trying to *make* the Department of Education do something which they were willing to do, if we had just approached them in the right way. That is the way we started, and it was wrong.

MR. GODSEY: You have your conservation program in the schools now, how did you proceed?

MR. CALDWELL: Well, finally we went to the Department of Education and asked how we could best fit into their program. Nearly every state is revising its curriculum, and ours was no exception. There is a tremendous amount of work being done on curricula everywhere and we simply went to the educational people and told them what we had and asked that conservation be taken into account in the new curriculum.

DR. PALMER (New York): Do you mean by that statement, that every state is doing the same thing?

MR. GODSEY: I believe it is true that most states do have some curricula planning process. Dr. Palmer, did you mean by your question, whether or not the plan that worked in Tennessee would be applicable in every state?

MR. CALDWELL: I don't think it is fair for one state to say what another should do. The point is that our state curriculum planning committee did take up conservation. We spent one whole summer with a committee of teachers from every grade level, going over the whole field of conservation education, trying to plan what should be taught in the schools.

DR. PALMER: On their judgment. . . .

MR. CALDWELL: And from that time since, we have been projecting our plan through the Department of Education's Program and have not tried to force a new *subject* into the regular school system.

MR. GODSEY: Mr. Paquin, you have had some experience in your state in regard to curriculum planning. Have you had any experience with certain groups wanting to force on the schools cooperation or anything of that sort?

MR. PAQUIN: The sportsmen have been interested in getting legislation making teaching of conservation compulsory in Michigan. A year and a half ago the Superintendent of Public Instruction, at our request, appointed a Committee on Conservation Education, to work out a program for the schools in Michigan. He included on that Committee, representatives of our department, his own department, county school commissioners, a Superintendent of Schools, a Smith-Hughes teacher, and a couple of grade teachers. The committee was going to have something ready in two or three months and discovered it was impossible. One difficulty we are having is this: That of organizing and making a program. We know that if we get something unsuitable in the schools it will kill the program for a long time. We are trying to get something substantial, realizing that if we don't get somewhere soon, the sportsmen will exert pressure and threaten legislation.

MR. GODSEY: You fellows have been very active in the program for several years and are constantly making surveys of the work in other states. Do you find that in any of the other states following a plan of projecting the concepts throughout the curriculum planning?

MR. CALDWELL: I believe West Virginia has done that, and also Wisconsin. We took up our own work with the Department of Conservation and Public Instruction and work hand in hand with them and I believe in those states where there is such cooperation much is being accomplished.

MR. GODSEY: A charge is being made that no conservation education work is being done today. Do you think that is true?

MR. PAQUIN: There is something being done in practically every school in Michigan. We are trying now to coordinate it.

MR. CALDWELL: I would say 90 per cent of our Tennessee schools are teaching conservation—and doing a good job of it, too!

MR. GODSEY: Assuming your two states are doing this kind of work, do you assume other states are doing likewise?

MR. PAQUIN: I think Paul Olejar of West Virginia is doing good work.

MR. CALDWELL: If you shove down something cut and dried, no telling what damage would be done. And that brings up the question of teacher training. Teachers have to be given some idea of what they are supposed to teach. You wouldn't expect a teacher to teach arithmetic or geography without having some training in that subject.

MR. PAQUIN: Going back to curriculum planning and teaching—several years ago we tried to work with the Department of Public Instruction and about the time we got them over the idea that we weren't trying to put across propaganda, they elected a new Superintendent of Public Instruction and we had to start selling him the idea, and he went out, and the man now there has been there for some time and it is the teachers who are putting pressure on the Department of Instruction to help.

MR. CALWELL: Once you get the program in the curriculum properly, it will stay there.

MR. PAQUIN: I, too, think it will, and the Superintendent of Public Instruction has taken over, and is going to sell a conservation education program in the schools. His department has agreed that while we will pay the individual, we will have a man working out of the Department of Public Instruction to help all the teachers.

FROM THE FLOOR: What is your opinion of conservation organizations in the school, or on the outside? We have some requests in Alabama for such an organization.

MR. PAQUIN: Junior Conservation Clubs you mean? For the youngsters up to fifteen—do they tie in with it? We think it is laudable. I imagine Town could give you more information.

MR. GODSEY: I would like to say we, in Missouri, are going forward with the Nature Knights in the Schools. While we are always willing and anxious to give the information outside our State, we are not trying to force our program on anyone, but if you are interested, we will be glad to go into details about it. However, first we want to demonstrate its value to ourselves before taking it outside.

FROM THE FLOOR: Don't you think it should go into the schools first?

MR. GODSEY: It is always necessary to go through the regular school activities.

MR. CALDWELL: A good point is that we have the 4-H, the Future Farmers, and the Boy Scouts, and I think most of these groups are willing to use whatever material we make available.

MR. GODSEY: We didn't set up the Nature Knights as a separate organization, we are merely providing the necessary materials and distributing these aids through the existing activity organizations.

MR. JOHN M. PHILLIPS (Pennsylvania): I have been interested in this work for thirty-one years. My uncle, for whom I am named, gave me a gun and a dog and I had an Indian tutor and I became a killer in 1889. I thought I had shot the last deer in Pennsylvania and reformed. When the Boy Scouts came along I became interested. We today have the *Boy Scout Manual.* The boys call it the outdoor Bible. Everything you have been talking about, you will find in the *Manual.* You can organize a troop in a school or a church. We have nine million of those boys that we have passed through the Boy Scouts and those boys are trained to the minute—all they need to be good soldiers. They can shoot, take care of themselves at night, know the stars, can give first-aid; they are outdoor men. You can't beat them. The fathers shoot the game and the boys set it out. They are trapping rabbits and discharging them. Those are the boys you want. If you could get those boys to help assist you in this matter, they are trained and will go a long way. They are going much farther. You can make them go much farther. We have nine million of them.

MAJ. H. W. SHAWHAN (West Virginia): Every man engaged in conservation is responsible therefore. The problem of conservation education for both adults and juveniles has been paramount for some of us for years, not for several months. Last night a high official of the Federation made the remark in my presence that Lundy's plan will go over big; that no state had anything as good; that some might think they had, but they wouldn't get up and say so. I wish to disprove that statement by saying that West Virginia after careful analysis of the offer of the Federation, by our Department of Conservation and by our Department of Education, that we are still of the opinion, that under our conditions, and for our State, that the plan adopted and as placed in the public school system is better. I wouldn't say so for any other state, and we think the offering of the Federation might be useful in our particular case simply as a reader supplemental thereto, but not in substitution therefor. We would like to see all over the country more done about conservation education in schools.

MR. GODSEY: We appreciate your comments, but let's get back to our subject "Curriculum Planning for Conservation." I would like to say, however, at this time, that our National Conference has discussed these various things and made no evaluation of them because we had nothing to evaluate and have not taken any definite steps either for or against anyone's plan. We feel that the other fellow is entitled to work out his own salvation, and as I said before, we in Missouri like the Nature Knights, but we do not try to push that plan on anyone else. While we work cooperatively, we are trying to work this thing out without interference.

MR. McCANN (Virginia): I would like to say with reference to Major Shawhan's remarks, that in Virginia we have an excellent plan and have been working on it in the same way as Tennessee and Michigan. We have the so-called new curriculum with the whole curriculum worked out in the second year high school subjects for units that have been adopted by the Board of Education. We are at least in one city, going to use the Federation material, by supplementing data that has been developed by the State Commission and by the colleges, but we have not seen that there is any value in it and we feel that the two may supplement each other and we may get some good from them.

MR. I. T. BODE (Missouri): May I ask, will there be a time, later on for discussion of the general program. I want to make some comments but don't want to interfere.

CHAIRMAN BROWN: Yes, sir. John, do you feel the responsibility of the department is to furnish the facts and the teachers to furnish the method?

MR. CALDWELL: Absolutely; and I would be very careful in how the facts are furnished. I think they should be taken from not too technically trained men to cooperate with state educational departments in furnishing the facts. The facts are liable to be unintelligible. We tried to separate conservation research entirely from curricula work.

MR. GODSEY: Thank you, I agree with that.

MR. PAQUIN: And help furnish facilities.

MR. CALDWELL: Facilities that we have and they don't have.

MR. GODSEY: I think we generally agree with the views of most of the educators dealing with the problem, that it is the responsibility of the various departments to furnish facts and material and for the teachers to determine the methods of projecting that material.

CHAIRMAN BROWN: *Immediately following the last speaker, the meeting will be thrown open and any speaker can ask a question. We are going to approach the question from the standpoint of the school itself. We are honored by the Superintendent of the Memphis Public School System, Mr. Ernest Ball.*

MR. BALL: I would like to turn my ten minutes over to the panel and let this running discussion continue. It is interesting to us to see you raise problems with which we wrestle all the time. Experience has taught me that we have only two real problems; one of them is to determine what we need and the other is how to get it. I think we know what we need.

We need material first, written in the language of children and out of the experiences of children rather than the experiences of experts. I think it is a sound educational principle that true learning evolves from experience rather than from academic process.

In the materials which we need, we need authors that are acquainted with local needs and conditions. If the children in the cities are to have conservation experiences, the printed material and physical facilities under which they may have such experiences must grow out of local conditions. The school laboratory alone is not enough.

We need also quite a bit of equipment with which to take care of the problem of instruction. It is a mighty easy matter nowadays for agencies and organizations to say: "Here is a great movement. It is an educational movement; therefore, we will hand it over to the schools." Such is taking place every day. I think there is danger in that trend. First of all, we must recognize that teachers are pretty hardworking individuals. If you don't believe that, go before 40 red-blooded, energetic boys and girls and try to teach them seven hours a day, and then go home and try to tie yourselves down to familiarize and inform yourselves about all of the new problems growing out of such a situation. We must find, therefore, a way to relieve the classroom teachers of the responsibility of reading all of the material which the technical experts throw at them and expect them to analyze and reduce it to an intelligible program for a 7-, 8-, or 9-year-old child The conservation program is strangled now because of a lack of good textbook material; that is, printed material written within the comprehension of children.

Also, some way must be found to finance the increased cost of a conservation program. We don't demand that the doctor take his time and spend his money to go back to school. New programs in the public schools demand that teachers do this on very average incomes. A partial way around this problem is to endeavor to interest business people to the point that they will purchase books, materials and equipment for the use of the schools.

Through the use of motion picture machines, the teachers can become directors of learning and be relieved of tedious hours of assimilating and giving back to children the printed material which may become available.

The releases from Washington and all other agencies are contributing materially to our general information, and we can in turn transmit such information to the school children. But we must rely upon your organization to inform and interest the adults in the homes.

We have all we can do to work with the children and to teach this program. We would like for the organizations represented here to carry on a lot of adult education so that when Johnny goes home enthusiastic about the program, he will find a sympathetic reception from mother and dad.

CHAIRMAN BROWN: *We will close this period of the discussions by approaching the problem from the viewpoint of the newspaper, the point of view of the press, and we are honored with the presence of Edward J. Meeman, Editor of the Memphis Press-Scimitar, Mr. Meeman.*

MR. MEEMAN: My first boss told me once that modesty in a newspaper man is a crime. I think you will agree with me that my predecessor on this program, Mr. Roberts, is no criminal, but is a very bright ornament to his profession. Neither will I be modest, and I am going to pass on to what Mr. Onslow had to say at the start when he said that the press is basic in publicity for conservation. I am going to chasten the press because I love it. I think the press is pretty much in the same position as our great southern staple "cotton." Cotton has suffered from the weakness of its great strength. Cotton is a wonderful thing, and because it is so wonderful and we have had it so long, we in the South found that everybody was taking it for granted and flaunting new things ahead of it because they had had promotion, using all the wonderful modern methods of getting the thing before the public. The press is like that. Being the oldest of these means of publicity, the press has been inclined to be old fashioned, to be behind the times, to consider itself still in the days when it was the only thing. I am very much dissatisfied with the way the press does its great job, because I believe that all these new things, radio, motion pictures, the modern magazine, have only brought out how essential the press is and how its position is the best, being produced in that most important and dramatic division of time, the day.

But the trouble with the newspaper has been that it has gotten the news too much by the day instead of for the day. Because it does come out by the day and has a certainty of attention by every intelligent reader, we newspaper men have tried to work by the day. Some of us were told when we were cubs to put the whole story in the first paragraph. If there ever was a writer who was able to do that, no reader could decipher it. We should have very unconventional stories. Instead of telling all the story in the first paragraph, sometimes the reader shouldn't know the point of the story until he gets to the last paragraph. A writer should be so good that his reader would follow all the way to the end. You can help newspapers in this production of material for the day, in the thoughtful bringing out in good writing of material which will get to that wide audience which only the newspaper certainly has.

To do that, we must use a lot of pictures. A picture is worth a thousand words, but better than that is the picture story in which pictures and text are combined, one supplementing the other one, that should be furnished the newspapers. You should cooperate with us in giving us that kind of graphic material.

We should have in our papers the sort of picture material you have out there in the corridor. How seldom do we see in the newspaper the story told in pictures—one that gets the story over, so that it is unforgettable. We should use those picture stories. We should use the photograph, the cartoon. You conservationists can furnish the press with that.

A cartoon is not some droll subhead in pen and ink. A symbolic picture makes a splendid cartoon and when combined with written editorial—with a short editorial—it is splendid.

For instance, look at the same technique as was applied in "The River." Some of you, of course, have seen it at every opportunity. How much greater that picture was because of the fact that it was accompanied by that splendid poem that goes with it. We should have that sort of thing in our newspapers—fine press writing that goes with pictures. There is nothing better. I think there are three main divisions of conservation publicity: First; the outdoor writer, who primarily is on the sports page, and appeals to the hundreds of sportsmen. Of course, he increasingly does not limit himself entirely to that field. He looks about and teaches the sportsman to preserve the thing he kills. Primarily his appeal is to the hunter and the fisherman.

Then there is the nature column, nature lovers' column, which is usually very short. And the next is all the rest of the paper, the news columns, editorial columns, which nowadays should be and most of them are, largely devoted to conservation.

The trouble, as I see it, is that there isn't enough of graphic presentation. I think that we ought to go to the great feature services and get them interested in preparing this graphic material. They will do it, I am sure, if they are asked. I have had some success in getting them to do it, as well as doing it in my own paper. Believing, as I do, that the trouble of conferences often is that they are not conferences but a series of speeches, I am going to stop so that we may start the forum.

CHAIRMAN BROWN: *The following remarks are inserted into the record by Bob Edge, of the Columbia Broadcasting System.*

MR. EDGE: During a recent hunting season in one of our Eastern States, it was reliably reported that a deer hunter who had taken up a point of vantage in a tall tree was shot from his perch and instantly killed by another hunter who claimed that he saw "something move" and fired. If it weren't for the tragedy involved, I might be inclined to chuckle at such an occurrence—for it is the first time in my career that I've ever heard of a white-tailed deer climbing a tree.

However, I am here on a much more serious errand, and I intend to do all that is within my province to present an idea which, while not having had its origin with me, has had my wholehearted support for the past five years. I refer to the necessity for the examination of all applicants for hunting licenses throughout these United States!

Immediately upon utterance, I can visualize the protest and ridicule even—which will greet this statement. Yet, in the light of clear reasoning, I cannot for the life of me see what objections an individual or group could conscientiously have to a plan which, if placed in operation, would result in saving human lives and in cutting down accidents in the hunting field.

How many of you recall the opposition to the first Automobile Safety Campaigns? The groaners and the defeatists who proclaimed in print and in private that the killing and maiming of persons on the public highways was to be expected?

Unfortunate? Of course—but such was the price of progress.

Besides, the wise ones said that any kind of a safety campaign would cost money. Inspect rattle-trap cars for bad brakes, faulty lights, and rotten tires? Well, we should say *not!* Examination stations would boost the taxpayers' already heavy load—it would make a lot of 'em sore—cost the boys at the State House a flock of votes—no, that would never do.

Yet, it *was* done.

Gradually in hundreds of cities, towns, and some commonwealths the public was educated to the need for exercising care in driving their cars and crossing the streets. Regulations governing those who took examinations for the right to drive a motor vehicle were tightened. The rattle-trap cars were ordered fixed up or to stay off the highways. Legislatures enacted heavy penalties for those involved in accidents. In churches, schools, fraternal organizations and business groups, the idea of safety was driven home until it meant something. John J. Citizen began to awaken to the idea that safety on the streets, whether walking or driving, meant something to him personally. He began to take pride in his town's safety record; and woe unto the individual who trespassed upon that record. What if the safety campaign did cost a little extra, it was getting results, wasn't it? The kids on the way to school weren't in any danger of being run down by a near-sighted galoot who could hardly see the radiator in front of him. It was even getting so a body could go for a drive of a pleasant Sunday afternoon without running the risk of being side-swiped by a crazy youngster in a borrowed car.

The safety campaign was getting results!

The automobile, a lethal weapon, is rapidly becoming less lethal in those sections of the country where people and politicians have had the foresight and courage to meet and combat the menace.

Yet we are sorry to say that there exists today a situation which parallels the danger of the automobile.

Rifles and shotguns are lethal weapons; and, as such, should be considered with the utmost respect. But are they? To the best of my knowledge, there is not one state in the Union where I cannot walk in and secure, upon payment of the proper fee, a license which gives me the right to carry a loaded gun through the fields, woods, and upon the waterways of that state. Of course, I may be asked a few questions by the clerk.

How many pheasants did I shoot the previous season? How many rabbits? Routine questioning—but never a word about my fitness to go among my fellow citizens with a weapon charged with buckshot, birdshot, or a rifle cartridge.

For all the license agent knows, I may be color blind, and then what good will the hunters' red be to the person wearing it in thick cover a hundred yards away? The red looks green or brown, and I might think it's a deer.

How does the clerk who sold me the license know if I know what happens when a fellow stumbles in the snow and jams his barrel full of the white stuff. Probably nothing until he picks up his paper next morning and reads about a non-resident who blew his left hand to bits firing that snow-clogged gun. "Too bad," he says, as he makes change for the next applicant. As he does, he's cussing, for he's got to close the store that afternoon and go to young Bill Jones' funeral—the danged idjut shot himself tryin' to pull a loaded shotgun through a fence. Folks is gettin' mighty careless—'twas only by the grace of God that Tom Smith's in the hospital instead of the morgue. Imagine a fellow as old as he is tryin' to shoot a 20 gauge shell in a 12 gauge gun!

And so it goes all over the country. Accidents, accidents—too many of them—if you but pause to analyze the reports. Twenty killed in this state—forty in that—over a hundred and fifty persons in the other, to roll up a long and gruesome total. For what? Why?

Without going too deeply into the matter of statistics, let us look for a moment at a report made available to me by Fay Welch of the Department of Landscape and Recreational Management of the New York State College of Forestry. Mr. Welch investigated 965 hunting accidents in 1939, and this is what he found: of the 965 gunning accidents, 279 hunters were killed, 686 hunters wounded (some died later), 370 hunters shot themselves, 363 hunters shot by hunting companions, 613 killed or injured by shotguns, 186 killed or injured by rifles, 280 under 20 years of age (of 628 whose ages were given), 70 persons firing shot unknown causes (based on partial analysis), 59 tripping or falling, 36 did not understand mechanism of gun, 35 mistaken for game (deer, 21), 34 "swinging" i.e. following flight of game, 24 pulling loaded gun toward oneself, 19 cleaning gun, 17 using gun as club, 12 defect in gun, 5 snow or mud in gun.

Taking up the first part of the analysis, it is apparent that the cause of these accidents was about evenly divided between those who shot themselves and those who were shot by others, 370 in the former case, and 363 in the latter. Further, we may learn that 280 of the killed or injured were under twenty years of age. In the first instance, it is apparent that carelessness was equally divided. In the second case, youth with insufficient experience paid a heavy penalty.

I am, however, more interested in the establishment of a system which will prevent these accidents in the future than I am in analyzing past disasters, although several lessons may be learned from them and put to excellent use.

What I offer is a plan for the fish and game, or conservation departments, of the several states. It is a simple plan—and one which is presented only as a guide to what can and should be done. Enlargement, change, or correction will undoubtedly be necessary to make it workable under the various existing state conservation set-ups.

What constitutes the plan is this: At designated inspection stations through the state, the application for a hunting license should be prepared to answer or demonstrate the following: (1) Reasonable knowledge of how to load, carry, fire, and unload a gun; (2) that his or her eye-sight meets with the accepted tests of oculists; (3) that he has a knowledge of state and federal game laws which apply to shooting hours, bag and possession limits, species, etc.; (4) that he knows at first glance the game birds and animals in his vicinity.

In answer to those who will remonstrate that such a system of examination stations is a costly proposition,I say this: certainly such a radical change is bound to be costly—at first. But if the conservation departments of the states would dispense with the present system of dispensing hunting and fishing licenses and in turn issue such licenses only through these central stations, as I have suggested, there would be no need for re-examination of the license holder, once he has passed the initial test. His license could be procured each year by the simple expedient of mailing his money to headquarters. After the first year of operation, staffs of examiners would not have to be large to take care of first time applicants.

And there you have a simple, sane proposal which should be acceptable to any sportsman, be he a veteran or a novice. In the veteran's case there should exist the element of pride in his knowledge, plus an awareness that in his cooperation with the system of examination he is setting a good example while at the same time providing himself with the cheapest form of hunting life insurance yet devised.

To the novice, the last sentence is particularly applicable, for he will have impressed upon him from the very start of his sporting career that safety in the field is at all times more important than the pursuing and killing of game. Further, if he is to pass this simple test, he will also go into the field with a knowledge of what he is after and the limitations imposed upon him by law. He will not, in other words, be able to tell the warden or the judge to whom he must answer for game law infractions the old story: "I didn't know—I thought that wood duck was a teal"—or, "I was positive that hen pheasant was a cock bird."

DISCUSSION

CHAIRMAN BROWN: Mr. I. T. Bode, Director of the Conservation Commission of Missouri, will now begin the discussion.

MR. BODE: I am going to ask the Chairman of the Commission to make some remarks in regard to our educational program in relation to the program being proposed by the Federation for the reason that just this year they have gotten under way a program of their own. I don't know how good it is. We don't even know that it is as good as any other program that may be brought in, but I do know one thing about it and that is that we have gotten coordination with our Department of Education on the thing that we are doing. We are quite hesitant and uneasy, so to say, about the introduction of something else immediately on top of it which might so confuse the issue that we might lose the good we have gained. I would like to have Mr. Stephens, the Chairman of our Department carry on.

MR. STEPHENS: Mr. Bode has lost his voice and I will have to pinch-hit for him. Since he is my boss, I will have to do it. I think, in order to clarify this discussion we should think about this thing of education and information from two standpoints. We are all public agencies, and therefore dependent on public confidence for our existence. That is one of the phases of public education or information with which we are confronted. In other words, if we don't justify our existence through the information of our activities the public receives, we won't exist. I understand that we are discussing for the moment, the question of public school education which is to develop this thing that we frequently hear called "A Way of Life," which they claim is another definition of conservation. The State of Missouri, approaching that problem, has recognized one fundamental consideration, and that is that the Commission, as such, doesn't know anything in the world about the technical phases of conservation, neither does it know anything about the technical phases of education. Therefore, we have submitted those two problems to experts in those fields so that whatever is presented to the teachers or to the pupils of the State will be found from the standpoint of scientific conservation and also from the standpoint of scientific education including courses of study, and curricula and, what not. But, even so, we haven't been bold enough yet to undertake to produce any material for pupils. We consider that before we can undertake to teach the pupils, we must teach the teacher, and therefore, whatever we have done has simply been in the form of a series of teacher movements which will undertake to provide teachers in grade schools, rural and city schools, first, a kind of orientation, and then some specific construction with reference to specialized subjects. Our position with reference to the Lundy plan is this: That since our teacher program is only half projected and will not be completed for several months, we are uncertain, as Mr. Bode has told you whether it wouldn't be confusing to introduce at the same time, and from a different source material for pupils since the teachers have not had the opportunity to understand, comprehend, or digest it. I think, therefore, that in the State of Missouri neither our problem, nor the interest of the organization will be served by the introduction of the plan at this time. We want it understood that we are in full sympathy with all objectives of the Federation in introducing this plan but as far as our particular State is concerned we do not think at this time that it is appropriate.

CHAIRMAN BROWN: Please confine the few minutes that we have to questions and answers.

MR. PAQUIN: Would it be in order for this group to take formal action—I am referring to the idea by Mr. Allen of the setting up of a clearing house on radio script? I think it is important and schools are interested in borrowing script. I think it would help Mr. Allen if we could pass a resolution asking him to set up such a department.

CHAIRMAN BROWN: That is very constructive.

MR. PAQUIN: I make a motion that such a clearing house be set up under Mr. Allen's supervision.

FROM THE FLOOR: May I suggest that you include motion pictures.

CHAIRMAN BROWN: You have heard the original motion.

(The vote was had—motion carried as originally stated.)

MR. J. D. MAULDIN (Texas): I am interested in finding out from the units of education over the country about this problem. I found in Texas A. and M. that they were using vocational agriculture as a medium of getting wildlife over to the boys and the prospective vocational adult students are not taking advantage of the wildlife classes. We had 200 prospective students and only four took wildlife courses.

ASSISTANT CHAIRMAN DELABARRE: I am wondering if something couldn't be done about that. We have only five that have been even interested enough to take wildlife courses and for another course that we have in game management we have never had a student.

FROM THE FLOOR: I happen to come from State College where there is a comparable unit to the one to which you refer, and I think the principal reason that the students do not take the wildlife course is that the prerequisite of biology training is required. I do have one general course in conservation and game management which they can get in, and in which about forty have gotten in, and I know of one or two other state colleges where the same procedure is being followed. The vocational students haven't had enough biology training to follow along.

MR. JACK VANCOEVERING (Michigan): We, in our State, have a number of normal schools that conduct summer school. I should like to ask if there are any other states which conduct similar training courses for teachers in conservation education.

MR. OWEN: (Ohio): Last year is the first time and this year there is going to be a larger school and the interest in it is so great that the Kiwanis Club, Junior Chamber of Commerce, and sportsmen are financing the attendance of the teachers to that school.

DR. PALMER: We are running a similar course next summer. We have run it four summers. It is filled now and we have not had the backing of the Kiwanis Club or anybody.

MR. CALDWELL: We had a 189 last summer.

MR. OLEJAR: May I ask if that is academic training?

MR. CALDWELL: Graduate and under graduate in Tennessee.

MR. RICHARD WESTWOOD (Washington, D. C.): At the last three conferences, we have heard the question asked: "What is being done about teaching the teachers in the school in the first place, to be a teacher—to teach conservation?" We have not had an answer. The question was asked yesterday. I should like to hear the answer.

MISS ALICE SEAY (Tennessee): May I answer, in part, the gentlemen's question about what is being done? The Garden Club of Memphis, the Woodland Trail Garden Club, last year gave me a wonderful advantage by sending me to the Audubon Nature Camp off the coast of Maine. They gave me that free, and I want you to know that they are teaching a full course. It consists of a course of two weeks. It was really a nature education and if we could get club people and women interested in giving the teachers that opportunity, if they are not able financially to take it themselves, it would really be a fairy godmother affair for the teacher.

CHAIRMAN BROWN: One of the most treasured recollections of my boyhood is the days of the Chautauqua. I think we could revise the old fashioned Chautauqua and make it a nature Chautauqua. Every state in the Union could have a nature Chautauqua in the summer time. We could bring out educators, people who know birds and flowers, and for a week or ten days or two weeks live in tents, get close to the ground and discuss the problems of conservation.

All the nature schools are splendid, but the teacher who is going to teachers' college to take courses from two to four years to become a teacher—that is where she is going to train, that is where they should teach conservation. Why don't we find out why the teachers' colleges don't teach conservation?

FROM THE FLOOR: We study nature study but whether that is in the schools now I don't know. I would like to hear Mr. Caldwell say.

MR. CALDWELL: There is a great deal of work going on. Every teacher at Teachers' College in Tennessee has conservation training. I think West Virginia does. I believe the teachers more than ever before, are getting conservation training in Tennessee. Our courses are taught throughout the year, and the summer and spring courses are sometimes taught in biology and sometimes in geography courses. We try to get teachers to talk not only about conservation, but how to teach conservation.

DR. FRANK THONE (Washington, D. C.): More books are becoming available for the training of teachers specifically in conservation, rather than in biology, nature study or some other subject. Across my desk come all the books pertaining to this subject. Up until three years ago, there were no books for college and high school use as such. Since then at least five have crossed my desk and probably two or three others. They are at least good and one or two of them are especially good.

MR. WESTWOOD: The point I am trying to get at is: The question is asked about what is being done. If it is a fact that in Tennessee they are required to teach it by law. . . .

MR. CALDWELL: It is entirely voluntary.

MR. WESTWOOD: I should like to know what is being done about this. I think it is a vital question.

CHAIRMAN BROWN: I think a survey along that line would be a tremendous work.

MR. W. B. HENDERSHOT (Ohio): I would like to ask the gentlemen in the discussion who mentioned having contacts with the educational departments of several different states, whether or not they know of any state planning board putting conservation in the schools as a definite subject:

CHAIRMAN BROWN: Can anyone answer the question?

MR. PHILLIPS: They are in Pittsburgh, but they are doing it through the Boy Scouts and everybody has fun too.

TECHNICAL SESSION

MONDAY AFTERNOON—FEBRUARY 17

Chairman: Dr. Leonard Wing
Washington State College

Discussion Leaders:

W. C. Glazener, *State Game, Fish, and Oyster Commission, Austin, Texas.*
Dr. Geo. O. Hendrickson, *Iowa State College, Ames, Iowa.*
Dr. P. F. English, *Pennsylvania State College, State College, Pa.*

CARRYING CAPACITY DETERMINATION ON WILDLIFE AREAS

FORAGE INVENTORY METHODS, WITH SPECIAL REFERENCE TO BIG GAME RANGES

H. E. Schwan and Lloyd Swift
U. S. Forest Service, Denver, Colo.

The most widely used method of inventorying forage resources on livestock ranges, as reported by Sampson (1923), was developed by Jardine of the Forest Service, and first applied on the Coconino National Forest in 1911. This technique, referred to as the "Reconnaissance Method" by the Interagency Committee (1937), interprets the value of the range by means of the formula:

$$\frac{\text{Density} \times \text{Palatability} \times \text{Surface Acres}}{\text{Forage-Acre Requirement}} = \text{Grazing Capacity.}$$

It is based on an ocular estimate of one or two selected plots of indefinite area per type. Stewart and Hutchings (1936) developed the "Square-foot Density Method," employing the same formula, but substituting randomized, replicated plots of measured area and estimating the densities in square feet.

While these density methods have served as a satisfactory index, they have certain fundamental weaknesses. Some of these are:

1. Density alone is not a true index of the amount of forage available for herbivorous animals, since an estimate in a plane presumably cannot account for differences in volume due to height of the plants.

2. Ratings of forage types, because of the formula employed, are necessarily in terms of ratio, and do not attempt to express a physical

measure of the forage present. This makes checking of results, as well as comparison between projects, difficult.

3. To select the proper intensity of stocking, a test must be made on a representative area of range on which use can be controlled, as prescribed in the Interagency instructions. Frequently, controlled areas are difficult to find and even where they exist, the final determination of proper use rests on personal estimates. Furthermore, adjustments for volume are necessarily made in the requirement factor and not in the estimate of the amount of forage. This leads to a fluctuating requirement varying from project to project.

4. It is often difficult to estimate plant density on big-game ranges, where forage may involve the lower branches of conifers and deciduous trees, diverse forms of shrubs, bare twigs, or plants partially unavailable because of snow.

Most workers using the density methods on big-game ranges have encountered difficulties and have pointed out that the resultant capacity figures are not to be regarded as highly accurate. Rush (1932), working on the northern Yellowstone elk herd, was particularly concerned over the absence of a reliable forage-acre requirement for elk. He recommended the construction of a 1,000-acre pasture containing representative types, where a group of elk could be confined and a forage-acre requirement determined. Grimm (1939), who worked several years later on the same territory studied by Rush, adopted a forage-acre requirement of 0.5 per month for elk. This was based on some cattle-elk comparisons given by Rush and on his own observations.

On the Pisgah National Game Preserve, Ruff (1938) made a survey of the white-tailed deer range, but was unable to develop a forage-acre requirement for these animals. Lacking better data, he adopted the requirement determined for domestic sheep under western range conditions.

Both Ruff's and Grimm's surveys emphasized the fact that game is dependent on wild lands for year-long range. This introduced a factor not usually considered in surveys for domestic animals, since they are under control and ordinarily are permitted to use the range only seasonally.

On the Pisgah, the range capacity during winter was found to be one-third that of the summer, principally because of the absence of leaves. Moreover, winter range capacity varies with snow conditions and the severity of the storms. For instance, Grimm found the available elk range in January, February, and March to be about 60 per cent of that for December or April.

Clipping has long been used as a means of obtaining detailed data on the forage of game ranges. However, clipping has not, ordinarily, been practiced as a means of determining carrying capacity, but more often to ascertain the degree of utilization or the variation in forage production. Grimm's work in the northern Yellowstone area is perhaps an example of this tendency.

One question that has come to the attention of some workers is the degree of difference likely to result when two or more techniques are applied to the same area. Rasmussen (1939) considered this point in Logan Canyon in Utah. He surveyed a 663-acre area where mule deer concentrated in winter and compared capacities indicated by density and by clipping methods. He used a deer forage requirement of .150 and air-dry food requirement of 105 pounds a month, and obtained the widely divergent capacities of 308 deer months by the density, and 630 deer months by the clipping, method.

Ordinarily, when weight appraisal has been considered, each worker has been inclined to develop his own technique, and as a result, various individuals have selected milacre, meter square, 100 square-foot, and other sizes of plots. In addition, weights have been recorded in variable units, such as grains, grams, and ounces. Hence, it has been difficult to reduce the data gathered to a simple record of pounds to the acre.

Pechanec and Pickford (1937a) pointed out the shortcomings of the density methods, as well as the fact that a straight clipping method is too tedious and costly. They tested the possibilities of a weight estimate method under controlled conditions, and advocated its use on livestock ranges. The same authors (1937b) found that the weight method was not only adapted to the estimation of forage production, but they advocated essentially the same procedure in determining percentage utilization.

It remained then to test the weight estimate method in actual large-scale surveys. This was done in 1939 and 1940 in connection with the regular Forest Service range survey projects in Colorado. The first investigation was made to test the correctness of species proper use (palatability) ratings. As a result of several hundred samples clipped from 76 species of plants, it was concluded that the forage values of the various species should be determined by carefully observing the degree of use made by the kind of grazing animals under consideration, then clipping ungrazed plants to simulate grazing, and expressing forage value in percentages based on weight. Such ratings should never exceed the use which the species can withstand and still maintain its vigor. Information on allowable use for various species is fragmentary, but based on the investigations of Julander (1937), Talbot

(1937), and others, as well as on original work on this project, it is ordinarily about 50 per cent of current growth.

The second phase of the study was to determine the relative accuracy of weight estimates under actual field conditions. Pechanec and Pickford's (1937a) findings that ". . . weight estimates are subject to slightly more personal error than density estimates" were verified in Colorado by some 150 tests by 15 examiners in three range survey crews. However, maximum error generally did not exceed 20 per cent. The relative personal error is not directly comparable between the density and weight estimate methods, since in the former the error must be computed against the crew mean, which may not be a true index, while in the latter method it is computed against actual weights. Since the weight estimate method was tested under varying conditions, involving grasses, weeds, and browse, and since demonstrated error was considered to be within acceptable limits, it was concluded that the method was suitable for inventorying all sorts of forage, including that on big-game ranges.

It has been demonstrated as a result of the 1940 work that a trained examiner can cover approximately as much ground when making weight estimates as when appraising density and that the costs, therefore, will be about the same.

Pechanec and Pickford (1937b) point out the uselessness of the density method for measuring differences in amount of forage for various species. Our work demonstrated that it also fails to account for differences in volume within the same species as well as the total volume of forage between types.

Probably the greatest advantages of the weight estimate method are its relative simplicity, and that it depends upon physical rather than ocular checks. Since the estimates are based on physical checks (weights), an individual can improve his performance. In this respect, it is unlike the density method, in which constant checks between men are necessary to maintain uniformity in the ocular concept of ground cover.

The physical term "pounds-per-acre" is more readily understood by the average person than the ratios, "forage-acre-factor" or "forage acre." This alone should have a desirable effect on hastening the acceptance of scientifically sound inventories and plans by sportsmen and the general public.

As pointed out previously, there has been a tendency for each big-game range specialist to develop his own range survey technique. A uniform procedure will, however, tend to standardize results, make them comparable and therefore more usable. The following methodology, which has been tested under field conditions, is recommended:

1. *Equipment needed*—a. A grass shears with stout 6-inch blades, or pruning shears where coarse browse is the principal forage. b. A scale registering in grams. c. A supply of small cloth or paper sacks.

2. *Proper-use tables*—The first step is to construct a proper use (palatability) table. Percentage ratings should be based on the amount utilized for each species, when the range is properly used, compared to the total current season's growth. This ratio should always be determined by weight.

3. *Maps*—A type map should be made for the area under consideration. The Interagency instructions furnish a suitable guide for type mapping. The use of aerial photos, when these are available, will greatly facilitate mapping and will increase the accuracy of the map.

4. *The use of plots*—A transect of three or more randomized plots should be established within each important type. The number of plots per transect or type will vary with the area, and for ordinary extensive surveys under western conditions, should average at least ten per section (square mile) of usable range. Costello and Klipple (1939) point out the need for a proportionately greater number of plots in highly important types, and it is suggested that the number of plots per section be increased according to the value of the type.

The size of plots may be varied according to local conditions. Twenty-five, or 100-square-foot circular plots (radii 2.82 and 5.64 feet) are desirable, since weight can be readily estimated with one-fourth-square-foot units on the former and with square-foot units for the latter.

The most satisfactory field technique in weight estimating is to clip a plot or portion of a plot immediately upon entering a new type. From this the examiner gains an overall concept of the weights for the type as well as for the principal species. As he progresses through the type, estimating random plots, he revises his estimate by the appearance of the forage as compared to that of a clipped plot. Approximately each fifth plot is wholly or partially clipped. It has been found that greater accuracy can be obtained by clipping a part, as one quadrant, of a greater number of plots, rather than clipping fewer plots completely. Of course, estimates cannot be checked by direct weights during rainy periods.

5. *Air-dry weights*—Final forage weights should be expressed in terms of air-dry weight, to offset differences in green weight due to curing as well as to tremendous differences in succulence between species. While it is possible to establish average air-dry ratios for each important species, a better practice is for each examiner to collect small samples at weekly intervals, for each significant species. These can be placed in manila envelopes which are superior to bulky

paper bags, and can be readily stored in racks for rapid drying. If large samples are taken, there is danger that the forage will mold.

6. *Seasonal adjustments*—Most surveys are made during the growing season. Where winter use by big game is a factor, it will be necessary to adjust the figures to compensate for the absence of leaves on deciduous shrubs and for forage covered by snow. It is desirable to make the survey during the period when the animals use the range, but if this is not possible, then ratios of leaves to stems and proportion of forage unavailable because of snow should be determined.

Forage classes, as grasses, weeds, and browse, should be listed separately to further provide for seasonal adjustments and to account for differences in livestock and big-game needs. This is especially important, since on a common range, game might feed primarily on one class of forage, as browse, while cattle or sheep would be using the herbaceous plants.

7. *Calculations*—Suitable forms should be prepared for use in the field. The most satisfactory method is to list the species encountered, recording them by species weight per plot. Species totals divided by the number of plots will give the transect average. This is reduced to air-dry content and for each species multiplied by the proper-use (palatability) rating. The result in grams should be converted to pounds-per-acre. Since 100 square feet are equal to 1/453.6 acre and one gram is 1/453.6 of a pound, multiplying grams per 100 feet by .96 will accomplish this conversion. An easier field method is to deduct .04, giving approximately the same result. If 25-square-foot plots are taken, the result must be multiplied by four.

8. *Ration allowances*—There is a real need for feeding studies to determine deer and elk requirements in terms of pounds of natural food, air-dry basis, which would be consumed under range conditions. Perhaps the best-known feeding experiment on deer is that of Nichol (1938). He worked with mule deer and Arizona white-tailed deer and concluded that 2.35 pounds of air-dry forage would be removed from the range per day for each hundredweight of deer.

Davenport (1939) fed white-tailed deer in Michigan and found that the total dry matter consumed for six natural diets generally ran higher than Nichol's figure. Deer fed an assortment of natural browse which proved the best, consumed 2.65 pounds air-dry per hundredweight, but still lost weight.

Some figures given by Rutledge (1938) suggest a daily air-dry requirement for the average animal to be 6 pounds for mule deer and 16 pounds for elk. These requirements were proposed after considering the known amount of feed given penned deer and elk in several zoos and other places where records of forage consumption had been kept.

It is believed that Nichol's and Davenport's figures are too conservative for western range conditions. This is based on the assumption that more food would be required to compensate for the expenditure of energy in foraging over rough terrain and where the food plants may not be abundant. Moreover, during the winter, snow conditions and low temperature may greatly increase the food requirement over that found ample under controlled and penned conditions.

Considering the limited amount of work done, no fully acceptable requirement is available for deer and elk on western ranges. For comparison, the figure of 150 pounds is taken as the average live weight for mule deer of all ages and sexes, and for elk, 500 pounds, or a rough ratio of 3⅓ deer to one elk. Pending further studies, the arbitrary ration requirement of 5 pounds of air-dry forage a day for deer and 17 pounds for elk is suggested.

The technique of basing big-game capacities on forage weights was tried by Means (1940) after conferring with the authors. Means, however, resorted more to actual weights based on clipped plots, due to the fact that he had CCC labor available. In other respects, his methods were essentially as herein outlined. The results of this survey have been substantiated by the conditions on the ground.

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DISCUSSION

PROF. GEORGE O. HENDRICKSON (Iowa): I am not at all familiar with this type of work, so I would like to ask what may be a very simple and obvious question to you. How often did you clip the vegetation from one of the plots?

MR. SWIFT: Ordinarily, as I pointed out in the paper, we clip samples from about every fifth plot. As we go out in an area to make our survey and we locate our plots on a random principle, at about every fifth one of those we will do some clipping to standardize our ability to estimate weight, and as we go along, this clipping takes out the inequalities in our estimating and gives us more or less a balanced concept of the weight per square foot, or other unit.

DR. CARL O. MOHR (Illinois): I have long been curious as to one point that bears somewhat upon my small mammal studies. You mentioned forage-acres and I judged from what you said that you were trying to devise some better method of estimating carrying capacity. You stated that if the forage were scattered widely, the animal would spend a great deal of energy getting food. Do you have any minimum standard for cattle or sheep or deer or any other animal, that is, where the forage would be so scattered that the animal would wear itself out getting the food?

MR. SWIFT: We have found, in connection with domestic stock, that there is a definite limit to the amount of territory the animals can cover and still maintain weight. Just exactly what that figure is, is something that would be impossible to say, because it would be determined by the conditions in the particular area, that is, how steep it is, whether there are bluffs or dense vegetation that obstruct animal movements, and so on. You might also have dense vegetation with little forage value.

MR. J. R. BENJAMIN (Ohio): In your paper you mention browse. Some animals use considerable browse in addition to the forage directly off the soil. Is that taken into consideration in your examinations and tests?

MR. SWIFT: Yes. I don't know whether I fully understand your question, but it is desirable in making a survey involving big game especially, to group the plants by the classes of browse, weeds, and grass. We have found in our work in the Western States that the forage that really carries deer through the winter is the browse. They can have access to ever so much grass, but if they do not have an ample amount of browse to go with it they will not do very well. We have had some instances in which deer actually starved to death where there was no browse but plenty of grass.

MR. P. R. HIGHBY (Minnesota): Can you pick out a key species of browse that will tell the story without taking all plants into consideration?

MR. SWIFT: Yes, range administrators make use of that very point, but usually as an indicator of the condition of the range. We know that certain plants are preferred and that an animal having choice will use these preferred species more, sometimes to the exclusion of all the others. By inspecting these key plants, therefore, it is often possible to tell when the rate of stocking is reaching a dangerous point and is likely to go beyond the sustaining capacity of the range. Utilization may reach the point where the preferred plants are overused and will die. Under those conditions you can determine about what the capacity is, although you may not know how many animals it would be desirable to maintain, that is, you have no direct measure of capacity in animal units.

MR. HIGHBY: Is there an indication that you could concentrate upon a few species and thus simplify your forage inventory and reduce the amount of work?

MR. SWIFT: Yes, I think so, in any one locality. The difficulty is that plant types are so varied, that the key species would differ from place to place.

MR. JULIAN A. HOWARD (Louisiana): Is there some method of standardizing the measurement of air-dryness so that it could be applied in places where the relative humidity is very great?

MR. SWIFT: Ordinarily we look upon that term as meaning air-dry under room temperatures, that is, in the neighborhood of 70° F. It is true that there would be variation depending upon the humidity. However, I don't believe that the point is so very important because there are so many variables that even if the air-dry ratios were very exact there would still be others that would show great variability. However, in very exact surveys it is true that a standard method should be followed.

MR. HOWARD: In order to make correlation with results reached in other parts of the country, wouldn't it be better to have oven-dry weights?

MR. SWIFT: I don't think so, for the reason that on large scale surveys it would be difficult, unhandy, and expensive to provide the facilities for obtaining oven-dry weights.

CARRYING CAPACITY OF SOUTHERN MICHIGAN GAME RANGE

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The term "carrying capacity" was employed by Errington to indicate the number of quail that could survive the winter on a given area in a year offering optimum weather and other conditions. In dealing with this matter as with most others, the game administrator must take into consideration large areas and average conditions, and use almost any available data, variable and imperfect though they may be. Thus with the estimates on southern Michigan game, not all are for the winter season. Some are not population figures, but kill records, which, however, indicate something as to the relative productivity of different types of range, and for lack of better information must be used.

None of our present most important farm-game species was plentiful in Michigan under primitive conditions. The later introduced pheasant, of course, was then absent. The cottontail rabbit and the fox squirrel were restricted to the vicinity of small prairies in the southwestern portion of the State. With the clearing of the land these two mammals spread out over the entire southern peninsula. But they are still found in abundance only in the lower third, a range that coincides with our most productive agricultural area.

Glaciation in Michigan left a complex pattern of soils that vary greatly in their agricultural productivity. They vary similarly in their game populations. Good farming areas generally yield good crops of pheasants. Marginal farmlands are Michigan's best cottontail habitat. Rabbits are not found in abundance either on land so good that it is intensively farmed nor on land so poor that it is not farmed at all. Fox squirrels are present wherever there are upland woods in Southern Michigan.

Other things being equal, a fertile soil will probably produce more than less fertile areas of any of these species. Our agricultural area has been cleared so completely and it is so intensively cultivated, however, that animals such as the rabbit, quail, and squirrel, which need brush or woodland, can no longer exist upon it in large numbers.

This discussion will deal with four sample areas that have been studied by the Game Division during the past five years. These tracts differ widely in their soil and cover conditions and serve to illustrate some of the game population problems involved.

Swan Creek Wildlife Experiment Station (Allegan County)—The Swan Creek Wildlife Experiment Station comprises approximately 5,000 acres, of which roughly two-thirds is second-growth oak woods interspersed with abandoned fields. The remainder is the Kalamazoo River bottom. The oak upland is largely Plainfield sand, a fifth-class soil too poor for farming. It supports black and white oak, and a remnant of white pine, but not the hickory that usually is found in farm woodlots.

The sandy upland in this tract has only a meager population of pheasants. In a two-year study completed in 1940, this area was also found to be poor rabbit habitat. The spring residue in 1938 and 1939 averaged 36.7 cottontails per section. Fall numbers were not even double this, being 56.1 animals per section. The failure of a large number of young to survive until fall is apparently the cause of this low population. As the oak woods is open in character, and the fields support anything but a lush vegetation, the indications are that a lack of ground cover exposes the young rabbits to heavy predation.

The second-growth oak of the Allegan area appears to have a lower carrying capacity for fox squirrels than typical oak-hickory woodland. In 1938, investigation revealed a fall population of approximately one fox squirrel per 3 acres. There was an increase in 1939 to about a squirrel per 2 acres, which may or may not have been due in part to a state-wide closed season that was in effect in 1938. The 1940 figures showed a further increase to about a squirrel per 1.5 acres. Black and gray squirrels, upon which there is a permanent closed season in that area, have also been increasing conspicuously in the river bottom at the station. This fact, together with the additional 1940 increase in fox squirrels, leads us to believe that squirrel abundance is due, not so much to the closed season of 1938, as to a cyclic trend.

Kellogg Farm (*Kalamazoo County*)—The Kellogg Farm and Sanctuary is for the most part third-class farm land. It lies on an outwash plain where the most important soil is Bellefontaine sandy loam. About 55 per cent of the area is cultivated for annual crops or hay, and 25 per cent is in permanent grassland. Approximately 3.6 per cent is in brush, 4 per cent in plantations of conifers, 2 per cent in marsh, and 6 per cent in woodlots. The remainder is occupied by Wintergreen Lake.

Pheasants have not been hunted on the Kellogg Farm during the past ten years, and fall population figures from 1935 to 1938, inclusive, showed that from 25 to 35 pheasants were using the 500-acre tract each year. We were especially interested in the pheasant population because of a restocking experiment that had been made in the summer of 1933 when 300 game-farm birds were liberated. In spite of total protection from shooting, the pheasant population four years later was practically the same as it was the year following the stocking. It seems reasonable to conclude, therefore, that the restocking had little or no effect upon the productivity of the tract for this species. Experience has shown that a fall pheasant population equal to that on the Kellogg tract, that is approximately 38 birds per section, is about what can be expected on a great deal of Michigan's less fertile agricultural land.

Our intensive study of the wildlife populations of the Kellogg Farm in 1935-37 indicated that winter losses accounted for less than a third of the pheasants and that, as with the rabbits at Swan Creek, the low population level must be ascribed to the failure of the breeding stock to rear a large crop of young.

For rabbits, the Kellogg Farm is the best area we have studied. By a box-trap-plus-hunting census in 1935, the fall population was found to be about 228 animals, of which 154 were shot. In the following year, by a different method, a population of 225 was calculated, of which the kill took 126. If these two years are a reliable index, this 500-acre area supports a fall population of near 288 rabbits per section. It has been clearly demonstrated that it is possible to shoot over half of the rabbits on this tract in the fall without impairing productivity the following year.

This tract has been a sanctuary for fox squirrels as well as for pheasants. Thus no hunting season crop was taken, but in the winter of 1935-36 the population probably was over one squirrel per acre of woodland. The following winter, squirrel numbers declined sharply, apparently due to an epidemic of mange.

Rose Lake Wildlife Experiment Station—This tract lies on a moraine 12 miles east of the City of Lansing. Its soils are variable, ranging from first to fifth-class within a short distance. Kettle holes and marshes with brushy fringes are well distributed in the region and there are numerous small oak-hickory woodlots. Observations were made on about 2,000 acres.

Formerly this was a fairly productive agricultural area; but destructive cropping practices have greatly reduced the fertility of most of the well-drained soils. At present approximately 39 per cent of this area is cultivated, 25 per cent is in pasture, 13 per cent in woodlot, 13 per cent in brush, and 10 per cent in marsh. As various units of depleted soil are brought back into production, the acreage of cultivated land will increase to about 65 per cent of the area.

Field work during summer and fall of 1940 indicated that pheasants were slightly more plentiful than in the year before. For all practical purposes, however, the pheasant popuulation and the kill were much the same in the two fall seasons. But the hunting pressure was roughly 75 per cent more in 1940 than in 1939.

Thus it appears that this is a case of "diminishing returns." The 1,126 hours of hunting per square mile in 1940 took approximately the same number of birds that 634 hours took in 1939 even though the populations were very comparable. The pre-season population of pheasants was about 156 birds per section or about four times that of the Kellogg Farm.

In spite of apparently good cover conditions, rabbits were not numerous at Rose Lake in the years immediately preceding 1940. In 1939 the hunting yield was 38.5 rabbits per section. In 1940 a conspicuous increase occurred in the numbers of this species, and a harvest of 96.9 rabbits per section was removed. It seems clear that some factor other than the physical nature of the habitat had previously been keeping the rabbit population down. There were reports of rabbits being found dead in their forms, but our pathologist was unable to get any proof of disease. The past and present conditions at Rose Lake remind us that even our best efforts in the field of habitat improvement will not guarantee a uniformly high population of game animals.

The upland woods on this area differs from the Allegan oak woods in that it contains hickory. It resembles that of the Kellogg Farm but contains more shagbark and less bitternut hickory.

In the 1939 open season the area yielded 365 fox squirrels per square mile of woods. In 1940 the comparable figure was 246. Box trapping showed the spring population in 1940 to be about 275 adult squirrels per square mile and the fall number was slightly more than one animal per acre.

Prairie Farm (Saginaw County)—In Saginaw County work has been done on an 8,400-acre area of low lake-bed clay. The tract has been diked and ditched, and water level is kept down by a pumping station. Formerly this area was a cattail marsh so there is a shallow overlay of muck in places.

The principal crops are sugar beets, corn, and beans. Fallow fields and ditch banks support a vigorous growth of giant ragweed, sunflower, and other herbs that provide ample summer and winter cover. In addition there are two large units of willow and aspen brush that are progressively being cleared. The woods are chiefly soft maple with local mixtures of elm, ash, and basswood.

Approximately 70 per cent of this area is now in agricultural production. About 11 per cent is in light brush or fallow fields. Dikes and canals constitute 6 per cent, woodlots 7 per cent, and heavy brush 5 per cent. Only about one per cent is pastured.

Table 1 gives the hunting pressure, in terms of gun hours, and the pheasant kill for each year from 1937 to 1940.

TABLE 1. PHEASANT KILL AT THE PRAIRIE FARM, SAGINAW COUNTY, MICHIGAN

Year	Total kill	Approximate kill per section	Total gun-hours	Gun-hours per section
1937	616	47	8,168	622.3
1938	1,244	94	14,068	1,071.4
1939	1,318	101	21,481	1,636.6
1940	1,058	81	14,999	1,142.8

It is to be noted that although hunting pressure rose sharply in 1939, being 50 per cent more than in 1938, the kill increased only seven pheasants per square mile. This suggests that beyond a certain point the hunting on this area was excess, in that it is not rewarded by additional birds killed. It appears that the amount of hunting on the Prairie Farm in 1938 and 1940 was about that necessary to harvest the crop of birds. The productivity of the area is from 90 to 100 cock birds per square mile.

The fall population numbered about 350 pheasants of both sexes to the section. Compared with the Kellogg Farm figure of 38 this gives a fairly good measure of the difference in productivity between good and poor pheasant habitat.

Due to the breaking of fallow ground and the clearing of brush, more than half of the best "escape" cover on the Prairie Farm was eliminated in 1938 and 1939. The fact that this change was not noticeably reflected in either the fall population or kill suggests that cover has not yet been reduced below what the present pheasant population needs. Heavy brush now occupies about 5 per cent of the tract. The Prairie Farm has shown a poor productivity of rabbits and fox squirrels, as would be expected from the types of habitat represented.

SUMMARY AND CONCLUSIONS

From these studies it appears that relatively intense agricultural use of the land does not particularly handicap the pheasant, but that such use removes the brush and woodland required by rabbits and squirrels. Marginal farmland, with waste areas containing brush, is Michigan's best rabbit range. These areas also support the oak-hickory woodland that is probably the State's most productive fox squirrel habitat, but their pheasant production is usually low. Submarginal lands too poor for agriculture usually are occupied by black and white oaks. This is a fair to good habitat for fox squirrels, but poor for rabbits and often supports no pheasants at all.

DISCUSSION

MR. VERNON BAILEY (Washington, D. C.): I would like to add a word about the squirrels. Mr. Ruhl spoke of their sometimes being scarce due to mange. That is probably true, because the squirrels are getting more and more affected by it all over the country. The disease is not difficult to check, however, as a handful of sulphur in a squirrel's nest-box will put a stop to it. A combination of sulphur and pyrethrum will kill the mange mites and fleas also. I have seen numbers of the squirrels die of mange and fall out of the trees, and I have seen young squirrels come down out of the trees and fall on the ground just covered with fleas. An active young fellow can climb where there are squirrels' nests and dump sulphur and pyrethrum in every hollow where a squirrel can go, and the mange can be stopped.

MR. D. R. ATZENHOFER (Ohio): I would like to ask Mr. Ruhl a question about the method used for trapping rabbits. We know the population was very low on some of the areas he described. I would like to ask if he believes after the population gets so low on an area, that the trapping efficiency is as great as it is when the population is higher.

MR. RUHL: To get enough animals to have a representative sample and thus avoid errors in computing the numbers, you certainly would have to work harder on a small area. The technic was developed by Arnold Haugen on Swan Creek, and the trapping was done very intensively until very few animals were caught. The results were checked later by shooting to get the proportion of tagged to untagged in the kill. We feel that we were able to get not all, but a consistently high percentage, of the rabbits.

MR. ATZENHOFER: The rabbits that you found in the forms were dead, I believe you said.

MR. RUHL: There were reports from local farmers and cooperating individuals that they had seen such animals but when we tried to get some, the dog had eaten them or the observer had forgotten what field they were in, or else it was too late.

We did get a few samples and took them to our laboratory, but we were unable to find any disease to account for the death.

DR. P. F. ENGLISH (Pennsylvania): Mr. Ruhl, on the Prairie Farm you got the population up to 350 pheasants per section in the fall. Is that going to be the maximum possible population?

MR. RUHL: I don't know, but as far as we can judge, it must be about the top, because there are no particular fluctuations. Within the errors of our census methods, it appears that the population is pretty stationary. The area, however, is not an easy one to census.

DR. LAWRENCE E. HICKS (Ohio): The Ohio pheasant workers have found ratios of kill in relation to population that just about duplicate the wide extremes which Mr. Ruhl has reported. We thought years ago that the percentage of area that should be covered for an adequate estimate of the pheasant population was considerably higher than it has turned out to be. We now find, as you have, that a coverage of five per cent is quite adequate in many cases, and it may be as low as two or three per cent, where a farm crop, as sweet clover, is the principal cover.

We have several places where the kill of pheasants has been more than 100 cock birds per square mile.

Where you had a kill of 101 cock birds per square mile, what was the total population? In other words, what per cent of the total, and what per cent of the cock bird population was removed?

MR. RUHL: I believe that the population was about 350 total, where approximately 100 were removed. There was a slight excess of hens over cocks in the fall. I believe in that particular area last year the ratio of hens to cocks observed after the hunting season was around eight or nine to one, so that the 100 represented a pretty good share of the cock birds. That ratio was another indication that our 350 was somewhere near correct for the fall population, and that there was a relatively small winter loss.

WINTER RANGE CONDITIONS IN ROCKY MOUNTAIN NATIONAL PARK

HAROLD M. RATCLIFF

Rocky Mountain National Park, Estes Park, Colo.

The purpose of this paper is to discuss range conditions on areas used in winter by the deer and elk herds of Rocky Mountain National Park.

The winter range comprises approximately 19,622 acres on the eastern side of the continental divide and is at elevations of from 7,500 feet to 9,800 feet. It is composed largely of southern and eastern exposures and open meadow land and is swept clear of snow by the winds that prevail throughout most of the winter.

The wintering area is restricted by private holdings both inside and outside the park boundaries. The village of Estes Park lies across a natural migration route to lower elevations.

The country along the eastern boundary of the park is thickly occupied by ranches, numerous summer homes, and other forms of development, that keep the deer and elk crowded back on range that is at the present very badly overgrazed.

A rather extensive study of winter range in and adjacent to the park was started in 1931. At that time the area used as winter range both within the park and immediately adjacent to it was privately owned, and it was heavily used as pasture for horses and cattle each year from about the first of May to October. Some of the land along the streams in the park was utilized by ranchers as hay meadows.

This pre-emption left very little forage for the deer and elk when they came down from the high summer range in September and October. Their additional demands on range already overgrazed began to tell on the forage; such plants as porcupine grass (*Stipa comata*), rabbitbrush (*Chrysothamnus* spp.), prickly pear (*Opuntia* spp.), and other weedy species began to increase over most of the range. These plants are well-known indicators of overgrazing.

Considerable acreage of the private lands within the park boundary was purchased by the Federal Government in 1932. This eliminated most of the competitive grazing and should have given the range a change to recover and improve. However, since 1932 continued use by ever-increasing numbers of deer and elk, combined with several seasons of drought, has reduced the range to a more depleted condition than ever before.

The range study begun in 1931 was continued by a ranger until 1934, when the advent of the Civilian Conservation Corps made it possible to put a full-time technician in the field. During the summer of 1934 eight quadrats were established on the winter range, enclosing vegetation typical of the area selected for study. These plots, each 20-feet square, were enclosed with an 8-foot fence to protect the forage plants from the deer and elk. Seven more plots were added during the 1935 season, and an equal number of unfenced plots of similar cover type were designated as check areas.

A five-year study of these plots has revealed that there is very little difference in the length of the annual growth of plants inside the fenced quadrats and those outside. In fact the plants browsed by deer and elk tend to make more growth than those that are not browsed. Plants within the fenced plots continue to grow in height retaining their natural proportions, while the heavily browsed plants in the check quadrats are lower but more expanded.

Yearly utilization of the browse plants varies on different sections of the range. For example, in Beaver Meadows, sagebrush (*Artemisia tridentata*) is utilized 41 per cent while on Mill Creek it is utilized 75 per cent.

Protected areas are grazed more heavily than those exposed to winds. Spots of "local overgrazing" tend to form on such areas where the range is utilized more continuously and by larger numbers of animals.

The degree of utilization of browse plants is determined by measuring the new growth each fall before the larger herds of deer and elk migrate to the winter range and again in the spring after the animals have returned to higher elevations. The difference between the two measurements is, of course, the amount of utilization.

The following tables illustrate utilization by figures averaged from measurements taken on all quadrats.

TABLE 1. UTILIZATION AS OF MAY, 1936

Species	Percentage of utilization
Purshia tridentata	61
Chrysothamnus spp.	61
Artemisia tridentata	41
Ceanothus fendleri	40
Populus tremuloides	31
Salix spp.	23
Ribes cereum	22
Pinus ponderosa	15
Prunus melanocarpa	6

TABLE 2. UTILIZATION AS OF MAY, 1940

Species	Percentage of utilization
Purshia tridentata	70
Chrysothamnus spp.	80
Artemisia tridentata	60
Ceanothus fendleri	60
Populus tremuloides	60
Salix spp.	50
Ribes cereum	50
Pinus ponderosa	80
Prunus melanocarpa	50

The condition of the range can best be presented by describing parts of the area delimited by stream drainages and timber types.

Mill Creek—This unit is a southern exposure extending along the glacial moraine separating the Thompson River and Mill Creek drainages. It supports a scattered stand of ponderosa pine, with an understory of antelope-brush (*Purshia tridentata*), sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* spp.), currant (*Ribes cereum*), chokecherry (*Prunus melanocarpa*), and a very few bushes of mountain-mahogany (*Cercocarpus parvifolius*). Grasses include: *Muhlenbergia gracilis, Agropyron smithii, A. spicatum, A. tenerum, Koeleria cristata,* and *Bouteloua gracilis;* a species of *Carex* also is present. A small meadow along the creek contains: *Phleum pratense, Agrostis* spp., and species of *Carex* and *Juncus.* There is a heavy growth of willow along the stream.

The area as a whole is very heavily utilized. All palatable plants show the effects of heavy browsing, and in some places they are dying

TABLE 3. QUADRAT NO. 11A. MILL CREEK

Percentage of utilization

Plant	Condition	9/23/36	6/12/37	10/25/37	10/17/38	5/31/39	9/30/39	5/9/40	9/12/40
Artemisia	Living	67	51	40	25	25	22	16	10
tridentata	Dead	4	20	31	46	46	49	55	61
Purshia	Living	20	20	20	20	13	13	13	13
tridentata	Dead	3	3	3	3	10	10	10	10
Ribes	Living	1	1	1	1	1	1	1	1
cereum	Dead	0	0	0	0	0	0	0	0

QUADRAT NO. 7A. BUCK CREEK

Percentage of utilization

Plant	Condition	9/23/36	5/24/37	10/25/37	10/17/38	5/31/39	10/2/39	5/9/40	9/16/40
Artemisia	Living	11	10	10	7	5	5	5	4
tridentata	Dead	0	1	1	4	6	6	6	7
Chrysothamnus	Living	9	8	8	8	8	8	8	8
spp.	Dead	1	2	2	2	2	2	2	2
Prunus	Living	6	6	6	6	4	4	3	3
melanocarpa	Dead	0	0	0	0	2	2	3	3

QUADRAT NO. 8A. HORSESHOE PARK

Percentage of utilization

Plant	Condition	9/24/36	5/28/37	10/25/37	10/17/38	5/31/39	10/2/39	5/9/40	9/16/40
Ribes	Living	2	2	2	2	2	2	2	2
cereum	Dead	0	0	0	0	0	0	0	0
Prunus	Living	16	13	13	13	13	13	13	12
melanocarpa	Dead	0	3	3	3	3	3	3	4
Ceanothus	Living	8	6	6	6	6	6	6	6
fendleri	Dead	0	2	2	2	2	2	2	2

from excessive use. Quadrat No. 11a (Table 3) illustrates the heavy mortality of sagebrush.

In some places along this moraine, the grass, notably *Agropyron smithii*, is gaining and is taking the place of the browse species that are either dead or being killed by excessive use. Ponderosa pine is so heavily cropped that all the young trees have a very definite browse line at a height of 4 to 5 feet and several of the smaller ones have been killed.

The average plant cover has not increased in density since 1931 and most of it has deteriorated very rapidly during the last two years. An ever-increasing number of weeds and less palatable species is coming into the composition of the range forage. In several spots where cover is sparsest, erosion is becoming evident.

Moraine Park Area—This division comprises approximately 2,600 acres, most of which is of the timber-brush type, with scattered areas of open grassland and meadow. Two large ranches in Moraine Park occupy most of the meadow land along the Thompson River. These meadows are composed entirely of hay land and pasture, the latter supporting a heavy growth of willows along the stream. The non-meadow type consists of an open stand of ponderosa pine with aspen in the glades and along the lower fringes. The shrubs are *Purshia, Artemisia, Ribes, Chrysothamnus, Prunus, Amelanchier alnifolia,* and *Ceanothus velutinus.*

The grass cover consists of the following species: *Muhlenbergia gracilis, Agropyron* spp., *Koeleria cristata,* and *Bouteloua gracilis.* Species of *Carex* and *Juncus* are also present. The herbaceous plants include: *Artemisia frigida, A. trifida, Antennaria* spp., *Arnica* spp., *Chrysopis* spp., *Eriogonum* spp., and many others utilized by deer.

Moraine Park still shows the effects of heavy grazing prior to 1932 when the remainder of lands then privately owned was purchased by the National Park Service. At present the browse species are barely holding their own, approximately 70 per cent of the new growth being utilized each year. The area does not have so large a proportion of dead plants as the Mill Creek area, probably due to the fact that sagebrush, which has suffered most severely in Mill Creek, is not so common on this area.

The trees have a very definite browse line at the maximum height to which the deer and elk can reach. Trunks of aspen are scarred by the gnawing of the elk and there is very little reproduction of this species.

Beaver Meadows—Deer Mountain—Buck Creek—These three areas form one large unit as there is no topographical division between them. It is one of the most important parts of the entire winter range as more animals are concentrated here for longer periods of time than on any other section of the Park.

A meadow occurs along the stream and the remainder of the unit has a cover of scattered ponderosa pine, with the woody shrubs, *Artemisia tridentata, Purshia, Ribes* spp., *Prunus,* and *Rhus trilobata,* and a considerable acreage of open sagebrush.

The Buck Creek sub-unit is one of the most heavily browsed areas in the Park. Most of the sagebrush there is dying and from 60 to 80 per cent of the annual growth of other browse plants, especially *Purshia,* is utilized each year. Table 3 illustrates the comparative mortality of species on three areas where check plots have been established.

A very definite browse line shows on the trees. The trunks of aspens are scarred by the gnawing of the elk and smaller groves are almost completely dead from such use, combined with associated increase of fungus infestations. Because it is so heavily browsed there is no reproduction of the aspen.

The grasses in this unit comprise the same species as in the other areas, including also some *Danthonia* spp. and *Stipa* spp. Grasses are not increasing in density but appear to be holding their own. The more desirable kinds as *Agropyron* and *Koeleria* are gaining, and with no further damage to the cover they should continue to thrive. Exclusive of the meadow, the average density of range vegetation is about 50 per cent which is the same as at the time of the first survey in 1931; and this, in spite of the increased numbers of elk utilizing the area.

The meadow along Beaver Brook is predominantly *Calamagrostis* spp.—plants that apparently are not utilized. However, as much as 90 per cent of the annual growth of the willows along the stream is eaten with resulting increase in mortality.

Horseshoe Park—This area includes about three sections along Fall River, consisting of both wet and dry meadow forage types, with a heavy growth of willow and birch along the stream. The remainder is largely a southern exposure, supporting a stand of ponderosa pine and douglas fir with an understory that is predominantly *Ribes, Purshia, Prunus* and *Chrysothamnus.*

The grasses consist principally of *Agropyron* spp., *Bouteloua gracilis, Koeleria cristata,* and *Muhlenbergia gracilis,* with a mixture of other herbaceous plants that form a fairly good ground cover of 60 per cent density.

While this area is heavily used by deer, elk, and a few bighorns, the understory browse is not in so poor condition as on most of the winter range. This may be due to the fact that the animal population is not nearly so large as the overwhelming numbers on areas such as Mill Creek and Buck Creek. Up to 60 per cent of the annual growth of browse plants is utilized but their vitality seems to be much better than in other sections. Comparisons of mortality of browse plants with that on other areas is shown in Table 3. However, aspen in this area is in very poor condition due to browsing and gnawing of the trunks by elks. Because of this browsing and use by the beavers, aspen reproduction is almost completely absent. The grasses are not improving in density due to increasing numbers of elk, as well as the longer period of use.

The elk population in Rocky Mountain National Park has increased from a transplanting of less than 25 head from Yellowstone National Park in 1913 plus a possible small remnant of aboriginal stock, to an estimated 1,100 head in 1940.

Population figures are based on actual counts made when the elk are congregated on the winter range. Corrections are made for those believed to be in hiding at the time of the count, and for herds in inaccessible areas.

Based on counts made when the elk return to the winter range, the annual calf crop is estimated to average 30 to 35 per cent of the adult herd.

The deer population appears to be static. Estimates for each of the past three years have placed the number wintering in the park at approximately 1,400. Deer and elk censuses are made conjointly with similar bases for determination of final estimates.

From surveys of the winter range made during the summer of 1936 carrying capacities were estimated as follows:

Total acres of range available	19,622
Per cent of cover	64.4
Percent of brush utilized	21.3
Per cent of brush not utilized	1.6
Per cent of herbaceous-grass utilized	37.1
Per cent of herbaceous-grass not utilized	5.4
Forage acres available—Elk	5,060
Forage acres available—Deer	5,202

In an effort to determine the carrying capacity for elk and deer, we have used the forage requirements for cattle and sheep, respectively. (Reliable data are not yet available for the wild species.) The figures are 9.6 forage acres required for an elk and 3.5 forage acres for a deer. Use of these standards gives a carrying capacity of about 530 elk and 1,470 deer for the winter range area of the Park.

The present overgrazed condition of the range indicates that these figures are nearly correct for elk. The standards for deer are not accurate, however. Theoretically, the carrying capacity of the deer range is only slightly exceeded. Actually, the very poor condition of the browse demonstrates a heavy overstocking. We undoubtedly require more accurate methods for estimating carrying capacity and palatability ratings of the food plants for deer.

SUMMARY

Examination of the winter range in Rocky Mountain National Park and immediately adjacent areas shows that the vegetation has steadily declined since 1931. Browse species, which form most of the food of deer, are being utilized to such a degree that their vitality is seriously threatened or is already destroyed. Such heavy use retards the ability of many plants to reproduce by seed because much of the available energy goes to produce the annual growth of stems.

Utilization of 40 to 50 per cent of the annual growth is considered the maximum compatible with survival. On much of the range the actual figure is as high as 75 to 90 per cent. This heavy use cannot be allowed to continue if the range is to be saved and restored to its original carrying capacity.

Grasses and other herbaceous species are not declining so fast as the woody browse, and in some cases they are increasing as succession types on browse cover areas. However, continually increasing demands by the elk, together with several seasons of drought conditions, have not helped them. An ever-increasing number of weeds and unpalatable species is occupying the area.

The coniferous species are being utilized to the extent that a definite browse line shows in most grazing units. Pine reproduction is being damaged seriously over most of the range and few young ponderosa pines are able to survive unless they have attained a height beyond the reach of deer.

All aspen groves have a definite browse line and the trunks of the trees are scarred by the tooth marks of the elk. This injury also paves the way for fungus diseases and, judging by increasing losses, this may result in practically complete elimination of aspen from the winter range.

The increase of the elk herds that do not migrate beyond the eastern boundary of the park has reached a dangerous crisis. This overpopulation is utilizing available forage to an extent that can no longer be sustained without irreparable damage to the range.

Reduction of the numbers of elk and deer must inevitably result. It will be either artificial, for which there is no present authorization, or natural, through starvation and disease. The gravest need at present is for legal authority to dispose of surplus animals.

THE DETERMINATION OF CARRYING CAPACITY ON WILDLIFE AREAS

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The determination of range capacities is one of the most vital problems that confronts the wildlife manager. The principal requisites of a sustaining habitat for any class of animals are shelter, food, and water. Whether the animals be herbivorous, carnivorous, or omnivorous, food is the element most difficult to supply and control on wild land. Some animals can be fed part time with other than natural foods and maintained in good condition, but they soon lose their status as wildlife, and come more or less into the exhibit class. Any change that is made in the natural habits of a game animal detracts from both its sporting and esthetic value.

However, water and shelter can be developed on wild ranges without fear of unfavorable results. Food plants and grains may be planted with good results for some species, such as unpland birds and waterfowl, but the maintenance of such forms of food usually becomes a continuing task. It is most important to provide for the highest production of strictly natural foods for any class of wildlife if the maximum population is to be maintained.

Settlement or other use of the land has restricted and limited wildlife areas to such an extent that in some places there is not a proper balance of yearlong range and forage. Despite this handicap to wildlife production, the recreational demand is increasing.

The administrator's job is to produce and maintain the largest number of animals the habitat will support on a permanent basis. His greatest problem is to determine the sustaining carrying capacity of the habitat and hold it to the maximum.

Because of the popular acceptance of deer and elk as typical game and of the frequent problem of providing forage for them, this discussion will be confined to the type of range used by those animals. It may be applied, however, with local variations to any range used by herbivorous animals.

Livestock range administrators have done much pioneering to find a practical and simple method of determining range capacities. They have been primarily concerned, however, in arriving at a capacity figure that could be expressed in numbers of stock or stock months. Several methods of range appraisal have been tried, as the square-foot-density, poundage-per-acre, forage-acre-factor, and others. All of these, while effective and usable, have a definite relation to local conditions such as topography, location of water, exposure, and factors sometimes not determined. Because of the wide variation in carrying capacity of well defined types on the different ranges due to local influences, it appears there are no simple type factors that can be applied to any range and multiplied by the type areas to give the correct carrying capacity of that range. It is still necessary to check each method with use and forage utilization of the particular range in question to arrive at a satisfactory conclusion. Finally the key area-key species method was developed. It not only embodies the essential factors of the other methods but gives full weight to local influences and to forage utilization of each range unit and is easily understood and applied by practical observers.

Generally deer and elk ranges are used also by domestic stock, and while there is some difference in the preferences of these animals for forage, the objective of management maintenance of the forage crop is the same. There are differences, however, in the methods of handling.

The manager has much more control over domestic animals; he regulates the time of their entering and leaving the range, the numbers permitted to graze, their distribution on the range, the time of breeding, and the salting and winter feeding. With game, however, most of these phases are beyond control. Since it is not practicable to ascertain the exact number of game animals using a range, their approach to carrying capacity must be interpreted from the condition of the forage plants. The game manager is not concerned so much with definite numbers of game animals or game animal-months as he is with maintaining a satisfactory food supply. Some adjustment may be necessary to meet local land-use economy, but, by and large, the objective is to hold a population that the range will support in good condition without deterioration of the principal forage species.

Another difference in domestic and wild animal husbandry is in range boundaries. With domestic stock a definite allotment is established, and stock are confined to, and managed on the basis of, that area. Since little can be accomplished in distributing game on the range or confining it within certain boundaries, the range unit becomes the area habitually occupied by a given game herd.

The observations of the writer and the references used in this presentation are limited to the coniferous timber regions and adjacent semidesert areas of the western United States. The key area-key species method of determining range utilization and carrying capacity is described here as the most practical method for determining the carrying capacity of the herd range.

Key Areas—On every summer herd range there are usually areas characterized by three degrees of use, namely, concentration spots, generally frequented areas, and those little used. The concentration spots occur around salt licks, watering places, and dust wallows— and any places, in fact, where the animals naturally congregate. Winter ranges and yarding areas will be discussed separately. Needless to say, range capacities can not be determined on the basis of use of the summer concentration spots. Overuse of such areas will have to be accepted provided it does not spread until the areas merge and present a major depletion problem.

Outside of the concentration spots are areas where the animals feed normally and cause no permanent damage. These may be large or small and are usually limited by topographic features. They may include south-exposed slopes, tops of ridges, or large benches, but they are the areas that support the bulk of the game forage. In other words, they are the key areas upon which management of the entire range should be based. They should be used as places for judging range condition, utilization of the principal forage species, for investigation purposes, and as a basis for determining range capacity. If the principal forage areas are in satisfactory condition, the little-used areas also will be.

Conditions along the lower reaches of the western slope of the Cascade Mountains of Oregon and Washington, where little snow falls, and there is slight variation between summer and winter use, may not readily indicate key areas. If the utilization of such ranges is about the same all over, then there would be no key areas and capacity determinations could, with safety, be made from the whole area or any part of it.

Winter Concentrations—Where winters are severe and snow covers the ground to varying depths, game animals either migrate to more favorable range or they "yard up" in the vicinity of available food. From a management standpoint the so-called yards are similar to concentration spots on summer ranges, and should not ordinarily be used as a basis for determining range capacity.

Where game winter ranges are limited to the extent that they become the controlling influence upon game populations, they should be treated as key areas and the capacity of the yearlong herd ranges based on their condition.

Key Species—All animals have food preferences. They may have to vary their choice and often do, according to the foods available, but on every range there are certain plants that provide the greater part of the total diet. Game animals grazing over a range nibble here, take a bite there, and move along. Observations show, however, that some plants are completely utilized, some used very often, and others seldom touched if at all. Study and observation will soon indicate which plants are most frequently used and which supply the bulk of the feed. On ranges where there are only a few usable plants, recognition of important species is fairly simple, but where there are a great many palatable species, it is more complicated. However, the task is not so difficult as would appear at first thought. Usually there are not more than six, and often there are as few as three, species that furnish the staple forage. The objective then is to determine the species of high palatability that are well distributed and form the major diet of the game animals using the range. Such plants will be key species. If the more palatable and important species are properly utilized, the less desirable species will not be overused and should have from 30 to 100 per cent of the current growth left to mature.

Forage utilization studies conducted by the Pacific Northwest Forest Experiment Station on the Umatilla National Forest, Oregon, in 1940 showed that on 319 plots examined, only 8 of the 68 species identified appeared on 50 or more plots, and of the 8, only 4 were utilized by deer and elk to an extent of 10 per cent or more.

Einarsen (1940) found that black-tailed deer (*Odocoileus c. columbianus*) on summer range in western Oregon, where there is an abundance of herbage, browse, and tree growth, made heavy use of only 3 abundant species as compared to moderate and light use of 19 others.

Cliff (1938) studying the Rocky Mountain elk (*Cervus c. canadensis*) and mule deer (*Odocoileus hemionus macrotis*) learned that three browse species furnished over 90 per cent of their diet on the winter range in northeastern Oregon.

Young and Robinette (1939) found that only 10 species of food plants were utilized by Rocky Mountain elk to the extent of more than 30 per cent and only 6 of the 10 were utilized 50 per cent or more on the best exposures of summer range in Idaho.

Edwards (1938) determined that only three plants furnished 90 per cent or more of the forage for mule deer on their winter range in eastern Oregon.

Schwartz (1939) reported that the Roosevelt elk (*Cervus canadensis occidentals*) on the summer and winter ranges of the Olympic Peninsula, Washington, relished only six shrubs and one herbaceous plant to the point of heavy use.

These findings indicate that on every range there are a few important species that supply the major part of the feed, and, their identity having been established for the range unit, observations upon them should be the basis for determining the carrying capacity. They are the key species. Not all plants that are highly palatable are properly classed as key species. Occasionally one will be found which, while highly palatable, furnishes but little food because of its infrequent occurrence or low productivity. Such species are called tidbit plants and should not be used as a basis for judging range capacity. Mushrooms might be cited as an example.

Key species should: Be highly palatable; have about the same utilization factors; not be tidbit plants; be fairly abundant; be able to stand fairly heavy use; be perennials; and be suited to the class of game using the range. A key species must also be abundant and well distributed.

On depleted or over-utilized ranges, some of the most valuable plants may have been greatly reduced. Under such conditions one should seek to restore those species to assure maximum carrying capacity when the range is properly managed. For success, drastic reduction in the numbers of game animals may be required during the rehabilitation period, but the expected long-time use of the range will justify that action. An example may better illustrate the point.

A winter range that originally supported good stands of bitterbrush (*Purshia tridentata*), snowbrush (*Ceanothus velutinus*), curlleaf mountain-mahogany (*Cercocarpus ledifolius*), and sagebrush (*Artemisia tridentata*) had been utilized until the bitterbrush was 75 per cent dead and the mountain-mahogany high-skirted. The snowbrush was still in good condition. To continue stocking this range with snowbrush as the key species would mean accepting a carrying capacity decidedly under that formerly prevailing. On the other hand, if the game population were reduced to allow the bitterbrush and mountain-mahogany to recover, the long-time carrying capacity would be greatly increased. The amount of sagebrush would have little influence one way or the other.

Another point of importance in selecting key species is to choose plants of about the same palatability. If there is a difference greater than 10 per cent in palatability of the species selected, the average used to compute the percentage of utilization will not be a true measure of the carrying capacity.

Unless a range is badly over-utilized, it is difficult to determine just what effect current use has on the trends of the principal forage species. Vegetative changes occur slowly, and, in the absence of established standards, are difficult to measure. The use of study plots protected from use by game offers the best opportunities for appraisal. Since the manager is dealing only with key species, plots should be planned to study only those species. This will be much simpler than trying to determine type trends of the composite range cover. In the absence of study plots, and on ranges where summer growth can reach the maximum, individual plants can be tagged at random over the area and the current growth measured on one or more exposed branches. After use by game, as for example on a winter range, the tagged branches should again be measured and the difference will indicate the per cent of utilization of the current growth. A range may look good and have a complete vegetative cover, but nevertheless be gradually declining in carrying capacity because of the replacement of more palatable, by less palatable species. Forsling and Storm (1929) found that cattle confined to pastures lost weight after the preferred species had been depleted. A similar result may be expected with game animals.

Palatability is measured by the percentage of the forage plants that is used when the range is properly grazed under the best possible management. The term "proper-use factor," which is easier to correlate with the definition, may well be substituted for palatability. The proper-use factor of any plant then is the extent to which that plant will be grazed when the range is properly used.

Little has been published as to standards of utilization for the browse plants that make up a large part of the diet of both elk and deer. Definite research is needed to determine standards of safe utilization of game food plants for each climatic region. The U. S. Forest Service contemplates studies of this nature in the near future, and it is anticipated that they will be of value in connection with game range management.

Browse plants are considered 100 per cent utilized when the current leaf and twig growth within reach of the game has been taken. Herbaceous plants are 100 per cent utilized when all of the leaves and stems have been grazed to the ground. Some exceptions should be made for species with coarse woody stems.

Forsling and Storm (1929) determined that for bitterbrush (*Purshia tridentata*) and birchleaf-mahogany (*Cercocarpus montanus*), two very important game browse foods, the cropping by cattle of a high percentage of the current season's growth did not appear to affect the development of the plants if there was enough of the current stems left to support one or more lateral buds.

Julander (1930-36) found on the Kaibab National Game Refuge for mule deer in Arizona that aspen (*Populus tremuloides*) made only fair improvement when browsed 65 to 70 per cent, but cliff rose (*Cowania stansburiana*) was actually stimulated by browsing up to 65 per cent, although 75 per cent was the maximum it would endure.

These studies indicate that generally a safe degree of utilization of browse species would be from 60 to 70 per cent of the current growth. Herbaceous species as a group may be utilized 50 to 60 per cent by volume, with a margin of safety. These percentages are the best guides available and, until research or experience furnish additional information, may be considered safe to use, possibly with adjustments indicated by local conditions.

Since most browse plants produce rather uniformly leaved stems, the percentage of utilization may be determined by measurement as well as by weight. Perennial herbaceous plants usually do not produce foliage of even density in proportion to their heights. The grazing of some plants to one-half their height might remove only 20 per cent of the forage volume because the main bulk of the plants is near the ground. Other species might lose 40 per cent of their volume by the same degree of cropping. Each key species should be considered separately, and either measurement or weighing used to determine the percentage of the volume of the current growth that is being used.

With that ascertained, either a straight average or a weighted average of the percentages will give the percentage of use for the key area. And similarly, average for the key areas will give the percentage of use for the herd range. That figure will indicate to the manager what action, if any, should be taken to keep the range at maximum production. If the use is within acceptable limits, he should have no worry, but if overuse is indicated, immediate steps should be taken to correct the situation.

As stated before, the importance of numbers of game animals is relative to carrying-capacity, but in applying a percentage reduction there must be a point from which to work. The best estimates obtainable on game populations should be used as a basis for such determinations. Because of the limited accuracy in arriving at the percentage of forage use as well as in estimating numbers, the problem should not be considered solved by calculations alone. Periodic close inspections should be made to follow the vegetative trend and check the results from any control measures initiated. Immediate action to correct indicated needs should then be taken.

The dominant points that the wildlife manager should keep in mind are the controlling importance of the natural food supply and the difficulty of keeping populations within safe limits of the range capacity. Since food is the most difficult factor to control, the stocking of any game range should be on the safe side as to food supply and not take the risks involved by favoring increase of game animals.

SUMMARY

Food is recognized as the most important requisite of a game range and the one that is most difficult to maintain in a natural state.

The tendencies of game to use certain ranges and the difficulty en-

countered in changing those habits indicates that game ranges should be considered on a herd, rather than a land, basis. Each herd should be controlled separately as the conditions of food, environment, and land use indicate.

On each herd range there are certain areas that provide the major part of the game food. These areas should be considered as the basis for determining range conditions, utilization of forage, carrying capacity, and general management, and for investigations. Their use and management is the key to the production of the entire range, hence, they are called key areas.

Over-utilization of concentration spots and of limited yardage areas will have to be accepted as inevitable in the maintenance of maximum populations on a sustained basis.

On the key areas, there are a limited number of plant species that furnish the major part of the forage. These are species upon which the game population depends for more than 60 per cent of its food. The species selected as keys to range use should be highly palatable, fairly abundant, able to stand reasonably heavy use, have about the same utilization factor, be perennials, and suited to the class of game using the range. They should be the basis for judging range condition, forage utilization, trends in vigor and production, and carrying capacity. The percentage of use of key species is determined by comparing utilization of the current growth with plants ungrazed or previously measured. An average of the percentage of use of key species will give an average use for the key area and an average of key areas will show the percentage of utilization for the herd area.

Utilization factors of all important game food plants have not been definitely established. The studies that have been made indicate that most shrubs will endure 60 to 70 per cent utilization of the current growth without detriment. In any case enough of the current growth to support one or more lateral buds should be left to insure continued vigor and production. Native range foods are the most desirable but are also the most difficult to maintain. Any plan of management should be on the safe side as far as the food supply is concerned rather than favor numbers of game animals.

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THE CARRYING CAPACITY OF SOUTHEASTERN QUAIL LANDS

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The game possibilities of the Southeastern Coastal Plain have long been of great interest to sportsmen and game managers, chiefly because of the demonstrated fact that an annual crop of upland game can be produced almost wholly by land handling practices and because, though the harvest varies somewhat from year to year, there are, under proper management, few crop failures.

Since the bobwhite quail is the species of paramount interest to sportsmen and the one for which management technique is most highly developed, this paper will deal mainly with this bird. However, on sufficiently large acreages where half or more of the land is in forest and protection from over-shooting afforded, deer and wild turkeys thrive on any types that may be given over to quail management, even though better results with these can probably be obtained where the terrain has a higher precentage of hardwoods than characterizes ideal quail land. Turkeys, especially, like areas offering roosting trees over water. The main point is that both deer and wild turkey can be increased on any types used for quail shooting if the area under management is large enough and a sufficient proportion of it is timbered.

A surprise to many will be the fact that a great deal of the land where upland game has been brought to abundance through management has had an unusually long period of occupation by man; for instance, some of that in coastal South Carolina has been settled since 1670. Too frequently is the history of the land overlooked, although land handling practices of the past may have had a profound effect on both present and potential carrying capacity. The properties with which we are familiar are located in five Southeastern States, but the historical outline of all is similar in many respects, and varies more in the type of "money crop" used than in effect on the land.

The period of exploitive cultivation produced effects in the South that will long be felt. Even as early as 1800 many fields in the South Carolina coastal country were admittedly worn out, even on the strongest soils. Depletion occurred much later in the Thomasville and Albany, Georgia, and the Tallahassee, Florida, sections. In many respects, this period of intensive production of "cash crops" may be likened to the more recent history of the "dust bowl"; but it fortunately occurred in a region of heavy rainfall—consequently, when prices fell and land was thrown out of cultivation, it reverted to woodlands—largely pine forests. During the era of intensive farming little thought was given to game, which could not have been very abundant in many of the farmed areas, for the land was usually cultivated to the creek banks.

As time went on and intensive cotton farming declined, "patch farming" came into being, and the small and scattered fields made balanced quail territory. The practice of woods burning that formerly had been conducted by the Indians and the early pioneers in the virgin pine forests was continued in the second-growth pine, and kept the wooded land in ideal condition for quail. Today our management for quail consists essentially of duplicating the conditions accompanying the third stage farming.

In earlier days, hunters were not numerous and management was unnecessary; hence, game management as we know it now is a recent development. Certain large-scale trends in the South have in recent years made management a necessity if shooting is to be had by the increasing number of hunters, and need has arisen for *determining* the carrying capacity of lands, as well as *increasing* that capacity—especially for quail. A fact little realized is that, unless land is held and developed primarily for quail, the carrying capacity varies greatly with different trends in agriculture or land-handling practices. Lately the following three trends have become so unfavorable to quail that the carrying capacity of many *unmanaged* lands has been lowered or ceased to exist:

1. Many old field areas, particularly pine woodlands, are being protected from fire and are rapidly becoming unfit for quail. On such areas food supply has diminished and predators increased.

2. More intensive grazing, resulting from increasing numbers of livestock, has drastically lessened the carrying capacity of a large aggregate acreage in the South.

3. Fields are becoming larger and planted more solidly to one crop with the advent of small tractors and mechanized farming. Strip

cropping and other soil building practices are alleviating some disadvantages caused by this type of agriculture.

A few years ago, hunting clubs and sportsmen of means depended almost entirely on leased lands for hunting; today preserves are mostly owned and under management of the owner. Only through full control of the land can good hunting be achieved under present agricultural practices.

We have access to the records of many owned preserves where a large and surprisingly uniform kill of quail is made year after year. Because so much of the public hunting in the South is poor, many do not realize what really good quail shooting is.

In our opinion, good quail land is that upon which from 15 to 20 or more covies can be found in a six-hour day when hunted over with good dogs. On the types of land with which we work, it ordinarily requires about ten thousand acres to produce an average yearly kill of one thousand quail. If the land is poor, more intensive (and expensive) development is necessary to maintain this average than if soils are basically fertile and are good producers of native quail feeds. There are some properties with soils so poor that production of such a kill is impossible; likewise, on small areas of exceptional land, the yield may be at a higher rate. This does not mean that development can not be so intensified as to produce more birds; it simply means it is impractical and uneconomical to intensify management beyond a certain point on most of the vast area of cheap land available in the Southeast. An average quail population of a bird per two or three acres over large areas can be maintained at comparatively small cost. To double this population might cost ten times as much. Experience has shown that for best results covies should not be moved by dog and gun more than once a week—preferably not more than once in two or three weeks. Hunting parties usually cover about a thousand acres per day; consequently, large acreages are preferable, especially in regions with dense cover to which quail will retreat if disturbed too often.

We know of no short-cut to estimating or censusing quail populations; nor, from a practical viewpoint, has one been needed. Where a property is managed by capable men they learn to know roughly how much shooting it can stand, for they are in day-to-day touch with it. When doubt exists they go over the property thoroughly with slow-working dogs. Covies can also be plotted by making a record of their whistling at dawn. Under average weather conditions in the fall, covies whistle one or more times as they leave the roost. From some point the observer (who arrives just before daylight) marks the covies he hears. The next morning he repeats the procedure, but from another point close enough so that he can hear one or more of the covies of the previous morning. This is continued daily, weather permitting, until the property is thoroughly covered. A rough estimate of the average size of the covies is obtained by flushing a number of them. This, together with careful dog work and a good knowledge of the land in question, gives only a rough estimate of the birds on a property, but is sufficiently close for practical purposes. It is a time-consuming and difficult piece of work and in actual practice is rarely needed.

In determining whether a given property can support good shooting, there are many things to consider besides food and cover. Of greatest importance, we believe, is the soil. Good shooting cannot be economically maintained without soil that is basically fertile and adapted to the growth of native legumes and other feed. Too often, quail management is considered synonymous with feed patch planting. In the Southeast, feed strips are one of the last considerations for insuring a maximum yield, and may be used merely to balance properties having a poor distribution of field and woodland. A soil of such texture that rains seep into it is better than impervious clay, for the latter has to be drained before real development can proceed. Without drainage, native feeds do not flourish and standing water may be a hazard to young quail.

The actual carrying capacity at the time of examination can be judged by the amount of certain ''key'' legumes and grasses in woodlands and undisturbed areas. The luxuriance of weedy growths in the fields also must be considered. Such soil as Orangeburg fine sandy loam, one of the best Coastal Plain soils, seems to produce the best *woods* feed, while other soils, such as Norfolk fine sandy loam, appear to produce more feed *in the fields.*

A striking fact about southeastern soils is that, as a rule, those once cultivated produce better and more varied crops of native feeds; hence, our second growth old-field pine forests frequently make higher grade quail land than virgin soils. Virgin pine forests often have an undergrowth of wire grass that apparently tends to choke out more desirable plants. Furthermore, most of the lands left virgin are those that had soils so poor they were undesirable for agricultural purposes. An exception is furnished by virgin lands with a patch growth of dwarf oaks, as *Quercus pumila,* for this growth furnishes an abundance of food and cover for quail and wild turkeys, and usually occurs in greatest profusion on soils of from fair to high grade.

Fertility of the soil also has to be considered in relation to brush control, for on good soils burning may have to be done almost yearly, especially in years of heavy rainfall during the growing season. If such lands have not been burned properly and are "rough," they usually have a low quail carrying capacity and to bring them back into full production may prove a slow or expensive process. If no brush-cutting equipment is used, it requires about as long to get a property back into condition as it originally took to get out of condition.

The presence of cattle on a tract must be considered in relation to the soil as well as to the effects of grazing. If land has been grazed year-round very heavily, desirable quail food plants may have been largely eradicated and to bring these back is a gradual process, the time required to do this depending on how long the land has been pastured. Whether this eradication is primarily due to grazing of the plants or to compaction of soil is not known; probably both play a part.

The *proximity* of quail and turkey land to areas maintained under fire protection may also play a large part in determining practical "carrying capacity." If such areas have become "rough" they are havens for such predators as foxes, wildcats, skunks, opossums, and the like, and are a menace to surrounding lands managed for game. Also, whether mammalian predators of a region have been kept in check by night hunting with dogs or by commercial trappers may be an important factor.

The proportion of open or agricultural land to woodland areas as well as their distribution plays an important part in determining carrying capacity, though the limits are broad. It has been determined that good populations of quail can be maintained on heavily wooded lands provided at least 25 per cent of the terrain consists of openings or small fields; likewise, the reverse is true. The amount of open land actually in cultivation any one year can vary between broad extremes, depending to a large extent on the crops grown. Large acreages of cotton or peanuts are not desirable, but when planted to corn and watermelons need not be objectionable provided they are not in large fields and are well distributed over the property. Clean cultured crops are objectionable, though some good shooting has been obtained where cotton has been raised only in small patches, instead of in fields more than 20 acres or so in extent.

The harvesting of the game bird crop must also be considered, for a property may have a high carrying capacity and still the quail may be of little value for sport if they can not be conveniently hunted. Lands broken by numerous small brush-choked ravines or "branches" may produce large numbers of quail but the birds may feed in such inaccesible areas—particularly if too closely hunted—that they are not available. The *availability* of the crop is just as important as the number of birds on the land.

In conclusion, we would like to emphasize:

That potential carrying capacity must be contrasted to actual carrying capacity at the time of examination. Rarely are these the same on land that has not been under management for game.

Present, as well as potential, carrying capacity depends to a great extent on previous history of the land and whether the fertility of the soils has been lowered. Sometimes important clues as to possibilities of the soils may be found in small rich spots that have escaped intensive farming.

Carrying capacity also depends on proximity of the land to areas where land management unfavorable to quail is practised, for such areas may develop a large predator population that cannot be adequately controlled.

Only experience enables one to estimate how much carrying capacity may have been lessened by grazing, or how long it will take to restore luxuriant legumes and other plant growth if grazing is stopped. Areas protected from grazing, by the tops of fallen trees and corners distant from barns or feeding places, sometimes furnish clues.

It also takes experience to foretell the time it will require for brush-choked woodland to become productive after burning is resumed. On most good soil types, quail populations usually drop heavily after a program of non-burning of pineland areas has been in effect four or five years—sometimes in even less time. On pineland types unburned for ten years or more, quail are usually very scarce, or unavailable for hunting.

Whether soil is virgin or once cultivated plays a part in carrying capacity. Virgin soils especially good for quail production are indicated by a sprinkling of dwarf or runner oaks. Perennial native lespedezas, beggarweeds, and other legumes are indicators of the quality of the soil. When considering the significance of the prevalence of such plants, the grazing and burning history is important.

The amount and distribution of cultivated land and its proportion to woodland, what crops are grown, and what farming practices are followed; all influence the quail crop considerably, although these are more important in determining present than potential carrying capacity.

Thus, it may readily be seen that the estimation of present, as well as potential, carrying capacity of quail lands in the Southeast is most difficult, and much of the judgment needed for such appraisal must be hardened in the fire of experience.

DISCUSSION

DR. LAWRENCE E. HICKS (Ohio): The statement was made, I believe, that it takes 10,000 acres to produce a kill of about 1,000 birds.

MR. KOMAREK: Yes. We have found from practical experience with a large number of private preserves throughout the Southeast that it takes roughly about 10,000 acres to produce a kill of 1,000 birds. By that I mean the average bag; some years it may go to 1,200, others it may fall to 800, but we know of no properties that have been able to maintain consistently an average higher than that.

DR. HICKS: To complete the picture, how many birds all together do you have on that 10,000 acres in order to make the thousand kill possible?

MR. KOMAREK: On the preserves mentioned the population of quail is one bird to from 2 to 4 acres. We find that it isn't necessary to know definitely how many birds there are, that if the approximate number of covies is known, and the manager is on the land all the time, he will know whether the stock is being over-shot. Covies are not shot down too small; usually six or seven birds are left in each.

MR. GILBERT SIEGLER (Texas): You said that food patches are your last consideration in quail management. Would you explain that?

MR. KOMAREK: Unfortunately in recent years the impression has seemed to be, that as far as quail are concerned, all you have to do is plant a lot of feed patches and everything else takes care of itself. However, that is far from true. I have seen property with plenty of feed patches that will not produce quail simply because the environment is out of balance. If the woodlands have not been burned or are in a rough condition, if the fields are too cleanly cultivated, or if the property is over-grazed, feed patch planting will do little good, because it does not correct the main fault of the property. We do use feed patches extensively where there are not enough fields. Likewise, on estates where the owner wants the maximum quail he can get per acre and is willing to bear the cost, then an intensive feed patch program may be undertaken, but it is an expensive procedure. We can harvest a thousand birds per 10,000 acres rather economically but increasing the yield is costly. The only other circumstance in which we use feed patches is or lands that are so poor that it becomes necessary to fertilize heavily with commercial fertilizers so as to produce plants vigorous enough to come through a drouth or any other adverse condition.

MR. V. W. LEHMANN (Texas): You said that you use fire on woodland property to keep it in condition, and produced birds rather economically. How economically?

MR. KOMAREK: That varies, depending upon the way the fire is handled, and the type of property. If you have lands that have not been burned for years, the cost of applying the first fire may be rather heavy. Once the property is in shape, however, the maintenance cost may be rather light. I fully believe that we can maintain a very high population, and in fact to some extent do so, where we depend entirely on small patch farming. I really believe that in the past. under agricultural practices such as formerly prevailed in the South with patch farming, plus the woods burning that everybody practiced, the rate of kill was about what we get under management, and it was at very little expense because all that was necessary was to lease land for ten cents an acre.

MR. LEHMANN: What do you figure your birds cost?

MR. KOMAREK: We have never gone into that end of the matter, as the preserves are not run on a self-supporting basis. The cost of the birds is doubtless high if you consider that the land is held primarily for quail. I might answer the question in this way. In the Southeast it takes about 10 acres of land to produce one killable bird. It also takes about 10 acres of land to produce one steer, and a steer is worth about $60 to $80.

MR. PHIL GOODRUM (Texas): I noticed that you said in your paper grazing was becoming a problem in the Southeast. Texas being a cattle state, naturally we are concerned with the relation of wildlife to grazing. What I would like to learn from you is whether there is any tendency in the Southeast, or any necessity, for fencing small areas, or even large areas, as a part of quail management.

MR. KOMAREK: We have had some experience along that line. Cattle do interfere with quail in the Southeastern States and we have had clients who tried to control grazing by fencing or by planting feed patches. However, we have yet to find a successful property of that type.

MR. GOODRUM: When areas have been fenced, can you tell whether that has done any good?

MR. KOMAREK: Not much, because we usually consider grazed land as dead acreage; in other words, it is not in production for quail. When you put in small feed patches you still have only put in production a very small acreage, and while that small acreage will produce well the general population can not rise above the average productivity of the land which is greatly lowered by grazing. In south Florida there are indications that grazing may not be as detrimental to quail as it is farther north.

THE USE AND AVAILABILITY OF THE MORE COMMON WINTER DEER BROWSE PLANTS IN THE MISSOURI OZARKS[1]

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A small remnant of native white-tailed deer has persisted in several counties in the more rugged parts of the Missouri Ozarks. The presence of these and a nucleus of deer on state refuges, some of which were brought from Wisconsin, and a more recent restocking and redistribution on United States Forest Service refuges and state cooperative management areas, have been largely responsible for a steady increase in the deer herds of the State.

Little or no attention was given locally to ecological studies prior to the establishment of the national forests in Missouri. A preliminary investigation of the plants utilized by deer was made by Atwood and Steyermark (1937). Results from that study which was conducted within two enclosures covering a quarter section of land, indicated that deer were feeding on at least 134 species of plants, 85 per cent of which

[1]Contribution from the Missouri Cooperative Wildlife Research Unit, Missouri Conservation Commission, American Wildlife Institute, University of Missouri, and U. S. Fish and Wildlife Service, cooperating.

had a general distribution throughout the Ozark region (Palmer and Steyermark, 1935).

The present study is being carried on in a refuge area of 14,000 acres in the higher parts of the Ozark plateau in Dent County, south-central Missouri. Supplementary data are being gathered from refuges in Taney, Ozark, and Oregon Counties along the Arkansas border.

A knowledge of feeding habits and of the quantity and the seasonal availability of foods forms one basis for the management of deer. These data have an added significance where silvicultural practices may influence the kind, amount, and distribution of the more desirable deer foods. Methods of increasing various types of foods may have an important bearing upon the management of certain refuges, particularly with reference to the attitude of local residents whose farm crops are damaged by the animals.

Feeding habits of deer in the Missouri Ozarks indicate that at least 200 plant species are eaten. The variety available is large for nine months of the year but is considerably restricted during the winter. Of the 200 species of plants observed as deer food, 89 were noted in the fall (September, October, November), 70 in winter (December, January, February), 78 in spring (March, April, May), and 115 in summer (June, July, August). During the summer period 57 per cent of the plants were legumes and composites.

Certain forbs and grasses provide food during the winter. The dried flowers and stalks of several species of goldenrod and asters are generally utilized; a small annual grass (*Sporobolus neglectus*) found in abundance on the glades provides feed during the first part of the cold season. The green winter rosettes of some helianthoids and of the cone flower (*Rudbeckia* spp.) are kept clipped short, particularly where these species are abundant in glades. The small green basal leaves of several species of panic grasses also offer excellent feed, as do blue grass (*Poa pratensis*) and orchard grass (*Dactylis glomerata*). The extent of use of grasses and forbs during the winter are being determined in areas of greatest deer concentration. Quantitative studies are under way in which the vegetation on a number of paired quadrats is clipped and weighed. The leaves of pussytoes (*Antennaria plantaginifolia*), a plant widely distributed in the Ozarks, are eaten throughout the winter and are sought out from beneath snow. The annual lespedeza (*Lespedeza striata*), planted so widely in Missouri, is a source of food throughout the greater part of the year.

Of the 70 species recorded as being utilized during the winter the important woody plants contributing most of the browse are listed in the following table:

TABLE 1. WOODY PLANTS USED EXTENSIVELY BY DEER IN THE MISSOURI OZARKS IN WINTER

Plants	Distribution	Parts eaten
Ward's willow (*Salix longipes* var. *wardii*)	Common throughout	Twigs
Hazelnut (*Corylus americana*)	Common throughout	Twigs, catkins
White oak (*Quercus alba*)	Common throughout	Twigs, buds, acorns
Blackjack oak (*Quercus marilandica*)	Common throughout	Twigs, buds, acorns
Post oak (*Quercus stellata*)	Common throughout	Twigs, buds, acorns
Sassafras (*Sassafras variifolium*)	Common throughout	Twigs, buds
Wild rose (*Rosa* spp.)	Common throughout	Twigs, hips
Dwarf sumac (*Rhus copallina*)	Common throughout	Twigs, fruit
Aromatic sumac (*Rhus canadensis*)	Common throughout	Twigs, flower-spikes
Smooth sumac (*Rhus glabra*)	Common throughout	Twigs, fruit
New Jersey tea (*Ceanothus americanus*)	Common throughout	Twigs
Red maple (*Acer rubrum*)	Common throughout	Twigs, buds
Shrubby St. John's wort (*Hypericum prolificum*)	Scattered	Twigs
Gray dogwood (*Cornus racemosa*)	Scattered	Twigs
Low-bush blueberry (*Vaccinium vacillans* var. *crinitum*)	Common throughout	Twigs
Coralberry (*Symphoricarpos orbiculatus*)	Common throughout	Twigs, fruit
Greenbrier (*Smilax* spp.)	Common throughout	Stems, leaves

Measurements of twigs of the season's growth before and after browsing are being made upon all the species which appear to have value as indicators of the carrying capacity of the range.

There is an almost complete absence of the fruits of the coralberry by mid-winter. Yet on areas where few or no deer are present, the berries remain on the bushes until late in the spring. Preliminary examinations of some 25 deer stomachs indicate that these berries are choice food.

A measurement of the extent of winter browsing in three different habitats during 1939-40 was undertaken at the close of the winter (last two weeks of February).

Random milacre samples were taken at one chain intervals in which were recorded the total number of plants of each species, the number of stems on each plant, the number of stems browsed, and the percentage of the stems browsed. During the first winter's work, data were obtained from 470 such plots. All stems under 5 feet in height were considered.

In stands of black oak, white oak, and hickory, the following species were of primary significance (Table 2):

Woody species that showed less than a 10 per cent browsing of all stems were not included in Tables 2 and 3. On the basis of all the plants recorded on the 120 quadrats in the ravine type, 7.0 per cent of the stems had been browsed. Of the 40 species of plants occurring on these quadrats, one-fifth were not utilized in any way during the winter. In the oak-hickory types, 260 quadrats showed that only 5.8 per cent of the total stems had been browsed and that 44 per cent of the species occurring on the plots had not been utilized. The effect of deer feeding along the edges of openings in the forest is demon-

TABLE 2. EXTENT OF BROWSING IN OAK-HICKORY TYPES (161 QUADRATS)

Species	Frequency in quadrats	Number of stems	Number browsed	Per cent browsed
New Jersey tea	10	15	4	32.5
Red oak	7	91	14	15.4
Low-bush blueberry	69	286	82	28.7
Coralberry	12	31	8	25.8
White ash	4	31	5	16.1
Dwarf sumac	8	33	7	21.2
Wild rose	8	23	4	17.4
Post oak-blackjack (99 quadrats)				
Dwarf sumac	3	30	9	30.0
Low-bush blueberry	28	466	73	15.7
New Jersey tea	20	80	9	11.3
Sassafras	17	236	37	15.7

TABLE 3. EXTENT OF BROWSING IN RAVINE TYPE AND ON ROADSIDES (120 QUADRATS)

Species	Frequency in quadrats	Number of stems	Number browsed	Per cent browsed
Dwarf sumac	3	5	5	100.0
Box elder	3	5	3	60.0
Smooth sumac	3	16	9	56.0
Coralberry	83	274	117	42.7
Smilax	8	14	4	28.6
Dewberry	9	18	3	16.7
Poison-ivy	4	24	4	16.6
Aromatic sumac	11	180	29	16.1
Shrubby St. John's wort	4	19	3	15.7
Roadside-truck trail rights-of way (90 quadrats)				
Shortleaf pine	27	34	28	82.3
Low-bush blueberry	30	157	106	67.5
Coralberry	2	4	2	50.0
Sassafras	6	207	93	44.9
New Jersey tea	16	18	4	22.2
Wild rose	14	117	20	17.0

strated in the comparison of similar figures for a series of 90 quadrats taken at one chain intervals along truck trail rights-of-way. Here 28.6 per cent of the stems had been browsed and one-fourth of the species had not been utilized.

From these data and additional information now being procured, it should be possible to select winter indicator species. At the present time it appears that the low-bush blueberry, coralberry, aromatic sumac, and in many areas, New Jersey tea, winged elm, and greenbrier are species that may have a direct bearing upon the winter carrying capacity of the range.

The amount of available woody browse was determined on the basis of sample plots of milacre size, laid out on random lines one chain apart in three principal cover types. All twigs up to a height of 5 feet were clipped. Only the current annual growth was collected, or that of a twig diameter about $\frac{3}{16}$ths inch where the annual growth exceeded this diameter. All twigs of each species were weighed at the time of clipping on a single pan-metric balance sensitive to 0.1 gram. There were 195 plots laid out in the post oak-blackjack oak forest in the sapling, pole, and merchantable size classes; 334 plots in similar stands of black oak-white oak-pignut hickory type; and 107 in the ravine type. The post oak-black jack oak type occupied 49 per cent of the area where the browse was sampled; the black oak-hickory type, 43 per cent; and the ravine type, 8 per cent.

Table 4 summarizes the information on yield gathered to date in these three types.

TABLE 4. YIELD OF BROWSE IN OAK-HICKORY AND RAVINE TYPES

Size class	Cover type	Weight of browse in pounds per acre
sapling	Post oak-blackjack oak	89
pole	Post oak-blackjack oak	147
merchantable	Post oak-blackjack oak	184
	Average	140
sapling	Black oak-hickory	134
pole	Black oak-hickory	95
merchantable	Black oak-hickory	103
	Average	110.6
all aged	Ravine	61

The yield of a few outstanding winter food species are given in Table 5.

TABLE 5. YIELD OF BROWSE OF FIVE SPECIES OF WOODY PLANTS PROMINENT IN WINTER DEER DIET

Species	Number of plots	Average grams per milacre	Average pounds per acre
Low-bush blueberry	210	17.0	37.4
Coralberry*	48	4.5	9.9
New Jersey tea	94	1.5	3.4
Sassafras	43	0.8	2.4
Aromatic sumac	16	1.0	2.2

*Coralberry measured only in ravine type quadrats.

Although not a woody perennial, pussytoes (*Antennaria*), occurring on 240 plots, yielded an average of 15 pounds per acre, second only to the lowbush blueberry.

SUMMARY

The results of the present study are based upon data gathered on state and federal wildlife refuges in south central and Arkansas border counties, all within the Missouri Ozark region.

The deer have nowhere reached populations detrimental to the most palatable woody perennials, forbs, or grasses on the unrestricted range. Various degrees of over-browsing have been demonstrated, however, on one private game preserve. Here exclosure plots are indicating the rate and ability of certain species in recovering from prolonged over-browsing. Greenbrier (*Smilax* spp.) has demonstrated a remarkable comeback.

The greatest amount of browsing upon the stems of woody perennials occurs during the latter part of December, and in January and February. The low-bush blueberry, coralberry, aromatic sumac, New

Jersey tea, and greenbrier have proved to be highly palatable throughout the winter. Bluegrass, orchard grass, and several species of panic grasses are heartily utilized. The rosettes of such perennial forbs as the cone-flowers and asters are eaten throughout the winter period.

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DISCUSSION

MR. R. R. HILL (Wisconsin): I would like to ask Dr. Dalke what he considers 100 per cent utilization of browse, and also, in measuring weight of the crop on different plants, what was considered as available food for that particular species?

DR. DALKE: Everything was clipped on the milacre plots up to a height of 5 feet. In case the annual growth considerably exceeded the 3/16-inch diameter it was left. Weights were taken in the field at the time the material was clipped.

MR. HILL: Does that mean that guided by the 3/16-inch diameter, clipping would often take more than the current year's growth?

DR. DALKE: No, we did not go back of the current growth. Sometimes the annual growth might get as big as your thumb, in which case only the very tip would be taken, and in some cases even not that, as it would be too large. As to the extent of browsing, only the stems that had been actually browsed were considered, they were rarely browsed down past the annual growth, just the tips being taken.

MR. HILL: Do you use the same diameter limit to determine what hundred per cent utilization would be?

DR. DALKE: Yes.

MR. E. L. ATWOOD (Louisiana): I would like to ask, with reference to the sumac, whether the plant would be killed by 100 per cent utilization.

DR. DALKE: No, in almost all cases there would be new shoots; cutting back is a good way to spread sumac.

MR. ATWOOD: I found, a few years ago that when the plant was utilized about 75 per cent, based on the total height, it was almost always killed. I wasn't able to follow the matter out, but I found that staghorn sumac and dwarf sumac were species that disappeared from the range when 75 per cent utilization was reached.

DR. GEORGE O. HENDRICKSON (Iowa): I would like to ask Dr. Dalke how many deer there were on this range.

DR. DALKE: About an average of one deer to 70 acres throughout the entire refuge.

DR. HENDRICKSON: Would you like to state how many deer you think that range could carry?

DR. DALKE: No, not on present information.

DR. HENDRICKSON: Would you like to make a guess?

DR. DALKE: I think the range could support more deer than it has at the present time, but we are conditioned also by what goes on around the refuge, as to just how many deer we can permit to live on the refuge.

MR. ATWOOD: With regard to Dr. Hendrickson's question, I might say that having worked in the same region that Dr. Dalke has been discussing, we found that when the available area was reduced to about 12 to 15 acres per deer during the winter, certain palatable plants disappeared from the range. Using that as a criterion, it would appear that carrying capacity would be reached at a deer to about 15 acres during the winter.

TECHNICAL SESSION

MONDAY AFTERNOON—FEBRUARY 17

Chairman: DR. PAUL R. NEEDHAM

U. S. Fish and Wildlife Service, Stanford University, California

Discussion Leaders:

DR. D. I. RASMUSSEN, *Leader, Cooperative Wildlife Research Unit, Logan, Utah.*
DR. CARL L. HUBBS, *University of Michigan, Ann Arbor, Mich.*

APPRAISAL OF STREAM IMPROVEMENT PROGRAMS

AN APPRAISAL OF STREAM IMPROVEMENT PROGRAMS OF THE NATIONAL FORESTS OF NORTHEASTERN STATES

THEODORE C. FEARNOW
Jefferson National Forest, Roanoke, Va.

It is the purpose of this paper to analyze the methods used in a program of stream improvement for the 6-year period from 1934 to 1941 on the national forests of the Northeastern United States, and to appraise the results of the work.

The forests included in this appraisal are in Region 7, the eastern region of the Forest Service, which includes the Middle Atlantic and New England States from Virginia and Kentucky north to the Canadian Border. Most of the observations used as a basis for this paper, however, have been made in Pennsylvania and Virginia.

The national forests of the Northeastern States offer an exceptional opportunity for the practice of intensive stream management. They contain approximately 6,000 square miles of public domain and include the headwaters of many of our most important eastern rivers. Located within convenient reach of the country's great centers of population, the aquatic resources of this area provide a fertile field for a program of stream rehabilitation.

Under the direction of the United States Bureau of Fisheries, a program of experimental stream improvement work was started in 1934 on the White Mountain National Forest in New Hampshire, the Green

Mountain National Forest in Vermont, the George Washington and Jefferson National Forests in Virginia, and the Monongahela National Forest in West Virginia. During 1935, the work was expanded to include the Allegheny National Forest in Pennsylvania.

The work in 1934 consisted of building many types of improvement structures under a wide range of conditions in order to test their effectiveness and ability to withstand the hazards of flood and ice. Hundreds of devices were built, embodying almost every known feature of design.

It is apparent that pioneer workers in the field of stream improvement greatly underestimated the amount of destructive power developed by swift mountain streams at flood stage. Many early attempts at stream improvement were completely nullified by high water within a short time.

An analysis of results from stream improvement programs of the eastern region shows clearly that successful operations involve careful consideration of both engineering and biological principles. Re-examination of streams where improvement devices were installed during the early phases of the program indicates that more failures have been due to faulty engineering than to misapplication of biological principles.

A *Fish Stream Improvement Handbook,* prepared by M. B. Arthur, Hydraulic Engineer of the U. S. Forest Service, applying engineering formulas to stream improvement structures and setting up minimum requirements for anchorage, etc., has done much to overcome structural deficiencies. Devices built under existing specifications have demonstrated their ability to withstand severe floods and still perform the functions for which they were designed.

On many sites where the original structures, built during 1934, were destroyed by floods, they have been replaced with similar devices built in accordance with present-day specifications and are now rendering satisfactory service.

Early attempts to provide pools on trout streams by impounding water behind dams were abandoned in most cases, after it became apparent that the structural requirements of such installations were out of all proportion to the benefits derived from them. Pools of the impounding type were found to fill in badly on many streams, serving as sediment basins that collected material moved during high water. In some cases these pools actually filled in level with the crest of the dam, leaving them valueless.

Based on experience from the northeastern national forests, it is now believed that the best method for creating a pool in a trout stream is to put the current to work digging out a hole in the stream bed.

Overflow across a low log embedded in the stream channel will frequently bring about the desired result. Pools of this type have the advantage that the currents of water which create them remain to keep the pool from filling in.

During the early phases of the stream improvement program, much emphasis was placed upon the permanence of structures built of or supported by very large boulders. Gin poles, blocks, and other devices were used to move enormous boulders into place on the stream beds to impound water and anchor various types of structures. Further observation has shown that bulk and weight are not always enough to insure permanence in a structure that must face the fury of recurring floods. Low-lying, well-braced, "streamlined" structures, offering a minimum of resistance to floods, have in general been more successful. Properly built structures of this type offer remarkably little resistance to the passage of flood water (Figure 1) yet provide the desired effect at all normal stages. In many cases, low logs, projecting 6 inches or less above the stream channel, have been enough to direct the digging action of the stream current, forming pools 4 feet or more

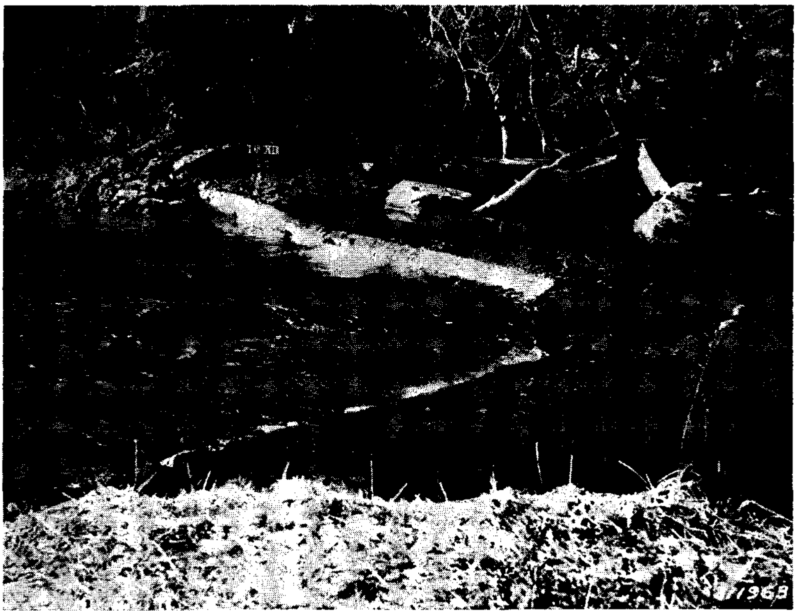

Photo by U. S. Forest Service

Figure 1. Structures of this type offer a minimum of resistance to the passage of flood waters and yet provide the desired effect at normal stream stages. Bear Creek, Allegheny National Forest, Pennsylvania.

in depth. During periods of high water, these structures are barely visible to the observer. By eliminating the use of bulky construction in stream improvement, objectionable appearance is avoided. Most of the structures currently used on the national forests are decidedly pleasing in appearance.

While the stream improvement program on the forests covered by this paper has not been in existence long enough to give conclusive data on the relative resistance to decay of the various kinds of timber used, this phase of the work has received consideration. In general, it is known that species having a high percentage of heartwood are most resistant to decay. Resistance to decay is especially important in timbers that are alternately wet and dry. Timbers placed below the surface of the stream bed where they remain permanently covered with water are relatively free from the hazards of decay.

Early log dams built in connection with national forest stream improvement programs frequently had a neat spillway cut in the crest of the top log (Figure 2). From the standpoint of appearance, this was very attractive, but after further study it was decided best to

Photo by U. S. Forest Service

Figure 2. During the early phases of the program, spillways were cut in the crest of log dams. After experience, the practice was abandoned in order to keep more of the structure covered with water and thus increase resistance to decay. West River, Green Mountain National Forest, Vermont.

permit water to flow across the entire length of the dam, thus keeping all of the main structure permanently watersoaked.

As the program of stream improvement advanced on the national forests of the eastern region, there was a very noticeable tendency toward simplification. Where twenty to thirty different designs were used in the early stages of the program, three or four types now suffice. These have proved their ability to withstand floods and at the same time perform the functions for which they were intended. V-shaped, K-shaped, and other elaborate types of log dams have, in a large measure, given way to the simple, straight-log dam (Figure 3) which has been developed to the point that it provides most of the advantages of more complicated structures at a smaller cost for both labor and material.

Use of deflectors in streams of steep gradient has been found subject to numerous difficulties. Single type deflectors, which project into midstream unsupported at one end, are extremely vulnerable to damage.

Double deflectors in use on the national forest streams have been improved to include an additional member embedded in the stream channel, which joins the two deflectors in midstream. Devices of this

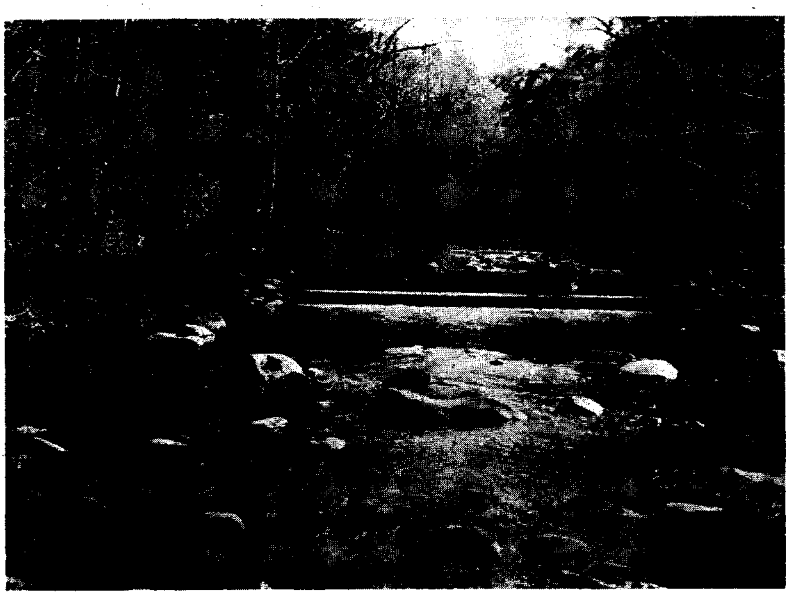

Photo by U. S. Forest Service

Figure 3. Simple straight-log dams of this type have been developed to the point where they provide most of the advantages of more complicated structures at a lower cost. North Creek, Jefferson National Forest, Virginia.

type have been used to narrow the stream channel and accelerate the rate of flow through open areas, with good results.

In some of the recently-developed structures, there is practically no cost for materials. Logs are taken from the forest, and, with the exception of a few iron spikes, usually made up on the job from iron rods, no manufactured materials are used. Few projects provide for such a high percentage of expenditure for labor out of each dollar alloted.

Commenting on the value of stream improvements for shelter, Davis (1934) pointed out that "probably nine-tenths of the stream improvements in common use have been developed for this purpose." While obviously the construction of shelters beyond the capacity of a stream to support fish cannot add anything of value, it is conversely true that streams deficient in shelter can be improved through the addition of suitable man-made cover.

In the primeval forest, timber reached maturity, became decadent and fell. Logs falling into rivers and brooks became water-soaked and were preserved for many years, thus forming an intricate maze of obstructions, sheltering pools in the forest streams. Today, there is no place for that method of providing stream shelters. The logical solution, however, appears to lie in a studied imitation of the natural processes that created favorable environmental conditions for fish. Sound stream improvement programs show real promise of filling this need.

Certain types of improvement installations, designed to dig deep pools, have proved their value in trout streams where low water conditions are encountered. In the common type of loose rocky stream bottom frequently found in mountainous areas, water may continue to flow beneath the stream bed during drought periods, long after all surface flow has ceased. Under these circumstances deep pools, gouged out of the channel by directed flood action, sometimes provides areas of safety for trout, permitting them to survive even through protracted droughts.

During the course of collecting operations on trout streams, it has been repeatedly found that the trout population tends to congregate in deep sheltered pools under stream improvement structures. Where long riffle sections are broken up by creating deep pools, these structures have the effect of bringing about uniform distribution of fishes throughout the stream. This is a condition much to be desired, especially in the case of streams that are under intensive management.

Evidence is accumulating on some of the streams under observation which indicates that stream improvement may be of value in holding stocked fishes in the stream, thus providing a higher ratio of catch.

In many sections of the country, it is becoming increasingly apparent that stream improvement has been "over sold", especially to groups of sportsmen who are looking for a panacea to cure the ills of an ailing sport. The blame for this condition can hardly be placed at the door of any one group; the same behavior pattern followed the introduction of artificial propagation of fishes and to a lesser extent the program for stocking fish of catchable size. There are many indications that stream improvement is now reaching the stage where it will be accepted by the game and fish manager and by sportsmen at its true value as a working instrument that has a place in fishery administration when intelligently used.

It must be conceded that the building of structural improvements on a stream can do little to alter basic conditions which regulate the carrying capacity. On the other hand, there are indications that existing productiveness of waters can be more effectively utilized by proper distribution of the fish population.

Protection of watersheds, through the restoration and maintenance of vegetative cover and the development of heavy deposits of mulch and litter on the forest floor, will permit more of the water falling on a drainage to reach streams through underground seepage, and less to rush off by way of surface run-off. Stability of waterflow and other factors affecting aquatic life are directly influenced by surface conditions on the drainage area of a stream. In a broad sense, one of the most effective forms of stream improvement is watershed protection.

Certain types of streams lend themselves to development through stream improvement technique much better than do others. Streams with low banks seriously limit the effectiveness of the usual devices that are used in stream improvement. Streams with high banks enable the stream improvement technician to utilize structures that can direct greater hydraulic energy to the various stream improvement purposes.

Streams over hardpan or rock are not susceptible to improvement by the common type of structures, as the erosive effects of water on their beds are negligible.

Streams having rubble bottoms quickly respond to the currents set up by deflectors and other devices, thus providing deep pools for shelter. The material washed out in the process of forming the pool is usually deposited a short distance downstream where is provides a clean gravelly riffle, frequently with considerable seepage underneath, thus furnishing ideal conditions for important fish-food organisms. The same areas also often provide spawning grounds for trout.

From an economic standpoint, it would seem difficult to justify the cost of intensive stream improvement programs on waters that are not safeguarded by long range plans for watershed management. Fire, excessive logging, or other destructive influences on the headwaters of an improved trout stream, can very readily nullify the effects of stream improvement work.

SUMMARY

1. Through an intensive program of experimental work in 1934, various stream improvements were tested on mountain-type trout streams on six national forests in the Northeastern States.
2. Structures have been developed that are capable of successfully withstanding flood action.
3. Improvement of shelter conditions by stream improvement has been accomplished.
4. A technique of stream improvement has been developed that preserves and even enhances the natural beauty of the streams.
5. A technique of stream improvement that involves little cash outlay for materials has been developed. This helps to qualify stream improvement as desirable in employing labor during slack periods.
6. Beneficial results in effecting good distribution of fish populations are indicated as a result of stream improvement operations.
7. Development of local conditions favoring increased fish food production is apparent through stream improvement, but further study is needed to establish definitely results as to increase in desirable food organisms.
8. Cost of intensive improvement necessitates that streams be safeguarded by long-term plans to protect watersheds and insure continued availability of the improved streams for sport fishing.
9. The value of stream improvement is generally overestimated by sportsmen.
10. Experience on the national forests of the eastern region indicates that fisheries administrators will find in stream improvement a good tool for use in the profession, but not a panacea.

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CHAIRMAN NEEDHAM: *Since we are somewhat behind schedule, I will call on Dr. H. S. Davis to follow up with his paper, and then we can discuss both of these papers together.*

THE MANAGEMENT OF TROUT STREAMS

DR. H. S. DAVIS
U. S. Fish and Wildlife Service, Leetown, W. Va.

It must be apparent to anyone interested in the conservation of our game fishes that we are faced with a critical situation and that old ideas must be revised and new measures adopted if we are to utilize this resource to best advantage. This is especially true of trout streams, which are usually small, and consequently peculiarly susceptible to over-fishing and other adverse factors. The increased numbers of anglers combined with the great extension of roads into wilderness areas have created a situation in which the old more or less haphazard methods of maintaining the fishing are no longer effective and our only hope lies in the adoption of a management program based on scientific principles.

In the development of any management policy, consideration must be given to the following factors: (1) Improvement of stream conditions so as to make them more suitable for trout and provide better facilities for spawning; (2) artificial stocking; and (3) legislation to limit the catch both in size and numbers. The control of predators and competitive species may also be required in some localities.

It is scarcely necessary to point out that an adequate survey of each stream is a prerequisite to management. The survey provides an inventory of conditions in the stream without which successful management is impossible. There is still much difference of opinion as to the amount of time and labor that should be devoted to this preliminary. As ordinarily conducted, the survey provides a certain amount of factual information on each stream valid on the day it was made. What the conditions may be at other seasons is known only by inference. This is the greatest weakness of present method of conducting surveys. Since funds for this purpose are usually limited, it may be advisable to make a less intensive survey at first and to supplement it with information obtained at other seasons. In that way we would get a much better idea of the stream as a unit and that is what is needed for intelligent management.

We all remember with what enthusiasm stream improvement was heralded as the solution of all our fishery problems. Its most enthusiastic advocates assured us that stream improvement would displace the hatcheries and make them as obsolete as the dodo. There were, of course, very few who went to this extreme but there were many who hailed it as a major advance in management. The principle of stream improvement was not new, having been practiced for years in Europe and to a limited extent in this country, but it so happened that an almost inexhaustible supply of labor was available in the CCC, with the result that stream improvement projects blossomed out almost over night from one end of the country to the other. This, in my opinion, was very unfortunate since experts on stream improvement were as scarce as the proverbial hen's teeth and stream improvement most emphatically requires expert supervision. As a result, our streams from Maine to California were cluttered up with a motley array of structures, the majority being unsuitable. Of course, not all of the work was bad. Some structures proved to be a valuable asset to the stream and were able to withstand the most severe floods.

The extent to which the various structures benefit a stream is still largely problematical. There is no question that dams and deflectors when properly constructed and located may provide excellent cover and thus make a stream more habitable for trout. It has also been shown in some instances there has been an increase in the abundance of food organisms after improvement. Probably the best example of a beneficial effect upon the fishing is that described by Tarzwell (1938) in Arizona. Studies on two streams very similar in every way except that one had been improved to the practical limit, showed that this stream yielded more trout per acre, both in numbers and poundage than the untreated stream. Furthermore, the standing crop of bottom organisms averaged 84 pounds more per acre than in the unimproved stream. It must be recognized, however, that conditions in the mountain streams of Arizona and New Mexico are peculiar to the region and that it does not necessarily follow that equally good results will be obtained elsewhere.

Tarzwell (1939) also found a material increase in the bottom fauna in Michigan streams after improvement. This resulted from increase in the area of the more productive types of bottom through construction of dams and deflectors. Hunter, Thorpe, and Grosvenor (1941) made a comprehensive study of the area affected by construction of a "V" dam in a Connecticut stream where for some distance the water was uniformly shallow, with a flat bottom of the gravel-rubble type. These studies showed that the section was made more habitable for trout which remained in the area throughout the winter and that the bottom fauna showed a marked increase both above and below the dam.

In the light of these studies, it is evident that stream improvement may be an important aid in maintaining the fishing and that it has a place in any management program. It is also apparent that stream improvement has limitations and that it should be employed only after careful study. Many streams do not need improvement while in many others the cost of effective improvement is prohibitive.

It is noticeable that the trend in stream improvement is toward simplification. Only a few types of structures are now used and these are as simple in design as possible. In fact a large boulder in the right place may accomplish as much as an expensive deflector. The massive and expensive log cribbing is, I trust, gone forever.

Even more important than attempts to improve the natural environment is the elimination, or if that is impossible, the amelioration of harmful factors, which as a consequence of our rapid industrial development, are continually becoming more destructive. First and foremost among these destructive agents is pollution with industrial and domestic wastes but this is a problem that can better be considered elsewhere.

A more recent hazard is the construction of impassable dams for the production of power or for flood control. These dams are destructive chiefly to migratory fishes as the salmon and steelhead but may ruin long stretches of trout streams through flooding and raising water temperatures. On the other hand, in some cases the resident trout have been benefited through increase in the food supply and extension of their range in impounded waters.

A major menace to the welfare of our game fishes is the unscreened irrigation and power ditches that take an enormous toll of fish each year from our western streams. Here again, however, the migratory fishes are the principal victims although it is well known that large numbers of trout, in addition to steelheads, have been swept into irrigation ditches from whence there is no return. While many more ditches are being screened each year there is still an appalling number with ineffective screens or with no screens at all. To maintain effective screens requires eternal vigilance especially with the smaller ditches whose numbers are legion. It is these ditches that are especially destructive to trout since many tap small mountain streams where they may easily escape notice.

There is no doubt that large numbers of young trout are captured by predators and in many instances it is probable that predators may destroy more fishes than all other agencies combined. It is well known that large trout are very predacious and this is one of the most important reasons for limiting the number of these fish in our streams. It has been shown by Fry (1939) that the production of lake trout increases as the percentage of large fish in the catch decreases as long as the number of adult fishes are not reduced below the level required to insure sufficient reproduction. This principle is probably of general application and is worthy of serious consideration in the management of trout streams. Other species of fishes, birds, and mammals all take their toll but it is doubtful if in most instances any attempt to control their numbers is necessary or advisable.

So far we have considered only natural propagation and means of increasing its efficiency. It is still true that the trout populations in a much larger percentage of our streams than is usually realized are primarily maintained by natural reproduction. In fact our studies indicate that in spite of the enormous number of trout produced annually by our hatcheries, wild fish still predominate in the great majority of our trout streams. With the exception of several Eastern States, as New Jersey and Connecticut, and some isolated examples in the West where the trout fishery is maintained almost entirely by planting legal-size fish, it appears that hatchery fish usually supplement the wild stock and are not the main reliance of the fishery.

In our efforts to evaluate the results of stocking, we have been greatly surprised by the poor showing made by hatchery fish. For example, Surber (1940) found that of 11,107 trout planted in the St. Mary River in the George Washington National Forest, Virginia, only 268 or 2.4 per cent have been recovered. Another striking example of the failure of hatchery fish to influence the fishery is provided by the Davidson River in the Pisgah National Forest, North Carolina. During 1937, 1938, and 1939 most of the stocking was done in the fall, a total of 18,135 trout over 6 inches long having been planted during this time. Of this number only 795 fishes or 4.4 per cent have been recovered. Quite different results were obtained from a plant of 3,809 large trout during the spring of 1940 in the same stream, 31.4 per cent of these fishes having been taken by anglers the following summer.

The frequently cited case of Furnace Brook near Rutland, Vermont, furnishes evidence of a similar nature. This is an excellent trout stream inhabited by both brook and rainbow trout. In 1935, when complete records of the catch were first obtained, the rainbows made up approximately one-third of the catch. Since that time the stream has been stocked heavily each year with brook trout but no rainbows have been planted, this species being maintained entirely by natural propagation. In spite of this handicap, the rainbows have gradually increased in numbers and now compose more than 50 per cent of the catch. Such instances do not, of course, prove that artificial stocking is a failure but they do indicate that something is wrong with our stocking methods.

It is evident that where the fishing intensity is high we must either reduce the annual catch to the level where an adequate brood stock is left in the stream at the end of the open season or we must supplement the wild stock with hatchery-reared fish. That such a policy also has its drawbacks is shown by the experiments of Hazzard and Shetter

(1938) who found that planting legal-sized trout resulted in a decided rise in the catch of wild fish of the same species. From this they conclude that stocking with large fish may deplete the stream of wild adults.

As previously indicated there is little doubt that present stocking methods can be greatly improved. Much progress has been made in this field during the last few years but we still have a long way to go. The practice of delivering fish to private applicants for planting cannot be too strongly condemned and it is most encouraging that each year more fishes are being stocked by the federal and state agencies concerned rather than by private individuals. The number of fishes, which in the past have been wasted by this practice, must reach staggering proportions.

Modern trucks, whether designed to carry fish in tanks or in pails, are much superior to those in use only a few years ago but it is still true that even with the best of care, fish reach their destination after a long journey in a weakened condition. Upon arrival they are given no time to recuperate or adapt themselves but are plunged into an environment with which they are not familiar and which all too frequently is characterized by an abrupt change in water conditions. Recent studies have shown that sudden changes in temperature have little effect within certain limits but there may be other differences to which the fish may not be able to make such rapid adjustment. Many of our hatcheries have a highly mineralized water supply and a sudden transfer of fish raised in them to soft water with a low mineral content, such as is found in the majority of our trout streams, necessitates fundamental physiological readjustments. The same is true, of course, of the gas content which may show great variations.

This problem has received little attention but we do know of instances where high mortalities have followed the sudden transfer of fishes from one water to another, even when both types of water supported a heavy fish population. In many cases, at least, the effect of such changes is not immediately apparent and consequently is completely overlooked.

There are other flaws in our stocking practices that are too obvious to require comment here, such as planting fish in waters unsuited to that particular species, planting small trout in places where they fall an easy prey to predators, or so-called "spot" planting where large numbers of trout are released in a small area.

One of the most promising efforts to insure better survival of stocked fish is the use of so-called "conditioned" trout. These are fish that have been held for several weeks or months under more natural conditions than are found in the ordinary hatchery pond. Transferred to a more natural environment, the fish quickly acquire a better color and their general appearance is greatly improved. It is logical to assume that such fish will stand a better chance for survival when planted in natural waters and experiments are now underway to determine if this is the case.

But fish conditioned at the hatchery may not necessarily be adjusted to the type of water in which they are planted. This will require conditioning ponds on each watershed which, of course, should have a stream supply. Such ponds can be constructed very cheaply since it will be necessary to hold the fish in them for only a short time. This would enable the fish to recuperate from the effects of their long journey and to become physiologically adjusted to new conditions.

We are still, of course, woefully ignorant with regard to the size and numbers of trout that should be planted under different conditions but this is a problem that requires carefully conducted experiments continued over a period of years. Such experiments are now underway in widely separated localities and it is hoped that in time we shall have the factual information that will enable us to work out our stocking policies with much greater confidence than at present.

The importance of proper legal restrictions to conserve the fishery is so obvious as to require little discussion. Failure to enforce proper fishing regulations adapted to local conditions may easily neutralize the effect of all constructive measures. The primary purpose of regulations is to spread the catch over a longer period and make it possible for more anglers to participate in the fishery. With the exception of streams in which conditions are not favorable for natural propagation, the maintenance of an adequate brood stock is also of the greatest importance.

In my opinion the creel limit in most states is still too high although it has been reduced recently in some instances. After all, the trout fishery is primarily for sport and should be managed as such. The day has long since passed when the role of trout in the national economy could be measured by its food value. Any angler knows that in terms of calories, or even as a delicacy, there are innumerable foods that will give far greater value for the amount expended. In short, the object of trout management should be to provide satisfactory sport for as long a period as possible and to as many persons as the fishery will allow, consistent with a sustained yield, and all fishing regulations should be drawn up and administered to this end.

Finally, I should like to emphasize the importance to management of systematic observations on conditions in each stream. As you know, the usual procedure in the past has been to work out a stocking policy, based on stream surveys if possible, and to continue to follow the same program year after year. No attempt was made to determine the condition or abundance of trout and other fish carried over from one year to the next, with the not infrequent result of serious maladjustments in the fish population. Without accurate knowledge of present conditions, it is impossible to manage a stream intelligently. It may be that the stream has been overstocked and that to continue the original policy would make a bad condition worse. On the other hand, it may be that few or no hatchery fishes remain in the stream and that the stocking policy requires radical revision.

The creel census is a valuable aid to management but in most cases it is impracticable to obtain accurate statistics on the catch and the use of unreliable data may lead to very erroneous conclusions. Even under the best of conditions the creel census provides very little data on the trout under legal length and on other fishes in the stream which, for management purposes, may be fully as valuable as adequate catch statistics.

It is evident, however, that even under the most favorable conditions the management of trout streams is essentially a pioneer job. Our knowledge of many factors important to management is so limited that we must continually be on our guard lest we accept conclusions based on insufficient information. Furthermore, we must remember that, within limits, each stream is a separate problem and that recognition of this fact is essential to successful management.

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DISCUSSION

CHAIRMAN NEEDHAM: For the benefit of those who came in late, I will say that we have had two papers presented. Mr. Fearnow gave the first on "An Appraisal of Stream Improvement Work on the National Forests of Northeastern United States," and Dr. Davis of the U. S. Fish and Wildlife Service just followed with one on "The Management of Trout Waters." In their remarks, these men have cut through—in one way or another—practically the whole range of management problems. If Cleland Feast is here, perhaps he would like to make some comment.

MR. C. N. FEAST (Colorado): I have supervised and observed a great deal of stream improvement in Colorado, Wyoming, and South Dakota, where it became very popular as a man-using job.

We had a number of CCC camps and forest camps and utilizing man-days was a big problem. I found that these organizations had in stream improvement just what they had been looking for when it came to getting rid of manpower.

In very few instances, however, would I recommend stream improvement in Colorado or Wyoming. Agreeing with a paragraph in the first paper, I would say that the most important thing to do is to improve the watershed. Without improved watersheds in our section of the country, we cannot achieve material stream improvement. A stream that has a good watershed in Colorado is a good stream, and any so-called improvement work upon it would be—as we have observed in hundreds of cases—a needless expense. In the case of those streams where improvement seems to be in order, the watershed is in such a condition—speaking as an engineer, which I am, as well as a biologist—that steel, and solid rock foundations are required, and that, I believe, is stretching stream improvement beyond its economic value.

We have one stream for which I am recommending an expenditure of $15,000 for improvement, and that is the only stream in the State upon which I would spend a dime. It is one close to Denver that is heavily used; through over-grazing and forest fires, its watershed was destroyed to the point where a bad rainstorm some five years ago washed in millions of tons of disintegrated granite, so that today the stream that formerly had many pools is now uniformly shallow.

Some years ago that stream was improved to some extent by the construction of herringbone, rock-filled, wire cribs. We found that when we had structures on one side, we were likely to move the stream, but the herringbone-type served fairly well. On the whole, however, I do not believe that the benefits of stream improvement in those three states will warrant expenditure of a great amount of money. Yet that would be required to do the proper engineering to protect the structures that you install, considering hydraulic conditions.

Stream improvement is quite complicated, and I would say that it is still in a highly experimental stage, considering the amount of money that has been spent on it.

MR. JAMES R. SIMON (Wyoming): In '34 we got our share of stream improvement in Wyoming. The following spring there wasn't such a thing as a stream improvement device in the State. There has been bad feeling about it, because the program was started without proper foundation; it was advertised widely and then when high waters washed out the devices, the public opposed any further work.

The only program we now have can hardly be called stream improvement. It is directed more toward the preservation of the natural conditions in the streams of our national forests. We think we are justified in that, because the finest stream improvement "devices" in the world are those we find in the primitive areas of our State.

These are extensive in Wyoming but when one gets away from them, irrigation promptly interferes with any work along the line of stream improvement. We have streams which, if left to flow naturally, could be nicely handled with stream improvement. With irrigation we have alternate flood and drought, so that stream improvement is hardly applicable.

MR. DAVID H. THOMPSON (Illinois): I would like to explain first that we have no trout in Illinois. I understood that most of the stream improvement work that has been discussed was intended for trout streams.

There is one thing in Illinois, however, that seems to have been instigated by the trout fishermen, and that is a clause in our legal code, to the effect that there be a fishway in every dam across the Illinois Waterway. Right now we are most interested in getting that clause repealed, because we think that the only efficient way of improving fishing in Illinois is to increase the amount of water area. That can be done most easily by creating artificial lakes. In order to improve fishing, we have to limit the fish population as far as we can to the species that will produce hook-and-line fishing. As long as we have this clause requiring a fishway in every dam, carp, buffalo, suckers, and all the other species that will not take the hook, have ready access to the whole waterway, and will crowd out the kinds that do take the hook.

We have plenty of evidence to show that in any water in Illinois, we can produce more than a hundred pounds per acre per year of hook-and-line fishes—that is, bass, bluegills, crappies and bullheads. Hence, when the trout fishermen insist about fishways and stream improvement, they should make an exception for the warm water fishes.

MR. SIMON: I might say that the Wyoming legislature passed a bill just two weeks ago doing away with the law requiring ladders on all the dams in the State.

CHAIRMAN NEEDHAM: In that connection—referring to western salmon and steelhead streams—I would like to put in a word here. For a long time they have been building fish ladders in the West, but the story of getting steelhead and salmon upstream is not one of success. In fact, I think that the bulk of the fish ladders installed in western streams can be said to have worked only about 50 per cent of the time.

DR. CLARENCE M. TARZWELL (Alabama): During the past three years I have not been connected with stream improvement, but for eight years previous to that time I had considerable experience with it. To me, stream improvement means environmental improvement, and I don't believe stream improvement should be restricted to the placing of structures in streams.

In 1934 I pointed out that stream improvement should begin on the watershed, and not with the streams themselves. If you are going to improve a stream effectively and permanently, you must remove the cause of the unfavorable conditions, rather than treat their effects in the stream itself.

If we are going to have lasting stream improvement, we have to get out on the watershed and remedy—as far as possible—the unfavorable conditions that have damaged the streams. Over-grazing, fire, deforestation, and numerous other causes have led to floods that have destroyed the cover along our streams and widened them and silting that has filled pools, and covered food-producing areas. In addition the grazing of bottom lands, not only in the West but in the East, has tended to destroy shade along the streams and to remove the trees and shrubs that hold the banks. When the trees and shrubs are gone the stream is widened by flood action. If the trees and shrubs remained, less damage would be done by floods.

Hence, it seems to me that fencing stream bottoms to prevent grazing and working throughout the watershed to prevent floods represent true stream improvement. We are going to have to work along these lines in the future if we want real results.

After such steps have been taken is the time to put in structures. When you have vegetation along the banks and when you have flood control, then perhaps, you can put in some of the things that will make cover or catch debris and make the stream richer.

Often a stream is injured as fish habitat by putting in dams. In arid regions, of course, dams are quite helpful in the smaller streams. They will produce a pool below the dam, valuable as a resting place and to which the trout can retreat during the dry season.

In the West, especially, great benefits may result from the fencing of stream bottoms. On the whole, I think we should look upon stream improvement as a problem in applied ecology, and consider all the phases of it, and not just the addition of structures. I don't believe that stream improvement should be condemned because certain structures don't hold, because they are only one of the factors.

DR. THOMAS LANGLOIS (Ohio): We are often confronted with the problem of what to do to make better fishing. Dr. Davis mentioned in his paper that stocking programs may not be as effective as we have hoped. He is trying out methods to make plantings more fruitful.

Our friend (Mr. Feast), from out West tells us that stream improvements in his area are not particularly effective.

Mr. Thompson concludes that the best way to make better fishing in Illinois is to create new fishing areas.

Dr. Tarzwell argues that we can't condemn stream improvement processes because some attempts have been ineffective, and he mentions that what we should really be getting at is the more fundamental problem of land use in stream basins. In that I heartily agree.

My own experiences in Ohio have involved some of these things. There have been some attempts at installation of improvement devices in some Ohio streams, but they have not been particularly effective. We have ended by concluding that they are not worth the comparatively heavy investment we have put into them. We have recently become convinced that we should do something like Dave Thompson is advocating for Illinois, and have been spending money for the creation of new fishing areas. That brings us back to the fundamentals of land use around the headwaters of our streams where we discover that we have a community of interest with many other people.

It isn't just a case of fish production. Our interests are the same as those involved in the general conservation of wildlife. We are "hand in glove" with agriculturists, with all agencies involved in erosion control, and recently it has been brought to our attention that we have a common ground with the industrialists.

In Ohio, there are sections where the ground water level has gone down rapidly. In the Miami Valley, in the southwestern part of the State, the water table has dropped about 90 feet. The manufacturers in that area, who use a great deal of water, (one of them uses as much as the entire City of Cincinnati), are seriously concerned about the ground water supply.

Our Governor recently called a conference of all the interested groups, including representatives of the industries, agriculturists, conservationists, foresters, and geologists, and it seems quite probable that an agency will be set up for the purpose of assembling all available facts on the ground water supply and possible methods of storing it.

It is obvious that the water withdrawn from the underground supply by industrialists makes our pollution problem after it passes through their factories. The industrialists are very much concerned lest the fish and game agencies get control of the ground water supply, and they are afraid of the fish and game groups on account of this pollution problem.

Possibilities of recharging the ground water supply of Ohio seemed rather limited. There is an underground flow which it might be possible to dam. We are building a few headwater reservoirs and restoring ground cover to retard the rate of run-off. If we could only stop some of these W.P.A. ditching projects that carry the water off faster than we can hold it!

All of these problems are involved in the movement for better fishing in Ohio, so we have concluded that expenditures for artificial propagation are wasted unless we can do something about the habitat. Within the last month the State of Ohio has taken the rather radical step of discontinuing the operation of 5 of its 13 state fish hatcheries. To our surprise, this met with very general commendation. The announcement was made that the Commission was going to increase expenditures for habitat improvement and that seemed to appeal to the public. The construction of headwater reservoirs has been popularized on the ground that we are creating a new type of fish farm. Here the fisherman takes fish directly as a substitute for the cumbersome and costly procedure of the Commission taking the fish and planting them elsewhere.

We have been planting a good many fish in Ohio in recent years, and find they just don't "stay put." We place them in the headwaters and they move down and out. Large fishes planted in Ohio have been caught within a month by fishermen in Kentucky and Indiana.

We are setting up some stream erosion control programs, and while we recognize that our two bits' worth isn't going to go very far if W.P.A. projects continue to destroy them as fast as we can make them or faster, still we are doing our best.

MR. R. S. WHITE (Canada): Two or three of the things touched on here have been of much interest to me, because we are dealing with them now. Most of our water control dams have been built to facilitate lumbering. While they have created large lakes, they have also served to destroy the brook trout, by backing the water over spawning beds. A fair number of lake trout survive but no brook trout.

As far as stocking fry is concerned, our program was very unsuccessful, as it was expensive and unfruitful. In recent years we have been stocking large fingerlings—from 5 to 7 inches in length—by airplane. At first we were afraid that dropping the fish from a plane might kill them, but we took a couple of them to the top of the Sun Life Building in Montreal and threw them off into mud, and then put them in a tank and found they were all right. The fish lived; they were kept for some time to make sure they were unhurt. Since then we have been stocking direct from the hatchery by plane into the lakes. It saves a lot of time and manpower—you can stock a lot more fish in much less time at lower expense.

PRODUCTIVITY OF THREE SMALLMOUTH BASS STREAMS

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The purpose of this paper is to present the facts gathered from the records of anglers' catches in three typical Appalachian smallmouth bass streams and to discuss accompanying forage fish problems.

Field studies were begun on the stream sections dealt with in this report in 1936 and 1937. Besides making observations on the bottom fauna, extent of natural propagation, growth of bass, forage fishes, etc., attempts were made in 1936 and 1937 to collect angling statistics on two of these rivers, the South Branch of the Potomac, near Romney, West Virginia, and the Shenandoah River near Berryville, Viriginia. At this time, neither Virginia nor West Viriginia had laws requiring anglers to file reports. Voluntary cooperation of the anglers was sought, but the number of reports received in 1937 declined to about half that received in 1936, so it was decided to abandon further attempts to collect data until compulsory legislation was enacted. This was done by the West Virginia Legislature in 1938. According to this act, each angler fishing the "test sections" was required to fill out a report at the end of each day's fishing whether successful or unsuccessful. Failure to comply with the regulations constituted a misdemeanor punishable by a fine of not less than \$20 or more than \$100, or confinement in jail not exceeding 30 days, or both fine and imprisonment at the court's discretion.

Cooperative plans between the West Virginia Conservation Commission and the U. S. Fish and Wildlife Service were completed for the collection of quantitative data on angling in the "test sections" on the South Branch of the Potomac and Cacapon Rivers during 1940. This is the first report on these studies. The experimental stream sections in West Virginia are located on the South Branch of the Potomac

River a short distance above Romney and on the Cacapon River between Largent and "The Rocks." The study section on the Shenandoah River is between Shepherd's Ford and Castleman's Ferry near Berryville, Virginia. Descriptions and comparisons of these rivers are contained in an earlier publication (Surber, 1937).

For the collection of the reports, red mail boxes were placed at boat landings, road intersections, or at other points of exit. A measuring board and pencil were furnished at each box. The angler was required to fill in on a report card the date, his name, address, license number, the number of hours he fished, the kind of bait used, the number and length of legal bass, the number of under-sized bass returned, and the kind and number of other species of fishes taken.

Legal size in West Virginia is a fork length of 10 inches, while the Virginia legal length is a total length of 10 inches. The open season in West Virginia in 1940 extended from June 29 to November 30, inclusive.

The data collected in these stream sections are given in Table 1. Of particular interest are the following facts:

1. The number of voluntary reports received during 1937 on both the Shenandoah River and South Branch of the Potomac River dropped to less than half the number received the preceding year. It is not known whether this was due to stream conditions or to a lag in interest. Both 1936 and 1937 were poor seasons for fishing with artificial lures in these rivers.
2. The average size of legal bass in the South Branch of the Potomac River has been declining through the 5-year period. On the other hand, the production of legal bass has been on an upward trend. The downward trend in average size may be due to heredity through the annual selection of the larger individuals from the stream or it may be an effect of overpopulation.
3. The proportion of illegal to legal bass in both the Cacapon River and the South Branch of the Potomac is large.

Table 2 gives the productivity of the three rivers in numbers of legal fishes of all kinds per acre and number of legal bass caught per fisherman-hour. It affords a comparison between voluntary and compulsory reporting on the South Branch of the Potomac River.

An examination of this table reveals:

1. A maximum production of 2.78 legal smallmouth bass per acre in the South Branch of the Potomac River during 1940. The section of the Cacapon River with its low production of 0.69 bass per acre and high yield of sunfish and rockbass can hardly be rated a smallmouth bass stream at present, although at one time this stream produced excellent smallmouth bass fishing.

TABLE 1. SUMMARY OF ANGLING TATISTICS COLLECTD IN SECTIONS OF THREE SMALLMOUTH BASS STREAMS

Length of test section (miles)	Year	Total number reports	Total hours	Number failing to report hours	Number legal smallmouth bass	Average length (inches)	Number illegal bass	Largemouth bass	Sunfish	Rockbass	Catfish	Eel	Sucker	Carp	Fallfish
							South Branch of the Potomac River								
3.25	1936	130	1,203	9	178	11.99	174	4	413	6	20	15	5	0	0
3.25	1937	56	395	11	183	11.75	98	0	142	0	14	8	4	0	0
4.50	1940	433	3,285	9	356	11.28	940	1	463	22	44	4	22	3	12
							Shenandoah River								
3.80	1936	97	452	12	129	13.06	80	6	20	1	59	0	4	2	0
3.80	1937	47	204	3	71	12.48	35	0	41	3	10	0	0	2	0
							Cacapon River								
7.25	1940	246	1.215	2	98	12.00	479	2	805	270	28	2	0	0	0

TABLE 2. PRODUCTION DATA FOR SECTIONS OF THREE SMALLMOUTH BASS STREAMS

River	Year	Length of section in miles	Area in acres	Nature of reports	Number of legal fish of various species per acre									Total legal fish per acre	Number legal bass caught per fisherman hour
					Smallmouth bass	Sunfish	Rockbass	Largemouth bass	Catfish	Eels	Suckers	Carp	Fal fish		
South Branch of Potomac River.....	1936	3.25	92	Voluntary	1.93	4.49	0.07	0.04	0.22	0.16	0.05	0.00	0.00	6.96	0.15
South Branch of Potomac River.....	1940	4.50	128	Compulsory	2.78	3.62	0.17	0.01	0.34	0.03	0.17	0.02	0.09	7.23	0.11
Cacapon River.........	1940	7.25	143	Compulsory	0.69	5.63	1.89	0.01	0.20	0.01	0.00	0.00	0.00	8.43	0.08
Shenandoah River...	1936	3.80	159	Voluntary	0.81	0.13	0.01	0.04	0.37	0.00	0.03	0.01	0.00	1.40	0.29

2. No suckers were caught in the Cacapon River section. The erection of the hydro-electric dam near Great Cacapon is probably responsible for this by stopping the upstream movement of suckers during their spawning season. The installation of an efficient fishway in this dam would undoubtedly be a worthwhile project.
3. Although the Shenandoah River in 1936 produced fewer legal bass per acre than the South Branch of the Potomac River, the number of legal bass caught per fisherman-hour in the Shenandoah was more than twice as great.
4. A striking difference in the productivity of the various kinds of fishes is revealed. Greater similarity exists in this respect between the South Branch of the Potomac River and the Cacapon River. The Shenandoah River is considered a type of stream that can profit by further stocking with fingerling or larger bass, while the South Branch definitely does not require stocking with bass. General field observations indicate that the Cacapon River has been undergoing a change during the past four years. There has been a decline in the number of both bass and forage fishes, and it is probable that sunfishes and rockbass have now gotten the upper hand to such an extent that the restoration of good bass fishing will have to follow upon either the stocking of large fingerlings (or even yearlings) or the stocking of large numbers of forage fishes. The latter procedure has been resorted to for experimental reasons since the Cacapon River is decidedly deficient in true forage fishes. It remains to be seen whether the stocking of forage minnows can do any good in the face of the large population of sunfishes and rockbass. It is becoming evident that it will require the stocking of hundreds of thousands of minnows to produce noticeable results.
5. The length of time required to catch a legal bass is considerable in all of these streams, varying from about 3.3 hours in the Shenandoah River to about 12.5 hours per bass in the Cacapon River.
6. The stream (Cacapon River) with the lowest bass production produced the largest number of legal fishes of all kinds. These were caught at the rate of about one (0.99) fish per hour as compared with the second best rate in the Shenandoah River (0.62 fish per hour in 1937, 0.49 fish per hour in 1936). These rates are low when compared to those for lakes. For example, Fife Lake, Michigan, (Eschmeyer, 1936) produced an average of 1.4 fish per hour in 1934. Eddy (1941) observed that 53 Minnesota lakes averaged 1.78 fish per man-hour in 1938, and 76 lakes in 1939 averaged 1.73 fish per man-hour. Considering bass production alone, the yields of bass in these rivers are relatively high. Eddy (1941) found that largemouth bass did not constitute more than 4 per cent of the catch, and Eschmeyer (1936, 1937) had yields of only .09 smallmouth bass per fisherman-hour in Fife Lake.

TABLE 3. PERCENTAGES OF LARGE BASS CAUGHT IN SECTIONS OF THREE SMALLMOUTH BASS STREAMS

River	Year	Total legal bass	Total large bass	Per cent large bass	Length in inches 15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	20.0-20.9	21.0-21.9
Shenandoah River......	1936	129	25	19.38	9	9	0	5	1	1	0
South Branch of Potomac River........	1940	356	14	3.93	4	3	1	3	1	2	0
Cacapon River..........	1940	98	8	8.16	2	2	0	2	1	0	1

The ideal of the angler who fishes purely for the sport of it is to catch a few big ones. A truly large smallmouth bass in this region is one weighing 4 pounds. They are rarely taken. Bass 19 inches or more in length usually weigh 4 pounds, although the writer saw one Shenandoah River specimen 21.75 inches long that weighed only 3.75 pounds. Any smallmouth bass 15 inches or more in length is a prize fish in this region. Table 3 has been prepared to show the percentages of large bass. The Shenandoah River leads other experimental sections by a substantial margin in this respect. Judging from my association with smallmouth bass anglers and from participation in the sport, the ideal toward which our management practices should be aimed in smallmouth bass streams is toward holding the average size of legal bass above a certain limit, perhaps 12 inches. The attainment of this goal will be at the expense of greater production in numbers, and in certain streams will involve the control of large populations of undersized fishes.

The amount of data on hand at present on the relationship between the number of bass nests per mile and the take of legal bass is sufficient only to indicate the possibilities of correlation. Table 4 has been compiled from these scant data. The number of legal bass removed per mile is roughly equal to the number of bass nests per mile. Bass less than 9 inches long have not been seen over nests. The estimated number of bass of spawning size is equal to twice the number of bass nests per mile, but all bass of spawning size (estimated at 9 inches or more) are not of legal size.

TABLE 4. RELATION OF NUMBER OF BASS NESTS PER MILE TO NUMBER OF LEGAL BASS CAUGHT PER MILE OF RIVER

River	Year	Number of legal bass per mile	Number of bass nests per mile	Estimated number of bass of spawning size per mile
South Branch of Potomac River	1936	55	52	104
South Branch of Potomac River	1937	56	75	150
South Branch of Potomac River	1938	....	56	112
South Branch of Potomac River	1940	79	....	....
Shenandoah River	1936	34	30(1939)	60

TABLE 5. ANGLING METHODS EMPLOYED BY FISHERMEN IN SECTIONS OF THREE SMALLMOUTH BASS STREAMS

Name of river	Year	Percentages using various kinds of bait: Mad-toms	Minnows	Worms	Crayfishes	Hellgrammites	Artificial	Artificial only	Total number of fishermen reporting methods
South Branch of Potomac River	1940	0.00	51.69	55.80	33.57	28.74	29.23	8.45	414
Cacapon River......	1940	0.00	37.23	56.28	9.52	18.18	31.17	12.12	231
Shenandoah River	1936	13.58	41.98	7.41	1.23	0.00	56.79	33.33	81

The methods employed by anglers in taking bass in the three rivers are compared in Table 5. The methods of fishing the Cacapon River and the South Branch of the Potomac are similar, but they are very different from those employed on the Shenandoah River where larger fishes are sought with larger lures. The extensive use of worms in the former streams is obviously for the purpose of catching pan fishes.

From the beginning of our field observations on these bass streams differences in the abundance of forage fishes have been obvious. The practical method adopted for determining these differences has not produced uniform or entirely satisfactory results, but the fact that forage minnows are generally scarce (except in the Shenandoah River) probably is responsible for the irregularity of the data. The method adopted consists of drifting downstream in a canoe at a distance of about 15 feet from shore and of recording all schools of minnows and other fishes seen over a stretch of several miles, noting their approximate size and number. Since recently hatched blunt-nosed minnows occupy the feather-edges, they cannot always be observed unless one person is delegated to walk the shore line, trailing slightly behind the boat. Certain species of fishes such as darters and mad-toms are not included at all, but in these clear mountain streams schools of the larger blunt-nosed, attractive or rosy-faced,[1] and straw-colored minnows can be counted and the presence of stone-roller minnows, stone-rollers and common suckers, fallfish, etc., can be recorded. Estimating forage fishes probably could be more satisfactorily done by employing at least three boats drifting parallel to each other simultaneously downstream with one man on each bank trailing 10 to 15 feet behind the shoreward boats. This method would reduce errors due to failure to record schools of minnows in midstream where they are frequently found, usually at the foot of riffles.

[1]The attractive minnow, *Notropis amoenus*, and the rosy-faced minnow, *Notropis rubellus*, cannot be distinguished in field surveys.

TABLE 6. RESULTS OF FISH CENSUSES MADE BY BOAT IN THE EXPERIMENTAL SECTIONS OF THREE SMALLMOUTH BASS STREAMS (COMBINED AVERAGES FOR SPRING AND FALL SURVEYS—1938)

Species	Size in inches	Shenandoah River: Average number of schools per mile	Shenandoah River: Average estimated number of individuals per mile	Cacapon River: Average number of schools per mile	Cacapon River: Average estimated number of individuals per mile	South Branch of the Potomac River: Average number of schools per mile	South Branch of the Potomac River: Average estimated number of individuals per mile
Carp	−9	....	0.13	....	....	....	....
(*Cyprimus carpio*)	+9	....	17.89	....	....	....	....
Stone-roller sucker	−6	....	7.11	....	....	....	69.82
(*Hypentelium nigricans*)	+6	....	2.90	....	0.42	....	5.45
Common sucker	−6	....	....	....	6.04	....	3.64
(*Catostomus commersonii*)	+6	....	....	....	0.63	....	....
Fallfish	−5	....	....	....	....	14.18	1,022.18
(*Leucosomus corporalis*)	+5	....	....	....	....	....	....
Silver-fin minnow	−2	....	....	....	....	....	....
(*Notropis spilopterus*)	+2	....	1.58	....	....	....	0.36
Attractive and/or rosy-faced shiner minnows	−2	31.32	1,690.92	5.42	209.38	8.73	5,081.45
(*Notropis amoenus* and/or *Notropis rubellus*)	+2	7.50	1,165.66	0.63	87.50	1.09	1,392.73
Blunt-nosed minnow	−2	7.76	1,752.11	2.51	482.28	12.72	1,575.27
(*Hyborhynchus notatus*)	+2	8.29	6,137.76	4.79	311.46	14.55	4,529.45
Stone-roller minnow	−2	....	....	....	....	2.18	154.55
(*Campostoma anomalum*)	+2	....	....	....	....	....	7.27
Smallmouth bass	−8	....	1.58	....	26.67	....	82.54
(*Micropterus dolomieu*)	+8	....	4.22	....	9.17	....	10.54
Sunfish	−3	....	....	....	65.42	....	21.09
(*Lepomis auritus* and *Apomotis cyanellus*)	+3	....	4.88	....	91.05	....	19.28
Rockbass	−3	....	....	....	....	....	....
(*Ambloplites rupestris*)	+3	....	....	....	7.92	....	....

TABLE 7. COMPOSITION OF FISH COLLECTIONS FROM THE "TEST" SECTIONS OF THREE BASS STREAMS, 1938

Name	South Branch of Potomac River Number of specimens	Per cent	Shenandoah River Number of specimens	Per cent	Cacapon River Number of specimens	Per cent
Catostomus commersonii	276	9.69	171	7.15	11	0.58
Hypentelium nigricans	61	2.14	24	1.00	12	0.64
Cyprinus carpio	....	....	1	0.04	....	....
Nocomis micropogon	17	0.60	....	....	....	....
Rhinichthys atratulus	6	0.21	....	....	1	0.05
Rhinichthys cataractae	2	0.07	....	....	....	....
Leucosomus corporalis	308	10.81	5	0.21	124	6.58
Notropis hudsonius	191	6.71	273	11.41	....	....
Notropis spilopterus	305	10.71	330	13.79	82	4.35
Notropis amoenus and N. rubellus	371	13.03	270	11.28	314	16.66
Hybognathus nuchalis	2	0.07	....	....	....	....
Exoglossom maxillingua	....	....	....	....	3	0.16
Hyborhynchus notatus	1,018	35.74	720	30.09	894	47.43
Campostoma anomalum	100	3.51	6	0.25	3	0.16
Ictalurus punctatus	....	....	1	0.04	....	....
Ameiurus nebulosus	....	....	76	3.18	....	....
Schilbeodes insignis	....	....	....	....	1	0.05
Boleosoma nigrum	107	3.76	205	8.57	22	1.17
Micropterus dolomieu	49	1.72	204	8.52	213	11.30
Huro salmoides	15	0.53	18	0.75	2	0.11
Pomoxis annularis	....	....	28	1.17	....	....
Lepomis auritus	....	....	56	2.34	5	0.27
Lepomis cyanellus	18	0.63	5	0.21	73	3.87
Ambloplites rupestris	....	....	....	....	119	6.31
Catonotus flabellaris	2	0.07	....	....	6	0.32
Total number collected	2,848	100.00	2,393	100.00	1,885	100.01

The combined results of two forage fish surveys on each of the three "test" rivers are given in Table 6. The figures recorded are the averages for one spring survey made in the last week of April and one fall survey made over the same stretches during the last week of August, and first week of September, 1938. These counts give a fairly useful picture of conditions in the three rivers. A more accurate idea of the fish fauna of these rivers can be drawn from Table 7 which is a summary of the composition of a series of seine-haul collections made throughout the summer of 1938. One surprising thing was that the South Branch led the Shenandoah River in numbers of attractive and rosy-faced minnows and number of schools of blunt-nosed minnows per mile. It is believed that even rough surveys such as these will be useful in checking on the: (1) Results obtained from the stocking of suitable forage fishes, and (2) changes in the forage-fish—game-fish ratios of these clear Alleghany Mountain streams.

TABLE 8. RATIO OF LEGAL BASS TO COMBINED FORAGE FISHES EXCLUSIVE OF THE SUNFISHES AND ROCKBASS

River	Legal bass per mile	Year	Combined forage fishes (1938) (individuals per mile)[1]	Ratio
South Branch of Potomac River	79.11	1940	13,842.17	1:175
Cacapon River	13.52	1940	1,047.71	1:77
Shenandoah River	33.95	1936	10,776.06	1:317

[1]This includes all species of fishes in Table 6 exclusive of smallmouth bass, sunfishes, and rockbass.

In Table 8, the ratio of combined forage fishes in individuals per mile based on the 1938 (the latest) surveys is compared with the 1940 production of legal-sized bass per lineal mile of river. Since catch figures are not available for 1940 from the Shenandoah River, the 1936 production of legal bass is used as a means of comparison. From this compilation, which is open to criticism because the game fish yields and the forage fish counts do not represent the same season, there is suggested a method of determining whether bass or forage fishes should be planted in a particular river. If the ratio of legal bass to forage fish is as high as it is in the Cacapon River (1:77), then forage fishes should be stocked.

When the number of bass of all sizes seen in the forage-fish counts were used for calculation of ratios, the following result was obtained:

TABLE 9. RATIO OF BASS OF ALL SIZES TO THE COMBINED FORAGE FISHES, EXCLUSIVE OF SUNFISHES AND ROCKBASS

River	Number of bass per mile[1]	Combined forage fishes per mile	Ratio
South Branch of the Potomac River	93.08	13,842.17	1:149
Cacapon River	35.84	1,047.71	1:29
Shenandoah River	5.80	10.776.06	1:1.857

[1]Number of bass does not include spring fry.

TABLE 10. PERCENTAGE LEGAL-SIZED FISHES IN HOOK AND LINE CATCHES (ARTIFICIAL LURES ONLY) 1938

	South Branch of Potomac River	Shenandoh River	Cacapon River
Total catch	136	51	122
Percentage of legal-sized bass	16.9	88.2	11.5
Percentage of undersized bass	83.1	11.8	88.5

The data presented in Table 9 offer a logical explanation as to why Shenandoah River bass grow more rapidly than those in the other two streams.

What is believed to be a fair picture of the relative sizes of bass in the three rivers is afforded by the data presented in Table 10.

Scale studies made over a period of several years show conclusively that Shenandoah bass grow much more rapidly than those of the Cacapon and South Branch of the Potomac. This is believed to be the explanation of the much greater prevalence of legal-sized bass in the Shenandoah River.

To conclude this more or less theoretical consideration of the forage-fish problem, let us speculate as to how many forage-fishes would be required to add a half pound to the weight of every under-sized bass:

With abundant forage fishes, bass reach the legal length of 10 inches in two years. From the above figures, the importance of having an ample supply of forage fishes per bass is obvious. Furthermore, it indicates that the Shenandoah River (Table 8), only, of the three streams has an adequate standing forage-fish population to permit the growth of bass at their maximum rate.

TABLE 11. NUMBER OF FORAGE MINNOWS PER MILE REQUIRED TO ADD ONE-HALF POUND WEIGHT TO ALL UNDERSIZED[1] BASS

Name of river	Number of legal bass per mile produced (See Table 4)	Year of creel census	Calculated population of undersized bass (on the basis of Table 10)	Number of forage minnows per mile required to add one-half pound of weight to all undersized bass[2]
South Branch of Potomac River..	79	1940	389	243,125
Cacapon River	14	1940	108	67,500
Shenandoah River	34	1936	4	2,500

[1]Few of the undersized bass included here are under 6 inches in length. They were caught by means of artificial lures only.
[2]These numbers are based on the fact that 1,000 adult blunt-nosed minnows weigh 4 pounds and that 5 pounds of fish are required to produce a pound of bass.

CONCLUSION

The angling data on the sections of the three rivers discussed in this paper reveal lower yields of fish per acre and lower catches per fisherman-hour than have been recorded for lakes. Considering smallmouth bass alone, the catches are high when compared to the published records for yields of bass (both largemouth and smallmouth) in natural lakes. Of the three rivers, the Shenandoah River has the best bass-forage fish ratio, and it is probable that it is the only stream of the three in which the stocking of bass is likely to be beneficial. The control of large populations of undersized bass and the stocking of large numbers of forage fishes will be required for improvement of angling for bass in the South Branch of the Potomac and Cacapon Rivers. In the study section of the latter river, large numbers of forage minnows have already been stocked without noticeable results, and it is becoming doubtful whether the stocking of forage minnows can result in the improvement of forage-fish conditions in the face of the large populations of rockbass and sunfishes that now have the upper hand. In the case of the Cacapon River, the fishermen should decide (or it should be decided for them) whether smallmouth bass fishing or just fishing is wanted.

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CHAIRMAN NEEDHAM: *Thank you, Mr. Surber. Dr. Langlois says that his paper is similar in some respects to yours and suggests that he give it now, and then we will discuss the two papers jointly.*

DR. LANGLOIS: *I am not so sure, Mr. Chairman, that my paper does cover the same territory as Mr. Surbers's after all. I thought it would before he got under way. However, both deal with warm-water species, and in that respect may be covered by the same discussion. I just want to make this comment upon his paper—that since he got approximately one adult bass per mile of stream and about 4 young bass per mile, obviously a big reduction takes place during the very early stages. Hence the problem of trying to improve that fish population would certainly involve working in behalf of those early stages. My suggestion would be that it would be better to provide nourishment or shelter for them rather than to supply forage fishes for the larger-sized bass.*

TWO PROCESSES OPERATING FOR THE REDUCTION IN ABUNDANCE OR ELIMINATION OF FISH SPECIES FROM CERTAIN TYPES OF WATER AREAS

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Changes in the fish faunas of Lost Creek in Defiance County have been shown by Trautman (1939) to result from man-made modifications of the creek. Except at its headwaters, Lost Creek had been dredged, and changed from a constant-flowing clear-water creek to an intermittent ditch. The food fishes, including the common sucker, the red-horse sucker, bullheads, and all sunfish species except white crappies are far less numerous in the dredged sections than they were before dredging. The same was found to be true for some forage fishes as the creek chub and the black-nosed dace, but it was not true of turbidity-tolerant forage species like the blackhead minnow.

The decline in the catch of commercial fishes in Lake Erie and the changing importance of certain kinds of fishes in the catch have been interpreted by some workers as due primarily to too intensive fishing operations. Many observations have led us to the opinion that the nature and extent of the changes that are taking place in the fish population of Lake Erie are also due to changes in the environment. These changes bring about the reduction in abundance of some species and increase in others, but the annual yield in poundage is approximately the same although the species composition is different.

The claims of depletion of the Great Lakes fisheries have been made principally by biologists who have tried to apply to the Great Lakes the methods which W. F. Thompson has applied to the halibut fishery of the Pacific Ocean. It is our contention that these methods are not applicable because certain facts about the Great Lakes as fish habitat and about the fishes themselves are different from the ocean and the west coast species studied by Thompson.

Specifically: (1) There are changes taking place in the fish habitats in the Great Lakes that lead to variations in the associations of fish species present, while in the ocean the habitat conditions apparently are more stabilized; (2) Thompson's procedure with the halibut involved increasing the numbers of mature, spawning fishes and hence of spawn, so that as increased numbers of young grew up, the commercial catches were composed to a greater extent of mature, spawning fish, leading to more eggs and young. In the Great Lakes the occurrence of dominant year classes of such species as the yellow pickerel leads to years when there are mature, spawning individuals in abundance, but the stocks are not increased thereby. Peak production years almost invariably are followed three years later by low-production years, and, peak production years always come from seasons when the brood stock is at its minimum. No consistent year after year high production for any given species can be hoped for, and imitating Thompson's procedures would fail of its purpose in Lake Erie.

Van Oosten recognizes changes in the nature of fish associations in his paper "From Ciscoes to Perch to Pike," but fails to state their causes. Hile, studying the effects of artificial propagation of the yellow pickerel showed that there is an inverse relationship between the numbers of fry planted and the abundance of the species in later years. All of the evidence now available provides overwhelming support for our argument that the succession of species of fishes dominant in any association cannot be materially altered by additions to or withdrawals from the population. Such changes in trends of varying abundance come only from changes of habitat such as we have definite record of in Lake Erie.

Habitat niches are filled, not left vacant. There are enough breeder ciscoes left in Lake Erie to populate the lake with that species if the habitat niche were simply being vacated, i.e., if conditions were still satisfactory for their welfare. It is our opinion, based on current statistics of the fisheries as well as on records of past years, that the species of fishes now forming the major share of the catch in Lake Erie are not depleted or in danger of early extinction by intensive fishing. Deason in his manuscript study of the pike-perches of Lake Erie states on p. 89, "It must be concluded on the basis of the statistical data presented that the yellow pike-perch fishery appears to be maintaining itself." About the blue pike fishery he states on p. 353, "The fluctuations of abundance were rather irregular and due to the occurrence of dominant year classes." Van Oosten states on p. 660 of his study on the age and growth of the Lake Erie sheepshead, "there is no evidence that the sheepshead is being depleted in Lake Erie."

The specific factor that may be held responsible for changing Lake Erie from a suitable place for the cisco whitefish, and perch is the increased turbidity of the waters in the western part of the lake. The ciscoes and whitefishes spawned over the clean hard bottom around the islands, and these bottoms are no longer clean. The average of 40 parts per million of suspended matter in the water there has been found to change quickly to more than 200 parts per million with a strong wind. This increase can only be explained as material picked up from the bottom by wave action, and this sediment is carried into the lake by the currents of south shore streams. From an airplane I have seen the brownish streak of Portage River water reaching from Port Clinton at least 5 miles into the lake to a point north of Green Island. Deposits of this stream-borne material cover all hard bottoms around the islands. This same factor of turbidity is doubtless mainly responsible for the elimination of the vegetational areas that are so essential to perch and other fishes.

In 1887 the Michigan Fish Commission obtained spawn for their whitefish hatchery in the St. Clair River. In 1892 the center of operations shifted to the Detroit River opposite Belle Isle, and in the early 1900's most whitefish spawn came from Monroe. At the present time most of it is obtained from the island region, where also conditions are rapidly becoming unfavorable. Agricultural development in the thumb region of Michigan, led to increased silt loads in the St. Clair River in 1890, and silt pollution has become a major factor in all of western Lake Erie. The lotus beds of Monroe are gone. the dense aquatic meadows that once prevailed in Sandusky Bay are a thing of the past, the leafy aquatics described by Pond in 1905 for Maumee Bay have disappeared, and roily waters prevail everywhere.

Perch are known to spawn in and over water plants, and the present dearth of aquatic plants along the south shore may well be the most important factor limiting this species. Yellow pickerel have made their major spawning run for decades into Maumee Bay and up the river. The importance of clean, clear water for that species is too well known to require mention. The total lack of rainfall in the Maumee Valley during the months of April and May, 1926, probably accounts for the successful crop of yellow pickerel produced that year. The silt loads carried into the bay and the lake by the Maumee River during many springs since then may well account for the failure of other year-classes to become abundant and make continuously good fishing for that species.

The fishermen around the island know that they catch pickerel only in the relatively clear water, and when a southwest blow stirs up the bottom the pickerel move out. They also know that saugers show up in their nets when the roily water comes, and we have recently learned that young saugers thrive best in roily water. Three years after a spring when roily water occurs in the shallows during the sauger spawning period, the saugers reach legal length and the catch is heavy.

Besides saugers, the sheepshead, catfish, and carp appear to thrive in turbid water, and these species have increased in the catch as they have increased in abundance and as less hardy species have declined.

The staff members of the Stone Laboratory have concluded that they need to begin with the fundamentals. Studies are being conducted of the influence of sunlight and wind upon the production of primary food organisms in the lake. Sunlight must penetrate the water of the lake or there will be no primary plant crops and secondary crops of fish food organisms, and sunlight cannot penetrate waters thick with silt.

Investigations of this type, together with studies of the interrelationships of all fish species in the lake, particularly with such predator-prey relationships as that of the blue pike and lake shiner, must supply the basis for an effective action program. It now appears that the main problem of maintaining the commercial fisheries industry of Lake Erie may be one of land use and closely associated with the erosion problems of farmers, conservationists, and industrialists. It may be that the protection of forage fishes by increasing the fishing intensity on predator species would be more logical than the constant application of more restrictions.

The improvement of the habitat by reduction in turbidity is the indicated plan of action if the first choice species, whitefishes, cisco, and perch, are ever to be restored in abundance. The practice of soil-conserving methods of farming and the construction of farm ponds and headwater reservoirs along the streams tributary to Lake Erie, and the control of shoreline erosion and bankwash are probably of much greater importance to the commercial fishermen than enforcement of legislative restrictions. The State of Ohio has been conducting this type of program for the past few years and recognizes that in this procedure it has common meeting ground for commercial fishermen, anglers, hunters, farmers, and industrialists.

Effective cooperation of the states and the Canadian province bordering on Lake Erie in continuous programs of studies such as these being carried on by Ohio would make for greater effectiveness and provide the basis for the cooperation between government and industry which must take place.

Changes in the fish faunas of small, isolated, glacial lakes of the type common in Michigan consist of successions of dominant types. These successions result in the elimination of species, indicating that the maximum number of species was present immediately following the separation of the lake from other bodies of water. The entire history of these lakes is one of changes leading towards their gradual extinction, mainly by vegetational encroachment, and there is an apparent correlation between the steps in progress toward the lake's extinction with disappearance from the lake of the various fishes.

That fish species are more selective in their choice of breeding conditions than of food has been emphatically stated by Reighard (1917), and Shelford (1911, p. 38), and this conclusion has also been reached by the writer of this paper as the result of studies through several field seasons on the small lakes of Michigan. The ecological changes of a lake that affect major modifications of breeding conditions for the several species of fishes are those here considered. These modifications may be due to one or several of the following factors: (1) Depth of water, (2) nature of the bottom, (3) presence or absence of vegetation, and (4) oxygen content and concentration of hydrogen-ions in the water.

Substantially quoting Shelford (1913, p. 133), the general tendency of succession in lakes is as follows: The first formation is the bare bottom type, which is locally transformed to the open water type. Vegetation usually begins in protected situations; hence the bays are ecologically oldest. These areas pass rapidly from the third open-lake type (the emerging vegetation association) to the bay conditions. When that stage has been reached the situations that have a lesser degree of protection from waves have reached the second stage. The larger lakes contain, at various points, all of these formations. The lake is reduced in size by filling in along shore and by the deepening of its outlet. The older stages are continually encroaching on the younger. The area of barren shoal is constantly becoming less as the lake fills and the outlet, if it has one, is lowered. Around the shores the development of prairie or forest is usually well begun and one or the other of these types of land vegetation finally displaces the lake.

While the progressive changes briefly described above are taking place, the modifications of the breeding conditions for fishes are as follows:

1. The seasonal fluctuations of lake level, caused by variations of the water table with drought or heavy rains, may be several feet. This may flood the breeding grounds or expose them to the air, in either case rendering them useless.

The sedimentation of organic debris, the slumping of the sides of the basin, and the settling of windblown material to the bottom of the lake tend to shallow the lake at a very considerable rate. In lakes deep enough to become thermally stratified, this results in gradual elimination of the hypolimnion, a replacement of the cold water zone of the lake by a shallow, warm water area that is more productive of fish food, and may even form bedding grounds for certain species of fish, in this way adding to the lake's capacity for fish production.

2. Changes of the character of the bottom are of the utmost importance in modifying the fish breeding grounds. Where sand and gravel are washed out of the bottom, a number of fish species lay their eggs under the remaining larger stones. This bottom may become covered with a layer of humus, of constantly increasing thickness, which eliminates certain species that nested on the clean bottom. Sand-spits and bars protecting bays are formed, and the bottoms of the bays shortly are occupied by a dense mat of water plants. Some fishes will clear away the vegetation and nest on the plant roots or on the solid bottom, but others are deprived of their spawning grounds when this mat is formed over all of the shoals. As the humus layer grows in depth, and the vegetation encroaches more and more from all sides on the open water, the solid bottom becomes increasingly difficult of access and the fishes requiring solid bottom are eliminated. At this stage the only place remaining for fishes to lay their eggs is upon submerged plants, and this site remains until the lake is completely extinguished.

3. The main role of aquatic vegetation is that of providing the organic debris forming the major part of the humus layer that finally covers the bottom. Also the presence of plant stems and roots, while apparently an asset to some of the nest-building species, seems to make nest-building too difficult for other species, even though the bottom material is suitable. And, finally, the stems and leaves of water plants

serve for the attachment of the eggs of species that do not build or excavate nests.

4. With the increase in age of a lake there is a decrease in the oxygen content of its water, accompanied sometimes, but not usually, according to Kurz (1928), by an increased concentration of hydrogen-ions. Shelford, as a result of a series of tests to determine the pH preference of a number of species of fishes, demonstrated that the fishes whose breeding grounds are last eliminated from a lake are those showing preference for the lowest hydrogen-ion concentration. Their elimination sequence is shown in Table I. Miss Hall (Shelford, 1923) found that fertilization and development proceeded equally well in acid, neutral, or basic waters if sufficient oxygen (4cc per liter) was present, but that death or early retardation of development resulted from pH 6.2 when the oxygen content was only 1cc per liter. No pH determinations have been made on fish nests in acid or neutral waters, but Shelford found bass nests in water having a pH of 7.4 and 7.9 and an oxygen content of 70 per cent and 150 per cent saturation on April 2, and July 16, respectively.

The changes in hydrogen-ion concentration that accompany the progression of a lake toward extinction are apparently dependent on the source of water. According to Jewell and Brown (1924), a lake may be entirely surrounded by encroaching vegetation within which the water is highly acid, and the lake water may remain alkaline, probably because the water enters from the bottom rather than from the sides. In such a lake the oxygen content needs to be as great as in acid lakes, as Miss Hall found that with the O_2 reduced from 4cc to 2.9cc per liter, development proceeded better in pH 6.2 to 6.6 than in pH 7.0 to 8.4.

The more important factor appears to be the oxygen content rather than the concentration of hydrogen ions. The amount of oxygen present is limited by: (1) The small surface area, providing minimum opportunity for aeration by wind action, and (2) the oxidation of accumulated organic debris, withdrawing oxygen from the water. The species of fishes remaining because of their ability to deposit eggs on the surfaces of the submerged vegetation are eliminated when the encroaching vegetation reduces the surface area to such an extent that a minimum of aeration takes place and the large amount of organic debris removes what little is taken in.

SUMMARY

1. Two processes, both operating on fishes by changing the conditions under which they live, are described as leading to reduction in

abundance or elimination of species from certain types of water areas.

2. The land-use practices of the past few decades in those areas where the streams tributary to Lake Erie arise have led to erosion and increased the silt loads in those streams. That has, in turn, increased turbidity and brought about the elimination of the dense aquatic meadows that once prevailed in the southwest shore bays.

3. Silt has also been carried into the lake and deposited over the hard bottoms around the islands. Hence the fish species which require clean hard bottom for the successful incubation of their eggs, including the ciscoes and whitefishes, have been greatly reduced in abundance and appear to be approaching extinction.

4. Those which need vegetational areas for spawning and early growth, as the yellow perch, are also showing diminishing numbers.

5. The fishes that require clear water for the production of successful year groups now are characterized by dominant year groups, spawned during drought years when tributary streams were low but clear.

6. Those which tolerate turbid water, as the sauger, sheepshead, catfishes, and carp are thriving under present conditions and in no danger of depletion.

7. The changes in the progress of small isolated glacial lakes towards extinction are of such nature as to modify the conditions required by the fish species for successful breeding.

8. Those of most significance are changes in bottom, kind and abundance of vegetation, and depth of water.

9. Modifications of breeding conditions by silting and vegetating offer sufficient explanation for the elimination of all fish species requiring access to clean bottom for breeding.

10. When all bottom breeding species have been eliminated there remain two or three species that lay their eggs on submerged vegetation.

11. Reduced oxygen content is probably the factor causing elimination of these last few species.

CONCLUSIONS

1. Ecologically induced changes of the fish fauna of lakes, and possibly of streams, involve reduction in the number of species present, though in streams there may be replacement of one fish fauna by another.

2. The fish species that are capable of reproducing under the greatest variety of conditions persist longest, those requiring the most specific conditions being first eliminated.

3. Environmental conditions absolutely control the fish associations present in any body of water. Additions to, or withdrawals from, the fish stocks do not materially modify these associations or their successional trends.

4. Attempts to restore fish species that have been decimated or eliminated should consist of restoration of the habitat conditions that prevailed when those species were thriving.

HABITAT CHANGES AND SPECIES ELIMINATION

Species	Conditions No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Johnny darter	X					
Northern brook silverside	X	X				
Northern smallmouth bass	X	X				
Cisco	X	X				
Blunt-nosed minnow	X	X	X			
Common white sucker	X	X	X			
Pumpkinseed	X	X		X		
Black crappie	X	X	X	X	X	
Largemouth bass	X	X	X	X	X	
Bluegill	X	X	X	X	X	
Northern brown bullhead	X	X	X	X	X	
Yellow perch	X	X	X	X	X	X
Northern pike	X	X	X	X	X	X

Condition No. 1: Sand or gravel bottom; barren, but with stones or clods; and twigs or brambles.

Condition No. 2: Sand or gravel bottom; with stones or clods, and with light humus cover; and with twigs or brambles.

Condition No. 3: Sand or gravel bottom; with stones or clods, and with heavy humus cover; and with twigs or brambles.

Condition No. 4: Sand or gravel bottom; with vegetation cover.

Condition No. 5: Any kind of accessible solid or firm base, with or without vegetation cover, but with twigs or brambles.

Condition No. 6: No accessible firm base; vegetation cover.

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DISCUSSION

MR. WILLIS KING (North Carolina): I have a question I would like to ask each one of these gentlemen. I will address the first to Mr. Surber. When he found such a difference in the growth rate and in the ages of the fishes taken from those streams, I wonder what his ideas were regarding a suitable legal size for the smallmouth bass?

MR. SURBER: I am not so sure whether there should be a size limit on our bass at all. I am inclined to believe that if the legal size were reduced to 9 inches, the average size of the fish would get down so that it would be under 9 inches.

I know, for instance, that the State of Minnesota doesn't have any size limit at all and I do not believe there is any reason for complaint. It certainly keeps the population of game fishes down, so that there is probably a larger number of forage fishes to support the bass present. If bass can grow 10 inches in one season—which they do, readily, where they have an abundance of food—then in such places there shouldn't be any size limit. Certainly a reduction of the legal size to 9 inches in West Virginia would result in the capture of a much larger number of bass, but over how long a period, I don't know.

CHAIRMAN NEEDHAM: Wouldn't the effectiveness of a size limit depend upon two major factors—first of all, the food supply of the bass waters, and second, the intensity of the angling factors controlling the age of the bass at removal? Mr. Hesen, would you like to comment on that?

MR. J. W. HESEN (West Virginia): Yes, I would. We have been confronted with that problem for a number of years. Each spring we have a series of meetings to receive recommendations from the sportsmen of the state with respect to legal sizes, creel limits, open season, etc., and for the last five years now a certain group has come along with the recommendation that the size limit of bass be abolished, and that they be allowed to take a certain number of bass—8, 10, or 15—and when a fisherman got that number he would quit, regardless of the size of the fish. I do not need to tell this group what the joker was. In order to be successful, that system would require that when the angler had the prescribed number of fishes, he would quit fishing. The point is that everyone is not a sportsman. Some fellows would reach in their creels, throw some of the smaller fish away, and start over again.

We believe that system of removing the length restrictions and substituting the creel limit may work in states where there is plenty of water. Mr. Surber mentioned Minnesota—there is a vast water area in Minnesota. In West Virginia we have a very limited water area—only eight-tenths of one per cent of the total area of the state. We rank forty-fifth in water area among all the States of the Union, but we rank eleventh in the sale of fishing licenses. We think if we had only a creel limit, that the result would be a lower fish population rather than better angling.

CHAIRMAN NEEDHAM: I might add to the comments made by Mr. Hesen that California has no size limit on trout, and there are a good many thousands of miles of trout waters in that state. The same thing happens there that Mr. Hesen mentioned—when the angler has caught his limit of 25 (which is the limit in most of the areas of the State now), he will throw away the smaller fishes and try to refill his limit with bigger ones. That is a common defect in the application of a "no size" limit on any game species of fish.

MR. SURBER: In the case of both rivers, probably the greatest source of food have auxiliary streams—small tributaries that will produce minnows, it would be impossible to put enough minnows in the stream, unless you poured them in, to raise the poundage of the bass. If this survey includes only the main stream, without taking into consideration the tributary creeks, I believe the latter should be examined as to their minnow-producing ability.

MR. SURBER: In the case of both rivers, probably the greatest source of food supply in the form of forage fishes comes from strictly river minnows, such as the attractive minnow and the rosy-faced minnow, which occur in very large schools. You don't find those minnows in a tributary stream, nor do you find the hog-mollies. The bulk of the forage fishes are produced right in the river. The attractive and rosy-faced minnows, by the way, are also found not only along the shore but in midstream.

MR. HOGAN: We have found in our ponds that if the water is clear, the bass will be absolutely clean out the pond. Where you have clear water such as you described, I just wondered if the bass haven't cleaned out those streams.

MR. SURBER: I believe they have practically done that in the Cacapon River, though it is a slower process than one might think, because the attractive and rosy-faced minnows are adapted for maintaining themselves in rivers, and in escaping the carnivorous fishes.

MR. HOGAN: There is another point I might touch upon in relation to Dr. Langlois' paper. In northwest Arkansas, where our streams are generally rated as smallmouth bass waters, the anglers are complaining about "jack salmon," as we call them, and largemouth bass coming in. It is obviously on account of the turbidity existing in the streams during the spawning season—bringing about ideal conditions for the reproduction of "jack salmon" and hindering the smallmouth bass.

DR. H. S. SWINGLE (Alabama): In our work with ponds, we get the same condition that Mr. Surber has indicated. We say, "There are too many fish in that pond," and take out part of them, later we drain the pond to see what has happened. We found it was a simple case of overpopulation, with more fish than there was food to support, and that by taking out part of them, the rest could grow. We found that if we took out about half of the fishes, the other half almost doubled in size.

I am wondering why more folks working on streams don't follow the advice given us by Dr. Needham—that is, conduct actual experiments in streams that can be drained. We drain our ponds, so why can't you construct an artificial stream, drain it, and find out just what the results are?

CHAIRMAN NEEDHAM: Thank you, Dr. Swingle, That point is very well taken. In work with both warm and cold water fishes, we haven't really begun to get down to brass tacks yet in terms of production per unit of water area. We have an experimental stream such as I talked about at the Detroit convention. We pump it dry at the end of the experiment to be sure we get a hundred per cent of the fishes there. We made a series of quantitative seine hauls in one pool, and took 15 trout; we ran the experiment through the season, pumped the pool dry, and took out 108 trout. From our quantitative seine hauls we had estimated there were 15; that showed us right there that the only way to get all of the fishes was to pump the pool dry.

DR. R. W. ESCHMEYER (Tennessee): I have this comment to make. We think we understand production in the Norris Reservoir. Forty-four per cent of the fishing there was in June, with 71 per cent of the fishes being caught in the first month of the season. Our bass are growing very fast and we have a suspicion that the heavy June fishing, upsetting the balance between fish and food may have a good bit to do with it. They take out about 100,000 adult game fishes the very first month, and from then on, fishing is poor. Some people think it is because the water is warmer, but it doesn't look as though that is the answer. This is a case in which a size limit is definitely needed, because the balance now favors the food rather than the fish. So while I would not ordinarily advocate size limits at all, on Norris Reservoir, we feel we should have them to keep up the supply so the fishermen can catch some of the fish.

As nearly as we can tell, and we had an extensive tagging program, about a fourth of our game fishes were removed last year. Fishing on the opening day was better than on the second day, and it was better on the second day than on the third day. The first half of June was better than the rest of the year. Apparently the taking of 71 per cent of the fishes in the first month did make a difference in catching the remainder. I would say that is one of the isolated cases where size limits are important to keep up the supply of predators and thus hold down the forage fishes.

MR. CHAS. K. FOX (Pennsylvania): I would like to ask Mr. Surber if there was any seining or catching of fish bait in his experimental areas.

MR. SURBER: Personally, in all my trips on these rivers, I have run across very little of it. I think they get most of their bait minnows from creeks. They often use the creek chub, a hardier fish than we have in the rivers. The attractive minnows and the rosy-faced minnows are of little value as a bait, and I don't believe the blunt-nosed minnow is used at all.

MR. FOX: I think there is no question about it being the fact in Pennsylvania that the best smallmouth bass fishing is in the streams where live bait is hardest to catch; in other words, in the deeper, and swifter waters. In the shallowest streams, where bait can readily be taken, the bass fishing isn't nearly so good, and the average size of the bass isn't so large as it is in the waters where it is hard to capture bait.

A very definite program has been carried on to promote the use of artificial lures in Pennsylvania, and it has been fairly successful, especially with the younger generation. There has also been a restriction as to the taking of bait, with the result that we are getting a slightly larger size of bass, particularly in certain sections where artificial baits are used a great deal.

DR. LANGLOIS: We thought we had a bait problem in Ohio too, Mr. Fox. A requirement was made of bait dealers that they should make a record of all the bait they took, showing the place where they got it. At the end of the year we tabulated all these reports, and found that dealers had removed something like from six to nine million minnows from Ohio waters. We thought that indicated a serious depletion, so we encouraged bait dealers to set up propagation ponds where they could produce bait, and we attempted to set up sanctuaries and restrict the removal of bait.

In Ohio we have a few areas where there are large reservoirs—relics from the old Canal days. People fish for crappies in those reservoirs, and the bulk of minnows used for bait was coming from nearby streams. So we made an investigation of the minnows to find out how seriously they might be depleted. Much to our surprise, we discovered that those streams were not seriously depleted, in spite of what looked like heavy inroads. We concluded that a lot of furor had been raised about something relatively unimportant. While we had advocated producing minnows in bait ponds and planting those minnows in the streams in an attempt to restore what might have been a case of depletion, and had also shown bait dealers how to produce their own bait, we were, frankly, sorry we got into the business at all. We don't think it was as serious a problem as it first seemed.

DR. W. J. K. HARKNESS (Canada): I am not at all satisfied that the question of size limits is as simple as it may appear on the surface. Speaking of smallmouth black bass in Ontario only, the size limit is 10 inches. Mr. Doan, carrying out experiments with spawning bass in Ontario, determined quite definitely that in some of the waters—Georgian Bay and Lake Huron, for example—only 40 per cent or possibly less, of the 10-inch or even 11-inch bass that spawned brought off their brood successfully; whereas bass beyond that size were a hundred per cent successful. So, with respect to those waters, we had a very definite feeling that perhaps we should increase the size limit from 10 to 12 inches. In other waters it apparently wasn't essential to do that, because the 10-inch size limit seemed to meet the requirements and there seemed to be adequate spawning.

In other waters—in small, isolated lakes—there was a tremendous population of bass that never reached the legal limit of 10 inches, where it seemed ridiculous to keep a whole lake full of bass and not allow anyone to take them on account of that 10-inch limit. If the limit in those lakes was reduced to 6 inches, or to any fish at all, there would be an improvement because, as has been demonstrated, if you reduce the population, you get an increased rate of growth in the fish that remain.

It would seem to be advisable to consider each area on the basis of the possible productivity of its individual waters, even if it requires considerable extra effort to enforce the regulations. I think every area, and possibly every individual water body, should be considered as a separate problem.

Just as an indication of the necessity of spawning, I would like to run over, very briefly, the situation existent in Ontario with respect to the bass. Up to 1926 the bass season opened on the 15th of June. Our observations demonstrated clearly that the bass were then in the midst of their guarding activities, and as we found out by experimentation, that is the very easiest time to take bass. You can take practically the whole spawning population with a minimum of effort.

In 1926 the season was changed to the 1st of July. Returns of questionnaires issued by the Fisheries Research Laboratory and the Ontario Department of Fisheries demonstrated that the bass fishing was very low at that time.

In 1928 we were working on the bass in a good many waters, and observed that the population of bass fry was very great. It was a successful spawning season, for some reason. There has been a very definite upward trend in bass fishing in Ontario waters since 1930, attributable only— as far as I can see—to the change in beginning the open season from the 15th of June to the 1st of July.

One other comment I would like to make is with respect to rate of growth. From our study of lake trout in different lakes, we have found that a rapid rate of growth is not always favorable to the maintenance of a good stock of catchable fish. In the Algonquin Park lakes, when the lake trout go into the deep water in the summer, there is a stock of food in some of the lakes consisting of whitefish, round whitefish, and cisco. In other lakes there are absolutely no forage fishes although there are large numbers of plants and crustaceans. In the large lakes with forage fishes, the trout grow fast, and there is a good stock of them. They reach spawning size in three years, and they spawn successfully; the populations are fairly vigorous and maintain themselves.

In the small lakes they do not reach catchable size or at least don't bite until they are 18-20 inches long. They are naturally protected by the fact that they do not rise to a plug; do not take bait. In these small lakes, these fish reach spawning size about the third year before they attain the size at which they will take bait, so they spawn successfully, and with moderate fishing will maintain themselves. We have concluded that it would not be advantageous to increase the food supply by planting deep-water forage fish to increase the rate of growth and bring them into the fishery before they had successfully spawned. Every population of every species should be considered as a unit, and analyzed by fish culturists and fishery biologists, not by administrative laymen.

CHAIRMAN NEEDHAM: The idea which Dr. Harkness proposes might be expressed in terms of individual management, in the light of biological conditions, for each individual body of water. While it may be biologically ideal, I am afraid that we must oftentimes postpone things that are not administratively possible.

Maybe I am wrong, but it strikes me that we will be more apt to manage waters in the future in terms of their similarity in character, and in light of the funds available, rather than in terms of the individual waters, except in those cases where the waters are fished with extreme intensity, or, for some other reason, are of great value to any given state.

A SECOND SEASON OF CREEL CENSUS ON FOUR TENNESSEE VALLEY AUTHORITY RESERVOIRS

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One of the chief objectives of fishery management in the lower TVA reservoirs is the maintenance of a desirable balance in the sport catch between the game, pan, food, and coarse fishes. Therefore, one of the first steps in a management program is to determine the relative abundance of each species in the catch, and the changes in ratio from year to year. In order to obtain this information, a fishing inventory on the lower reservoirs was started in 1939, and continued on an increased scale during 1940. For the current year, fishing records were obtained from the four lower reservoirs, as well as from the tailwater areas below Guntersville, Wheeler, and Wilson Dams.

During 1940 data were obtained on 47,030 man-days of fishing on these waters. These data showed a total catch of 158,590 fishes weighing 154,393 pounds in 234,155 fishing hours, which is at the rate of 0.7 fish per hour.

All the census records, except those from the tailwater below Wilson Dam, were collected by the operators of either privately-owned or TVA leased boat docks. The records below Wilson Dam were procured by CCC enrollees. The census data were collected at 32 docks (8 on Guntersville, 9 on Wheeler, 6 on Wilson, and 9 on Pickwick), and the sample is considered fairly reliable with reference to distribution and coverage. For the individual reservoirs, the number of usable records taken in 1940 were: Guntersville 6,401; Wheeler 19,118; Wilson 3,303; and Pickwick 18,208. According to the fishermen counts made on these reservoirs during the same year (Tarzwell and Miller, 1941), these census returns represent the following percentages of the total fishing for the season: Guntersville 1 per cent, Wheeler 4.5 per cent, Wilson 4.6 per cent, and Pickwick 13 per cent. Methods of taking the census were similar to those employed in 1939 (Eschmeyer and Tarzwell, 1941). A printed card was used for recording the data, including: type of fishing, time consumed, total catch, weight of the catch, and number of each species caught. Records were kept for anglers who did not catch fish, as well as for those who did, and there was no selection of fishermen as the operators attempted to keep a complete record of the fishing at their docks. There was, however, some selection with reference to the type of fishing, because fishing from the docks is mostly by boat. Nevertheless, enough bank fishing reports were obtained to serve as a representative sample of this type of fishing. The data procured made it possible to determine for each type of fishing: the percentage of fishermen who did not catch fish, as well as the average catch; the weight of the average catch; the average time fished, and the fishes caught per hour. In addition, the recording of each species made it possible to ascertain the relative abundance of game, pan, food, and coarse fishes as well as the general tendencies of the fishing. Such data are of value as suggesting regulations needed to protect species that are decreasing or to control those species whose continued increase would be a detriment to sport fishing. Again, the collection of such data over a period of years will show the evolution and trend of the fish population. This is especially true in new waters, such as Wheeler, Pickwick, and Guntersville which were impounded in the springs of successive years—Wheeler in 1937, Pickwick, 1938, and Guntersville, 1939.

The 1940 fishing inventory covered the lower four reservoirs and the tailwater areas below the dams. The tailwater areas are quite similar in that river conditions prevail in them even though they are really parts of the reservoirs. These areas resemble deep turbulent rivers as they have rapid, well-aerated water, deep pools, and many rocks for cover. Fishes seem to be attracted to these localities and in the spring, late summer, and fall there is a great concentration of fishes in them.

Guntersville, Wheeler, Pickwick, and Wilson are all run-of-the-river reservoirs, that is, the flow through them is large in comparison to their storage volume. The first three are similar in that each of them may be divided roughly into three sections: an upper section where the water remains within the original river banks and river conditions prevail; a middle section characterized by wide expanses of shallow water, often separated from the main channel by the natural levee built up along the former river bank; and a lower section characterized by wide areas of deep open water where lake conditions prevail. Wilson Reservoir differs in that almost the whole reservoir corresponds to the lower section of the others. During the summer these reservoirs are subjected to weekly fluctuations coupled with a gradual drawdown for malaria control, and in the winter to a drawdown for flood control. The extent of the winter drawdown varies from one reservoir to another. It is 2 feet in Guntersville, 6 feet in Wheeler 2 to 3 feet in Wilson, and 6 or more feet in Pickwick.

Unfortunately no data are available on the extent of the fishing in the Tennessee River before impoundment. The testimony of older fishermen, however, indicates that the fishing is now far more extensive and that the catch is many times larger than it was before the reservoirs were made. Even in Wilson, which is 16 years old, the catch is reported to be several times larger than it was before impoundment. The heaviest fishing occurs in the middle sections of the reservoirs and in the tailwaters. The river conditions of the upper sections, exclusive of the tailwaters, do not seem to be attractive to game fishes, and the wide open areas of the lower section seem to be avoided by the fishermen, in part at least, because of frequent rough water. With the exception of drum, which are more or less confined to the river section of the reservoirs, the different species of fishes are fairly well dispersed throughout the middle and lower sections. The catch in these areas varies from month to month and changes are rapid with reference to the relative abundance of any one species. Variations during he past two years have not been parallel in the different areas. The catch, the relative abundance of the different species, and the trends or changes in the composition of the catch will be discussed separately for each reservoir and tailwater.

Guntersville Reservoir, which was impounded in January, 1939, has a length of 82 miles, a shoreline of 970 miles, and an area of 66,600 acres when full. In the first summer of impoundment it was not heavily fished and a creel census begun at the TVA boat docks that were opened late in summer resulted in only 386 individual fishing records. These recorded a catch of 2,293 fishes taken at the average rate of 0.9 fish per hour.

In the 1940 inventory, records were procured for 6,401 man-days of fishing. The fishermen took 15,158 fishes weighing 14,271 pounds in 37,065 hours—an average catch of 0.4 fish per hour or 2.4 fishes per individual trip. As shown in Table 1 game fishes represented 77 per cent of the total catch made by boat fishermen. White bass alone comprised half of the catch of these fishermen, indicating that this species has spread and is present in large number throughout the reservoir. In Wheeler and Pickwick Reservoirs, however, the distribution of the white bass is still rather restricted as this species comprised only 2 per cent of the total catch in each of these impoundments during 1940. White and black basses became prominent in the catch in Guntersville Reservoir in late June and early July and continued to be dominant through November. Fishing for these species was extensive until the water level was drawn down in mid-September. After the drawdown, fishing for these and all other species sharply declined.

Carp were dominant in the catch of the bank fishermen, representing 57 per cent of the total take. During the spring months, particularly in May and June, the shores were lined with thousands of people fishing for carp with cane poles and worms. During one day in June more than 500 fishermen were counted on a half-mile fill across South

TABLE 1. SUMMARY OF BOAT AND BANK FISHING IN THE LOWER TVA RESERVOIRS AND THE TAILWATERS BELOW GUNTERSVILLE, WHEELER. AND WILSON DAMS DURING 1940, AND THE RELATIVE ABUNDANCE OF EACH SPECIES EXPRESSED AS A PERCENTAGE OF THE TOTAL CATCH

Locality	Type of fishing	Number of fishermen	Number of fish	Weight of catch in pounds	Per cent fishermen taking no fish	Fish per hour	Average catch	Weight of average catch in pounds	Average hours fished	Percentage of each species in the total catch												
										White bass	Black bass	Sauger	Blue-gill	Crappie	Sunfish	Catfish	Drum	Carp	Buffalo	Dogfish	Others
Guntersville Reservoir	Boat	5,481	10,723	11,365	37	0.3	2.0	2.1	5.6	50	27	....	10	1	1	2	....	8	....	1	....
	Bank	920	4,435	2,906	6	0.7	4.8	3.2	6.8	4	3	....	13	4	3	6	3	57	....	7	....
	Totals	6,401	15,158	14,271	32	0.4	2.4	2.2	5.8	37	20	....	11	2	1	3	1	22	....	3	....
Wheeler Reservoir	Boat	9,552	23,708	27,908	25	0.5	2.5	2.9	5.1	2	18	....	25	37	....	2	1	12	....	1	....
	Bank	1,110	2,634	2,222	25	0.6	2.4	2.0	4.1	....	21	....	27	19	....	3	2	26	....	1	....
	Totals	10,662	26,342	30,130	25	0.5	2.5	2.8	5.0	2	18	....	25	35	....	3	1	14	....	1	....
Pickwick Reservoir	Boat	1,264	5,722	3,454	18	0.8	4.5	2.7	5.6	2	9	....	26	61	....	1	....	1	....	....	....
	Bank	551	1,691	637	21	0.7	3.1	1.2	4.4	1	5	....	72	11	6	1	....	1	....	....	2
	Totals	1,815	7,413	4,091	19	0.8	4.1	2.3	5.2	2	8	....	36	50	1	1	....	1	....	....	1
Guntersville Tailwater	Boat	8,456	22,709	24,023	44	0.5	2.7	2.8	5.7	38	3	5	3	1	....	3	40	7	....	....	....
Wheeler Tailwater	Boat	3,189	26,139	23,488	5	1.4	8.2	7.4	5.7	27	3	3	1	59	....	4	1	1	....	....	....
Wilson Dam Tailwater	Boat	8,222	38,235	40,054	16	1.0	4.7	4.9	4.7	8	4	20	5	17	2	9	27	6	1	....	1
	Bank	8,171	22,348	18,052	29	0.8	2.7	2.2	3.6	4	4	15	8	25	7	9	20	5	1	....	1
	Totals	16,393	60,583	58,097	23	0.9	3.7	3.5	4.1	6	4	18	6	20	4	9	24	6	1	....	1
	Grand totals	47,030	158,590	154,393	25	0.7	3.4	3.3	5.0												

Sauty Creek. Almost everyone caught carp and strings of 50 were common. Practically all the carp taken were from the 1939 hatch and were of a uniform size. This type of fishing dropped off suddenly in early July when a 2-week period of rain began. Because little of this bank fishing was done in the vicinity of the boat docks, few records were obtained while it was at its peak in May and June.

A similar peak in the carp catch occurred on Wheeler Reservoir in 1938 during its second summer of impoundment, but not on so large a scale. Such an occurrence was not observed on Pickwick Reservoir. This may be due in part to the greater spring fluctuations on this reservoir. Fluctuations on Guntersville Reservoir have been limited to 2 feet, and the water level has been kept more constant than in Wheeler and Pickwick Reservoirs. These observations suggest, that water fluctuations during the spawning season may be a means for carp control. Due largely to the abundance of carp, the catch per hour and the average catch for bank fishing was twice as large as that for boat fishing. In addition, only 6 per cent of the bank fishermen failed to catch fish, whereas 37 per cent of the boat fishermen were unsuccessful. Pan and food fishes ranked high in the catch of the bank fishermen, and they took seven times as many rough fishes as the boat fishermen.

Wheeler Reservoir was impounded during the winter of 1936 and 1937. It has a length of 74 miles, a shoreline of more than 1,000 miles, including islands, and an area of approximately 67,000 acres at spillway level. It has an overall fluctuation of 6 feet, plus an additional 2 feet in advance of a flood. A 6-foot drawdown dewaters approximately 17,000 acres. During the summer months the water area is between 57,000 and 60,000 acres.

The 1940 inventory on this reservoir was carried on at the same docks that kept the 1939 records. Excluding the returns from the Guntersville tailwater where conditions are different, records were obtained on 10,662 man-days of fishing. These showed a catch of 26,342 fishes, weighing 30,130 pounds, in 52,799 hours of fishing—a take of 0.5 fish per hour. The average catch was 2.5 fishes, weighing 2.8 pounds. General data on the fishing and the percentage which each species constituted of the total catch are presented in Table 1. According to the census records, fishing was heaviest during May and more than two-thirds of the reports were obtained during the months of April, May, and June. During this period the water was high and was maintained at a fairly constant level, providing conditions that are considered best for fishing by the dock operators and the fishermen, although the catch per hour was higher during some of the other months when these conditions did not prevail. During the months for which a considerable number of census cards were available, the catch per hour did not vary widely.

The catch of white bass remained about the same as in 1939, except at the Spring Creek Dock in the lower part of the reservoir. At this dock this species showed a decided increase and represented 22 per cent of the total take. Its next highest percentage at any dock was 3 per cent at Second Creek, which is also in the lower portion of the reservoir. Eventually this species may become abundant in Wheeler Reservoir. The catch per hour and the average take were similar for bank and boat fishermen, but the average catch for boat fishing averaged one pound heavier. Crappies were about twice as abundant in the catch of the boat fishermen as they were in the creels of the bank fishermen, whereas for the carp the reverse was true. The percentage of anglers failing to take fish was the same for both types of fishing. The average fishing time was 5 hours for boat fishermen and 4.1 hours for bank fishermen.

The recorded catches (Table 2) for Wheeler Reservoir for 1939 and 1940 show a considerable change in the relative abundance of the various species. The total catch of game species dropped from 28 per cent in 1939 to 20 per cent in 1940, while the pan fishes increased from 42 per cent to 60 per cent in the same period. The relative abundance of the food fishes, chiefly catfishes, dropped almost two-thirds. The carp increased from 12 to 14 per cent of the total take, and the dogfish dropped from 3 to 1 per cent. The drum, which also fell off in the catch, is becoming less abundant in the lower and middle portions of the reservoirs where the deposition of silt has destroyed most of the mollusks, upon which it feeds. However, they are still abundant in the tailwater areas and in the upper sections of the reservoirs where there has been little silt deposited in the original river channel.

The decline in the game fish catch was due to a decrease of almost one-third in the take of black bass. Testimony of fishermen also indicates that the 1939 catch of this species was smaller than that of 1938. During 1938, which was the second season of impoundment, bass fishing was better than in any other year. The fishes were small but they were abundant and fishing was good. Since that time they have increased in size but have decreased in numbers. During 1940 more large bass were taken than any year since impoundment. Bass weighing 4 pounds were common in the catch, and those weighing 6 pounds or more ceased to cause special comment. The evidence suggests that there was a large and successful hatch of bass in 1937, the first year of impoundment, when the total fish population was low, but since that time there has been a steady decline in the bass population. Conversely, there has been an increase in crappies, which in 1939 represented only 26 per cent of the total catch, whereas in 1940 they had increased to 35 per cent. In the same period bluegills increased from 16 to 25 per cent of the entire take. A somewhat similar situation was noted by Thompson and Bennett (1938) in Horseshoe Lake in Illinois.

It has been observed that there is a large and successful hatch in all the reservoirs during the first year of impoundment. After a population is built up the young of the game species are reduced in numbers and there is a tendency for the other species, especially the carp, to increase at their expenses, and as indicated in Wilson Reservoir, perhaps at the expense of the pan fishes. Possibly it is this replacement of species, rather than a decrease in productivity, which has brought about the reported decrease of sport fishing in some impoundments. If this is true, commercial fishing for the coarse species should be encouraged. At present netting is prohibited in the Alabama reservoirs.

Wilson Reservoir, impounded in 1924, is the smallest of the lower reservoirs. It is approximately 15 miles long, has a shoreline of 130 miles, and an area of 16,000 acres. It is the deepest of the lower reservoirs and has steep, rocky shores and very little shoal area in comparison with the others. Coarse fishes are abundant, carp having become especially numerous. Fishermen state that in some areas it is possible for a man to catch 100 pounds of carp with a hook and line in two hours. While coarse fishes have increased in numbers, sport fishing, according to the anglers, has declined during the last four years, due possibly to the prohibition of nets in 1936, to heavy sport fishing, or to some unknown cause. Fishing for the pan and game species was very intensive before the other dams were built. Until 1936 fishing was more or less a competition to see who could take the most fish, and it was not uncommon for one man to catch 300 crappies in a day. According to reports, bass were hauled away by truck loads, and before restrictions were placed on the catch of white bass, several hundred would be taken in a day by one fishing party. This heavy removal of sport fishes, especially during the spawning season, coupled with the prohibition of netting, may have allowed the coarse fishes to become so abundant that the population of game and pan fishes is now kept at a low level. At present fishing is not heavy on Wilson Reservoir except at the upper end in the tailwater below Wheeler Dam. Only 114 records were obtained from the lower part of the reservoir. However, this sample (Table 2) shows a catch of 0.5 fish per hour which compares favorably with other areas. Game fishes comprised 3 per cent, pan fishes 71 per cent, and carp 20 per cent of the catch. Most of the pan fishes were crappies. No definite

TABLE 2. COMPARISON OF THE SPORT CATCH IN THE LOWER TVA RESERVOIRS AND THE TAILWATER AREAS BELOW GUNTERSVILLE, WHEELER, AND WILSON DAMS DURING 1939 AND 1940

Locality	Year	Fish per hour	Average catch	Weight average catch	Per cent fishermen taking no fish	Percentage of each species in the total catch: White bass	Black bass	Sauger	Sunfish and bluegill	Crappie	Catfish	Drum	Carp	Dogfish	Others
Guntersville Reservoir	1939	0.9	6.0	3.1	....	3	5	2	35	2	13	2	27	4	7
	1940	0.4	2.4	2.2	32	37	20	....	12	2	3	1	22	3	....
Wheeler Reservoir	1939	0.4	2.6	....	....	3	25	....	16	26	12	2	12	3	1
	1940	0.5	2.5	2.8	25	2	18	....	25	35	3	1	14	1	....
Wilson Reservoir	1940	0.5	2.2	2.6	36	1	2	....	12	59	5	....	20	....	....
Pickwick Reservoir	1939	0.3	1.6	....	....	11	55	....	26	....	6	....	1	....	....
	1940	0.8	4.1	2.3	19	2	8	....	37	50	1	....	1	....	1
Guntersville Dam	1939	....	....	....	....	14	4	54	3	7	1	6	8	1	1
	1940	0.5	2.7	2.8	44	38	3	5	3	1	3	40	7	....	....
Wheeler Dam	1940	1.4	8.2	7.4	5	27	3	3	1	59	4	1	1	....	....
Wilson Dam	1939	0.7	3.1	3.4	....	40	9	5	17	5	7	12	4	....	1
	1940	0.9	3.7	3.5	23	6	4	18	10	20	9	24	6	....	2

conclusions can be drawn, however, from such a small number of records. Fishing at the upper end of the reservoir in the Wheeler Dam tailwater is very good. Game fishes are abundant and the average catch per hour during 1940 was 1.4 fish, which is the best recorded to date in the Tennessee Valley. During late August and early September, in the tailwater below Wheeler Dam, many fishermen caught the daily limit of 15 crappies in an hour. Many large bass were caught, among them being four smallmouth, weighing 8½ to 9 pounds. Wilson Reservoir is now sixteen years old, but it is by no means a "biological desert."

Pickwick Reservoir was impounded in February, 1938; it is 50 miles long, has a shoreline of 496 miles, and an area of 43,000 acres. Flats are not as extensive in this reservoir as they are in Wheeler but the overall fluctuation in water level is greater.

Records of the catch are not available for 1938, the first year of impoundment, but general observations suggest that fishing was not extensive. The fish population density, as indicated by seining and gill-net catches, was low. In 1939 three dock sites were leased and 150 fishing records were obtained late in the season. These are summarized in Table 2. Although definite conclusions cannot be drawn from so few records, it is indicated that game and pan fishes comprised the major portion of the catch. In addition to these records, taken in the reservoir proper, reports were gathered on 16,094 fisherman-days of fishing at the upper end of the reservoir in the Wilson Dam tailwater. Because fishing in the tailwater differs from that in the rest of the impoundment, these returns were not considered to be representative of the fishing on the whole reservoir.

During 1940 the fishing inventory was continued in the tailwater below Wilson Dam and was expanded on the reservoir proper where data were obtained on 1,815 fishing trips. The fishermen who provided these records caught 7,413 fishes, weighing 4,091 pounds, in a total of 9,500 hours—an average of 0.8 fish per hour. The average time spent in fishing was 5.2 hours, and the average daily catch was 4.1 fishes, weighing 2.3 pounds. Nineteen per cent of the anglers failed to catch fish—the lowest percentage of failure recorded in any of the lower reservoirs. The catch per hour and the average catch in Pickwick Reservoir was the highest recorded for any of the reservoirs in 1940. Although the take of game fishes was low, being only 10 per cent of the total, pan fishes were very abundant and the pan and game fishes combined comprised 97 per cent of all taken. Game fishing was good in the spring but as the season advanced, it declined and the catch of pan fishes increased. As in the other reservoirs the game fish catch was poor during the mid-summer months but in general, fishing improved later.

The catch per hour, the average catch, and the average weight of the catch increased, while the percentage of fishermen who failed to catch fish decreased. Fishing at the individual docks varied considerably and there were numerous differences in the catch of boat and bank fishermen. As shown in Table 1, the catch of the boat fishermen averaged larger and weighed more than that of the bank fishermen and the catch per hour was slightly higher. Bank fishermen took more bluegills and sunfishes and fewer crappies and bass. Food and coarse fishes represented only 2 per cent of the total catch, the lowest percentage found in any of the areas sampled. Netting is allowed in that portion of Pickwick Reservoir which is in the States of Mississippi and Tennessee. Sport fishing on Pickwick Reservoir is not so intense as it is on the other reservoirs, the tailwater area below Wilson Dam excepted.

During the past two years, since the impoundment of Guntersville Reservoir, there has been a concentration of fishes and fishermen in the area immediately below Guntersville Dam, and records have been taken at the boat docks in this area. These are summarized in Table 2. Information for 1940 is based on the catch for 8,456 days of fishing. The recorded catch was 22,709 fishes weighing 24,023 pounds, which were taken in 48,493 hours. This is a take of 0.5 fish per hour and an average catch of 2.7 fishes weighing 2.8 pounds. The data collected during 1940 are summarized in Table 1. The percentage of fishermen who did not catch anything was high, averaging 44 per cent for the year. This proportion tended to decrease as the season advanced and varied from 85 per cent in February to 18 per cent in December. In general, with the exception of a sudden rise in July and August when drum were dominant in the catch, there was a gradual increase in the average catch and catch per hour.

White bass were fairly prominent in the catch below Guntersville Dam from March throughout the rest of the season, with the exception of July and August when they dropped to 10 and 2 per cent, respectively, of the total take. In August the pan and game fishes, combined made up only 3 per cent of the total catch, while drum were 90 per cent. During this month there was also an unusually low catch of game fishes below Wilson Dam. Except at Guntersville Reservoir, the catch of game fishes was poor throughout the entire lower reservoir area in July and August. In September the white bass fishing in this tailwater improved to such an extent that white bass dominated the catch and made up 70 per cent of the total take. This species continued to be the most important in the catch during the remainder of the year, and in December it comprised 86 per cent of the total catch. The drum, on the other hand, dropped off sharply and represented only 2 per cent of the catch in September and was entirely absent in the December catch. Although drums were prominent in the take only during the months of June, July, and August, they were so abundant at that time that they comprised 40 per cent of the total catch for the year. Data on the 1940 census in this area are summarized in Table 1.

Changes in the composition of the catch below Guntersville Dam have been rapid and pronounced. In October, 1939, sauger appeared in the catch and quickly became dominant. It maintained this position until March, when it suddenly dropped from 71 to 7 per cent of the total take. After that it disappeared entirely until October, 1940, when it was common during November and December. At no time, however, did it approach its abundance of 1939. In 1940, its place was taken by the white bass, which increased from 14 per cent of the catch in 1939 to 38 per cent in 1940, while the sauger decreased from 54 to 5 per cent of the annual take. Crappies dropped from 7 to 1 per cent of the take while bluegills and sunfishes remained about the same. The change in the catch of black bass was not significant.

The census, started below Wheeler Dam in April, 1940, demonstrated that the fishing in the tailwater of this dam was the best in the lower reservoirs. Records on 3,189 fishermen-days showed a total catch of 26,139 fishes, weighing 23,488 pounds, in 18,146 hours—an average catch per hour of 1.4 fishes. The catch per individual fishing trip was high, averaging 8.2 fishes, weighing 7.4 pounds.

According to the reports of fishermen, the white bass was the most important species in the catch below Wheeler Dam during 1938 and 1939. In 1940, however, while it was still prominent in the catch for each month and made up 27 per cent of the total recorded take, it was exceeded in importance by the white crappie. The latter, which appeared in great numbers in the tailwater areas in August and continued to be abundant until the end of the year, comprised 59 per cent of the recorded catch. During September, when this species was most abundant in the catch and constituted 73 per cent of the total take for the month, the catch was 2.2 fishes per hour, and the average catch per fisherman-day was 11.4 fishes, weighing 8.3 pounds. Data on the census taken in the Wheeler Dam tailwater are given in Table 1.

Information on the fishing and fish catch in the Wilson Dam tailwater is based on records of 16,393 fisherman-days collected by CCC enrollees from Camp TVA-13, under the general supervision of the Biological Readjustment Division. These men worked in two shifts of four men each and were on duty seven days a week until the latter part of August. After that, they worked only on week days. Boat dock operators in the area estimated that these men interviewed about a third of the fishermen. This estimate is confirmed by the periodic fishermen counts made in this area (Tarzwell and Miller, 1941). The reports collected represented 67,663 hours of fishing and a catch of 60,583 fishes, weighing 58,097 pounds. The average catch per fisherman-day was 3.7 fishes, weighing 3.5 pounds and the catch per hour was 0.9 fish. The census data for this area for 1939 and 1940 are summarized in Table 2.

Records were kept for both boat and bank fishing and approximately the same number of each type were obtained. The returns for boat and bank fishing are incorporated in Table 1. As there indicated, boat fishing was considerably better than bank fishing. The average catch for boat fishermen was almost twice as large and weighed more than twice as much as the bank fishermen's catch. Boat anglers took more game fishes and fewer pan fishes, but due to the abundance of drum in the take during July and August they took more food fishes. Sixteen per cent of the boat fishermen and 29 per cent of the bank fishermen were unsuccessful.

The composition of the catch changed from month to month. As in the Guntersville tailwater, the game fish catch dropped sharply in July and was low in August, while the drum increased and dominated the catch. The white bass-sauger relationship observed in the Guntersville tailwater was reversed in the catch below Wilson Dam. In 1939 white bass predominated and comprised 40 per cent of the total take, and this species was still in the ascendency in the catch in January, 1940. In the fall of 1940 it declined and the sauger increased. The sauger increased from 5 per cent of the catch in 1939 to 18 per cent in 1940, and the white bass decreased from 40 to 6 per cent in the same period. Angling below Wilson Dam resembled that below Wheeler Dam in that the crappies showed a sharp increase in abundance during September and remained prominent in the catch until the end of the year. In 1939 crappies represented only 5 per cent of the catch, but in 1940 they made up 20 per cent. The percentage of drum in the take doubled in 1940 because of the large numbers taken during the summer months. Black bass and bluegills declined in the catch. Catfishes were prominent in the take in the spring months.

General observations, and the creel census data for 1939 and 1940, suggest that fishing in these run-of-the-river reservoirs is poor during the first year of impoundment, but that it tends to be excellent in the second season. Apparently a large and successful hatch of game fishes occurs during the first season, providing good fishing in the second year. During the third and fourth years, game fishes, especially bass, have tended to decrease, being gradually replaced by the pan and coarse fishes. Thompson and Bennett (1938, 1939) noted a similar trend in Illinois waters. Although bass have decreased in the catch in Wheeler Reservoir, the average size of those taken has increased each year. This would suggest that the very successful hatch of 1937 has resulted in the production of a dominant age group which has more or less limited the number of young produced in subsequent years. This may result in cycles of abundance of the different game and pan fishes. There are, however, other factors that may intervene to prevent or limit the upswing of the cycle and reduce the percentage of the total population composed of game and pan fishes. In Wilson Reservoir it appears that after some years of intensive fishing for the game and pan species, and protection of the coarse species by the prohibition of netting, there is a tendency for the coarse species, especially the carp, to partly replace not only the game but also the pan species. It may be that it is such a change in the composition of the fish population and not a decrease in productivity that has lead to the belief by some sportsmen and others that impounded waters become a biological desert after a few years.

. Although the game species have decreased somewhat in Wheeler Reservoir, they still constitute a larger proportion of the total catch than they do in most of the natural lakes which have been studied to date. For example, on twelve southern Michigan lakes game fishes comprised only 6 per cent of the total take (Hazzard and Eschmeyer, 1938). and on a northern Michigan lake the game fishes varied from 11 to 16 per cent of the total take over a period of four years (Eschmeyer, 1938). In addition. the fishes from the lower TVA reservoirs averaged larger in size than those from the northern waters for which data are available. The catch from the run-of-the-river reservoirs differed decidedly, however, from the take at Norris, a storage reservoir, located on a tributary stream in the upper portion of the valley. In Norris Reservoir four years after impoundment (1939) bass, walleye, and sauger comprised about 92 per cent of the total catch (Eschmeyer and Tarzwell, 1941), while the catch per hour was less than a third of that in the lower reservoirs in 1940.

In the tailwaters, trends in fishing do not seem to be the same as in the reservoirs proper, possibly because the oldest dam, Wilson, is at the head of one of the newer reservoirs and the newest dam, Guntersville, is at the head of the oldest run-of-the-river reservoir built by TVA. Fishing has been good in the tailwaters almost as soon as they have been created and has continued to be good for a number of years. Changes in the composition of the catch, however, are rapid and extensive. These changes appear to be partly due to migration of some species from the reservoir proper to the tailwater. White bass, sauger, white crappie, and drum are among the species attracted to these areas.

Although changes in the composition of the catch have not been as rapid or as extensive in the reservoirs proper as they have been in the tailwater areas, they are still large enough to be significant from the standpoint of fisheries management. Information on the amount, quality, types, and local concentrations of fishing, as well as some knowledge of the relative abundance of the different species in the catch, and changes in their abundance from year to year are essential to fisheries management. A continuing fishing inventory is needed to obtain this information which is necessary to the formation of adequate regulations for the maintenance of desirable species which are decreasing and are thus in need of protection, and for the control of less valuable or undesirable species which are increasing to the extent that they are displacing the more desirable or valuable species. In these waters the creel census continues to provide information suggesting that a more intensive carp fishery is desirable and that some protection for the game fishes is needed if a suitable balance is to be maintained. The Alabama Department of Conservation has decreed a closed season on game fishes in 1941. If a program for the control of coarse fishes by the permitting of netting can be developed, fishing for game and pan fishes should thereafter be improved.

Methods for the improvement of environmental conditions which are now known, other than those carried out on the watershed for the control of erosion and silting, are not practical in such large waters as the TVA reservoirs. In addition, artificial stocking is so insignificant in comparison to natural reproduction and the total removal, that it cannot be expected to maintain the game species under conditions of heavy fishing and continued competition with the coarse species. Regulation of the fishery is therefore the chief tool available for fisheries management in these reservoirs.

In addition to a knowledge of variations in the relative abundance of the different species, information on the trend of the total fish population and changes in productivity is also of importance for fisheries management in the TVA impoundments. If, as is believed by many, productivity reaches a peak shortly after impoundment and thereafter steadily declines, no system of stocking and regulations can be expected to maintain fishing. If, however, productivity does not inevitably decline, regulations designed to prevent the food and coarse species from becoming excessively abundant would be the chief means for maintaining sport fishing. Fairly reliable estimates of the total yield on three of the lower reservoirs in 1940 have been made from the data furnished by the creel census, the fishermen counts (Tarzwell and Miller, 1941), and the census of commercial fishing (Bryan and Tarzwell, 1941), conducted on these waters during that year. Estimates of the total catch and the average yield per acre for each of these reservoirs are listed in Table 3. In a period of ten months according to these calculations, bank and boat fishermen took somewhat less than 2 million fishes, weighing 1½ million pounds from Wheeler and Pickwick Reservoirs. During this same period the setline fishermen took about 800,000 pounds of food and coarse fishes. It is estimated that in the four lower reservoirs, the 1940 sport catch exceeded 3,500,000 pounds and the commercial catch was considerably more than 1,000,000 pounds.

TABLE 3. ESTIMATED TOTAL CATCH AND YIELD OF FISH PER ACRE IN THE THREE LOWER TVA RESERVOIRS DURING TEN MONTHS OF 1940

Reservoir	Sport catch Number	Sport catch Weight	Commercial catch Weight	Yield per acre Number of sport fishes	Yield per acre Weight of all fishes
Wheeler	1,044,000	992,000	288,000	15.5	19
Wilson	301,000	301,000	207,000	19.0	32
Pickwick	586,000	365,000	304,000	8.5	15.5
Totals	1,931,000	1,588,000	799,000		

The yield per acre varied considerably in the lower three reservoirs. Wilson, the oldest, had the greatest yield, 32 pounds per acre; whereas Pickwick, the newest, had only half that yield, 15.5 pounds per acre. Wheeler Reservoir which was impounded a year before Pickwick had a yield of 19 pounds per acre. These data suggest that the productivity of TVA reservoirs does not decrease as they become older and that they do not become biological deserts at least during the first 16 years of impoundment as indicated by Wilson Reservoir. These data also suggest that although fishing has been considered of minor importance in the general TVA programs, it may eventually become one of the more significant contributions to the welfare of the people of the valley when all the impoundments are completed.

SUMMARY

1. The creel census which was started on the lower TVA reservoirs in 1939 was expanded in 1940. In the latter year records were obtained on 47,030 fishing trips which listed a catch of 158,590 fishes, weighing 154,393 pounds, taken in 234,155 hours which is at the rate of 0.7 fish per hour.

2. Fishing is concentrated near centers of population and in the tailwater areas. In general, fishing was the best in the latter waters. The catch was 0.5 fish per hour below Guntersville Dam, 0.9 below Wilson Dam, and 1.4 below Wheeler Dam, whereas it was 0.4 fish per hour in Guntersville Reservoir, 0.5 in Wheeler Reservoir, and 0.8 in Pickwick Reservoir.

3. In the area, as a whole, 25 per cent of the anglers failed to catch fish. The average time spent fishing was 5 hours, and the average catch was 3.4 fishes, weighing 3.3 pounds. The best fishing in the area

was below Wheeler Dam where only 5 per cent failed to catch fish and the average take was 8.2 fishes, weighing 7.4 pounds.

4. Fishing was heaviest during April, May, and June but in general the catch per hour was largest during the fall months. The catch of game fishes usually falls off during July and August.

5. Game and pan fishes comprised 50 to 98 per cent of the catch of boat fishermen and 27 to 95 per cent of the take of the bank fishermen. Carp and food fishes were more abundant in the catch of the bank fishermen.

6. In the new TVA reservoirs, game fishes are more abundant in the catch than they are in most natural lakes, and the average catch and the catch per hour approaches those of northern lakes for which creel census data are available. The fishes taken in the lower reservoirs during 1940 had an average weight of about one pound.

7. Fishing has been poor during the first season of impoundment but there is evidence of a large and successful hatch of fish during that season.

8. The catch of game fishes is large during the second season of impoundment, but during the third and fourth years game fishes tend to decrease and pan fishes to increase.

9. Changes in the composition of the catch were rapid and pronounced. In some areas drum largely replaced the game and pan fishes in the catch during the summer months. Below Guntersville Dam, white bass increased in the catch and sauger dropped off while the reverse was true below Wilson Dam. Because of these rapid changes, a continuing fishing inventory is needed to furnish information on which to base regulations necessary for the maintenance of sport fishing and for testing the effectiveness of the regulations.

10. Carp have increased in most areas. Observations on the catch of this species suggests that water fluctuation during the spawning season may be an aid in their control.

11. Census data collected to date suggest the desirability of a closed season on bass during the spawning period and of permitting netting for the control of carp.

12. That impoundments do not invariably become "biological deserts," even after sixteen years, is shown by Wilson Reservoir which had the highest yield (32 pounds per acre) of the lower reservoirs during 1940.

ACKNOWLEDGMENTS

An inventory of fishing on these large waters requires the active cooperation of many persons. Thanks are due particularly to the dock operators who devoted much time and effort to keeping a record of the fishing at their docks. Without their cooperation and interest this study would not have been possible. I also wish to thank the Reservoir Property Management Department of TVA for promoting the census at the boat docks, and for collecting and distributing creel census cards. I record my appreciation of the cooperation of CCC Camp TVA No. 13, and its Superintendent James E. Davis in taking the census below Wilson Dam, and also of Game Warden J. B. Tanner of the Alabama Department of Conservation for his effort in extending the scope of the census. I am indebted to Dr. A. H. Wiebe, Chief of the Biological Readjustment Division, TVA, for his interest and encouragement and for making the study possible. I am especially indebted to Mrs. Vera Tarzwell for tabulating the creel census data and aiding in the prepaiation of the tables.

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DISCUSSION

CHAIRMAN NEEDHAM: Dr. Langlois, would you care to make any comment?

DR. THOMAS H. LANGLOIS (Ohio): I would be glad to do so.

These figures of production are very interesting and impressive. We have been watching productivity at some of our Ohio reservoirs with a great deal of interest. From many of them, suggestions keep coming that something needs to be done about increasing the average size of the fish. For instance, reports indicate that there is a multitude of 5-½-inch bluegills coming out of one of those reservoirs, but very few legal-sized fish. It is obvious to us that what is really called for is more intensive prosecution of that fishery; a heavier withdrawal from that stock would surely result in a yield of more satisfactory-sized fishes.

We have operated our own nets in some of the Ohio reservoirs, and transferred the fish to other waters. This has enabled us to understand what is happening to the fishes in those water areas. We have taken measurements each year, for several years, and kept a pretty close record of the average size of the fishes produced. Although at first we were a little afraid we were going to "kill the goose that laid the golden egg," we discovered that the harder we fished those reservoirs, the more satisfactory crops we got from them. Not only did the number of fish continue to be high each year, but the average size increased.

I am just wondering if the TVA reservoirs that Dr. Tarzwell has described, with their present intensity of fishing are yielding a satisfactory size of product, or if, possibly, something should be done to increase the fishing intensity as a step toward increasing the average size of the product.

DR. TARZWELL: Since October it has been called to my attention that four bass were caught below Wheeler Dam that weighed between 8½ and 9 pounds. One of them was four years old. As I said, the average weight of all the fish taken was about a pound—that includes bluegills, crappies, everything taken. The growth and increase of weight in the bass were very good. In one year they averaged 11 to 13 inches; in two years, 13 to 16 inches; in three years, 17 to 19 inches. I believe that is a fairly good growth rate.

DR. R. W. ESCHMEYER (Tennessee): I have the figures for Norris Reservoir on opening day, the weights being determined by our own personnel. The average bass taken weighed 1.32 pounds; the average crappie a little more than that; the average sauger, over a pound; and the average wall-eye, more than 2½ pounds. So we are not worried about stunted fish at Norris as yet.

DR. LANGLOIS: Always the talk is of restrictions—what should be done to hold down the size of the fish, or the number of fish that are being caught, etc. Whenever restrictions are adopted a policing problem is created. It seems to me that biologists should recognize that money can be spent only once. If it si spent on policing, it can't be spent in making more fish, creating new reservoirs, correcting pollution, or doing things that actually make for fish production and better fishing. So far as Ohio is concerned, I do not believe that our fishing would be harmed a bit if we removed every restriction except, possibly, that on dynamiting. Such action would ease the enforcing problem tremendously, and leave us more money for constructive enterprises.

MR. JOE HOGAN (Arkansas): I wonder if the fluctuations in your flood control reservoirs are more injurious—shall we say?—to the commercial fishes or the game fishes? Is there a point to which a reservoir could be fluctuated so as to hold down the carp and allow the game fishes to increase?

DR. TARZWELL: We don't know for sure. During the last spawning season the Water Control Board cooperated with us by attempting to maintain a constant water level in the pools, and they more or less succeeded in doing it. The carp spawn a short time before the bass and then return to the backwaters.

At Wheeler Reservoir the slope of the bottom is very gentle. A drop of 6 feet uncovers about 17,000 acres. When the carp are spawning, if we can get a 3-foot draw-down (which is rapid within a day), we could strand a good many eggs. I believe that might be successful as a control measure. If possible, we hope to try the experiment, but we try to keep fluctuations to a minimum during the bass spawning season.

With regard to regulations, we should like to see netting of coarse species allowed. We don't know for sure whether it would stop the shift toward preponderance of those fishes, but trying something is better than doing nothing, and the proportion of bass have been going down. They have been getting larger and fewer each year. We would like also to try a closed season on bass; if it doesn't work, we can take it off. I don't believe that one is needed for crappies and bluegills, as they seem to take care of themselves under present arrangements, but we might try it.

If the productivity of these lakes doesn't decrease—and from what evidence we have to date it won't—then I think we would be neglecting our duty if we didn't try to do something to prevent this shift toward the coarse species. The fishermen want the bass and the better species, and as good management that is what we should try to give them.

MR. L. D. LAMB (Texas): I can give you a little information on the control of some of our fishes by the fluctuation of water levels.

Dr. Wiebe is familiar with one of our lakes—that supplies water for the City of Dallas. About three or four years ago officials, in order to facilitate the handling of reservoirs decided rather suddenly, that they would lower the level of the lake, which they did by nine feet. That exposed a great deal of bottom, and in one section of about a hundred yards I observed 27 nice, large bass nests and several sunfish nests. As a result of that one abrupt lowering of the level, the fishing was unusually poor in the succeeding years, up until the past year.

That condition also prevailed with respect to the commercial catches. We don't use nets—that is, we hope we don't—on that lake, although every once in a while we find we do. Our commercial catch on all types had fallen off up until this past year, when it began to come back. The catch of bass has been better, that of crappie a great deal better, and the whitefish catch has assumed a prominence which we were afraid would never happen again.

We find that the white bass has definitely established itself in a number of our lakes, and has practically taken over some of them, much to the regret of the dyed-in-the-wool black bass fishermen. However, many people like to fish for the white bass, and I think it is likely to be the salvation of some of the reservoir fishing in our state.

DR. A. H. WIEBE (Tennessee): Mr. Lamb, I take back all I have ever said against the striped bass, because we find it an extremely convenient thing to fall back on if people want to catch fish. We are rather happy that we have that species in our reservoirs.

I would like to point out one or two things to you gentlemen. The TVA will, in the near future, have created approximately 600,000 acres of water, less the included area of the rivers that were dammed—a very small percentage. We are inclined to think that the fishing possibilities have been multiplied, perhaps, in the same proportion—or more—than the water area has been increased.

As you have seen from Dr. Tarzwell's paper we are trying to measure the intensity of fishing, and also to measure the catch. One thing that handicaps our work is the fact that we have too little data covering the period prior to impoundment. Of course we have many generalized reports from fishermen regarding conditions at that time, but we have no statistics. So this year we have stressed the amount of fish taken, the number of people fishing, etc. One reason for that has been to show the officers of the Tennessee Valley Authority that they have created something of great benefit to the region—an asset which, considering all of the recreational possibilities, may over-shadow some of the primary objectives for which these dams were built.

I told the General Manager last week that we were entirely conservative if we estimated that the Tennessee River, after the impoundments are completed, would yield an annual crop of fish totalling around 15,000,000 pounds.

As you know, the Authority has been criticized for taking land permanently out of production through flooding. Perhaps the protein and vitamin content of the fish in these reservoirs might, in some measure, compensate for the loss in acreage of corn. One question we would like to answer by our humble efforts is whether "biological deserts" are created by impoundments.

MR. C. N. FEAST (Colorado): In Colorado we are primarily interested in trout, so should not comment on your subject of warm water fishes. We have a few places where such fishes do well, but primarily it is a trout state.

I would like, however, to mention the results of one or two studies we made last summer that are pertinent to the discussion. We made quite an intensive creel census on the South San Juan River. We interviewed every fisherman seen on a 20-mile stretch of the River and we had the past three years' planting records. Out of about 375,000 trout planted in the last three years, which last year should have been two or three years of age, averaging from 2½ to 3½ inches in length, the take of untagged fishes was less than 1 per cent of the number of fishes that had been planted in the prior three years. At the same time we planted 5,000 tagged fishes which were distributed uniformly and periodically. We recorded where they were planted and where taken out, and we got a 40 per cent recovery of the tagged legal-sized fishes.

The curve for the untagged fishes was practically identical with that for the tagged fishes taken out. It was so nearly identical, at least, that we could adopt an integral calculus formula to determine the population, and, considering the results for three major streams in Colorado, I would say that we must have restrictions, as some of the fishermen are pretty selfish.

On one stream less than one-third of 1 per cent of the fishermen caught more than one-third of the fish. The other 99 2/3 per cent of the fishermen caught the other two-thirds, which means that about 12 fishermen out of 5,000 are catching one-third of our fish.

We must consider those 12 fishermen and their habits of fishing day after day. We feel that they must be restricted, considering that we have a 2-million-dollar demand for legal-sized trout in Colorado, and only $120,000 to spend in satisfying it.

DR. W. J. K. HARKNESS (Canada): I would like to ask Dr. Langlois if he would extend his idea of abolishing control of fishing to the spawning time of all species and make the season wide open at all times for all sizes.

DR. LANGLOIS: Well, maybe it sounds radical, but in general I think that I would. As a matter of fact, most of the evidence at hand indicates an overproduction of young fish, and early destruction of a great majority of the young that are produced. It seems probable that a greatly reduced amount of spawning would be enough to maintain the supply.

A comparatively limited number of breeders can produce enough young to fill a large area if the vacancy is there for the young fishes. This thought also mitigates the charges made against the carp, for instance. I have seen carp go swinging down over bluegill beds and crappie beds, and without doubt they destroy a great many eggs. I think it is a good thing, however, as the reduction in the number of young results in a better average size in the adults.

Except in a few cases that could possibly be covered by sanctuaries, I should say the spawning season is when the fishermen have the urge to catch them, and I'm blessed if I think it would hurt a great deal if they were allowed to catch them.

It has always seemed to me that administration is an integral part of fish culture. It is not a thing that we can brush aside and should be considered as one of the unit items of a fishing program.

Now I don't know whether there should be an open or a closed season, but I don't think we should have any generalizations. I think that whatever we do, it should be on the basis of knowledge of the particular body of water concerned.

DR. H. S. DAVIS (West Virginia): I want to make it perfectly clear that what I had to say in my paper applied only to trout streams. These are in a category by themselves, and I maintain that you can't manage heavily-fished trout streams without proper restrictions. Anybody in the East—and it is also more or less true now in the West—knows that the trout stream thrown open to unrestricted fishing will be cleaned out in a week or less. From the administrative standpoint, and from the standpoint of legal restrictions, the trout stream is in an entirely different category than the reservoir and other habitats of warm-water fishes.

CHAIRMAN NEEDHAM: With respect to Dr. Harkness' contention for individual management for each water, I must say that this is a matter which is causing a lot of difficulty in state fish and game departments, and in the federal services as well. The question is "How far can we go, administratively, in putting into effect the biological findings of the regional biologists?"

The custom years ago was to guess at the value of a measure and to put it into effect, in the hope that it might work. Now we are attempting to replace guesswork with facts, but I think there is still too much administration and not enough perspiration in some of this wildlife work.

DR. WIEBE: Coming back to Dr. Davis' remarks I think that they apply equally well to some bass streams. I think that they apply to Norris Reservoir and to Wilson Reservoir. Wilson Reservoir has very limited spawning areas, and they are apparently very well known to some of the local "sportsmen." With fishing permitted at spawning time, serious depletion can easily result and that is exactly what is happening on Wilson Reservoir.

The Secretary-Treasurer of the sportsmen's club wanted to know why it wasn't all right to spear the bass off in Wilson Reservoir. He wanted to know why it wasn't all right for them to go out and gig the fish off of their nests. That will indicate why I put the term sportsman in quotation marks.

DR. SWINGLE: I would suggest to Dr. Wiebe that he try to get some arrangement whereby they can close those little areas where the bass spawn in the reservoirs, rather than ask that the entire State of Alabama to be closed during the spawning season.

DR. WIEBE: We have not asked that.

TECHNICAL SESSION

TUESDAY AFTERNOON—FEBRUARY 18

Chairman: CHARLES E. JACKSON

Assistant Director, U. S. Fish and Wildlife Service, Washington, D. C.

Discussion Leaders:

DR. ALLEN M. PEARSON, *Leader, Cooperative Wildlife Research Unit, Auburn, Alabama.*

DR. K. BONHAM, *Texas A. & M. College, College Station, Texas.*

DR. H. S. DAVIS, *U. S. Fish and Wildlife Service, Leetown, W. Va.*

FISHERIES PROBLEMS IN IMPOUNDED WATERS

THE GROWTH OF GAME FISHES IN NORRIS RESERVOIR DURING THE FIRST FIVE YEARS OF IMPOUNDMENT

DR. R. W. ESCHMEYER AND ALDEN M. JONES
Tennessee Valley Authority, Norris, Tenn.

A study of the growth of game fishes is one of a number of inquiries on Norris Reservoir directed toward learning whether or not this reservoir will become a "biological desert," and what changes in the limnology and in the fish population accompany, or are responsible for, the decline, should it occur. In The Lake of the Ozarks, formed in 1929, the quality of the fishery has decidedly declined and this has been accompanied by a decrease in the growth of the game fishes (Weyer, 1940). A similar trend has been noted in other impoundments. Whether or not it will occur on Norris Reservoir is the problem, and, information collected during these early years will form a basis for later decision.

The rate of growth of the game fishes has been determined for 1938, 1939, and 1940 (by use of the scale method), and has been calculated for 1936 and 1937, the first two years of impoundment. This paper is intended primarily to show the changes in growth of the fishes for the first five years of impoundment. The number of specimens used for the study was:

Species[1]	Growth 1938	1939	1940
Largemouth bass	185	544	274
Smallmouth bass	97	168	213
Kentucky bass	51	70	92
Walleye	25	61	53
Sauger	2	44	70
Black crappie	5	108	176
Totals	365	995	878

[1]The black crappie, generally placed in the "pan fish" group, is included because it grows rapidly, attains a large size, and is frequently taken on artificial bait (plugs).

A description of the methods used in this study, as well as a description of Norris Reservoir, is given in an earlier paper (Eschmeyer, 1940). Growth determinations for 1938 were made by the senior author and for the next two years by the junior author. The scales used were all collected by our own personnel.

Scales for the 1939 and 1940 growth determinations were collected at the boat docks. Some fishes were alive when measured, others had died, and some, taken chiefly from the larger craft, were on ice. No allowances were made for shrinkage. Lengths of tagged fishes recaptured by fishermen at the opening of the season tended to be several millimeters shorter than measurements of the same fish at the time of tagging, a few weeks earlier. These differences cannot be attributed to differences in measuring because they were noted for fishes measured with the same equipment by various individuals. The measurements therefore show that in some instances a shrinkage had occurred in the interval between tagging and recapture, and suggest that the lengths for the 1939 and 1940 fishes are slightly lower than actual lengths. The error involved, however, is small.

The study is based on the assumption that the scale method is valid. With some exceptions the annuli on these young, fast-growing fishes were located rather easily and it is believed that the readings were essentially correct. Calculations made by the junior author for the 1938 growth corresponded with actual growth determinations made by the senior author, suggesting that readings made by the two were similar. The more difficult scales were examined by both authors.

Information was obtained on the accuracy of the scale reading and, because similar data are few, it is discussed here in some detail. In April and May of 1940, 1,010 fishes were tagged for another study (Eschmeyer, ms.) and scales were taken from some of them. Scale samples were collected from six specimens both at the time of tagging and of recapture. A comparison of the data (Table 1) indicates that in all six specimens the ages corresponded for the two readings, and that the calculated lengths for the first and second years of life were very similar, varying only a few millimeters. Except for one fish

TABLE 1. AGE DETERMINATION AND CALCULATED LENGTHS FOR SIX BASS AT TIME OF TAGGING AND AT TIME OF RECAPTURE, NORRIS RESERVOIR.

Tag number	Species	Age	Date	Number of scales[1]	Measured length		Calculated lengths					
							I		II		III	
					Standard	Total	Standard	Total	Standard	Total	Standard	Total
1551(Recaptured)	Largemouth bass	III	4-10-40	3	316	385	124	152	256	312	......	......
		III	5-30	4	312	374	117	139	247	294	......	......
1579(Recaptured)	Largemouth bass	III	4-17	2	308	375	135	165	252	307	......	......
		III	5-30	3	312	378	143	173	254	308	......	......
361(Recaptured)	Largemouth bass	III	4-25	2	309	366	167	198	256	303	......	......
		III	6-19	3	300	360	168	202	255	306	......	......
213(Recaptured)	Smallmouth bass	IV	4-18	4	347	417	109	131	216	260	285	343
		IV	6-22	4	334	402	111	135	209	251	273	328
263(Recaptured)	Smallmouth bass	II	4-25	2	292	356	165	201	......	......	......	......
		II	10-27	2	310	381	158	194	281	346	......	......
329(Recaptured)	Kentucky bass	II	4-19	3	269	315	180	211	......	......	......	......
		II	5-30	4	259	311	181	216	......	......	......	......

[1]Measurements were made for the number of scales indicated, and calculated lengths are averages for these scales.

(Tag 263) there had been little or no growth by the time of recapture, and the shrinkage mentioned above was noted in four of the six specimens.

Four bass, taken at or near the close of the growing season (after mid-October), showed increases in total length of only 2, 12, 17, and 25 millimeters, respectively, suggesting that these jaw-tagged fishes grew less rapidly than the average fish in Norris Reservoir. Any general conclusions on the growth of fishes in the reservoir would be of little value if based on data from tagged fish only, for the jaw tags seemingly interfered with normal growth.

Below are shown the growth rate determinations, by species, for 1939 and 1940, together with the growth curves for the first five years (1936 to 1940, inclusive). The scales used to determine the 1939 growth were collected in April, May, and mid-June of 1940, and those used for the 1940 growth were taken in October and November of the same year. Data presented in this paper show that nearly all of the 1940 growth was made between these two periods.

The scale samples were taken from two general areas of the reservoir: that portion of the reservoir served by Norris Dock, near Norris Dam, and that served by Clinch River Bridge and Cedar Grove Docks, located on the Clinch River arm of the reservoir about 30 miles by water above the dam. The samples were taken from these two widely separated areas to determine whether or not the growth differed in various localities within the reservoir. A comparison of the growth for October and November of 1940 for the two areas shows that fishes of the same age and species tended to be of similar size (Table 2). Because growth was found to be similar for the two widely separated portions of the reservoir, samples from both areas were combined in the growth determinations.

TABLE 2. AVERAGE LENGTH OF FISHES TAKEN FROM TWO GENERALLY WIDELY SEPARATED LOCALITIES IN NORRIS RESERVOIR, OCTOBER AND NOVEMBER, 1940

Species	Age[1]	Near Norris Dam			Upper Clinch River Arm		
		Number of specimens	Standard length (millimeters)	Total length (inches)	Number of specimens	Standard length (millimeters)	Total length (inches)
Largemouth bass	III	23	294	13.9	3	341	15.6
	IV	18	335	15.7	3	283	13.1
Smallmouth bass	III	35	294	14.1	7	284	13.1
	IV	58	346	16.6	2	361	16.8
Kentucky bass	III	16	270	12.8	16	269	12.7
	IV	17	313	14.8	5	317	14.6
Sauger	III	21	340	15.7	14	331	15.4

[1]Ages as recorded include 1940 growing season which was completed, or almost com pleted, at the time the scales were collected.

The largemouth bass is the game species most commonly caught in Norris Reservoir and ranks first in importance. In 1938 the computed average length of 2-year-old fish was 13.0 inches; in 1939 the average for fish of the same age was 12.6 inches; and in 1940 the average was 11.9 inches. This suggests that the rate of growth of this age group has declined.

The above data are for fish of 11 inches or more in length, i.e., for legal-sized fish only and therefore fail to reveal one important change which seems to be occurring. Apparently an increasing number of bass are failing to attain the legal length by the end of the second growing season. It seems safe to conclude that in 1938 a majority of the 2-year-old largemouth bass were available to the fishermen, whereas within a very few years only a small percentage of this group will have attained the minimum legal length, if the trend toward slower growth continues. In fact, that condition probably exists now (1940).

Growth of the largemouth bass in Norris Reservoir is still much more rapid than growth of this species in some Wisconsin and Michigan waters (Eschmeyer, 1940), and is far more rapid than in The Lake of the Ozarks (Weyer, 1940)..

Figure 1, based on data in Table 3, shows that the fish hatched in 1937 appeared to grow more rapidly than those born during the first year of impoundment.

This may be attributed partly to a possible increase in food by 1937, and partly to the presence of a large group of predators (born 1936) that influenced the survival of the fish born in 1937. The hatches of fishes in 1936 and in 1937 were probably similar in size, because approximately the same amount of brood stock was present both years.

TABLE 3. LENGTH, BY YEARS, OF LARGEMOUTH BASS FROM NORRIS RESERVOIR. TOTAL LENGTH IN INCHES, STANDARD LENGTHS IN MILLIMETERS[1]

Years	Age group	Number of specimens	Standard length	Total length	Calculated lengths by years: I Standard	I Total	II Standard	II Total	III Standard	III Total
1938[2]	III	4	299	*14.1*	144	*6.9*	214	*10.3*	......	......
	II	132	272	*13.0*	148	*7.0*	......	......	......	......
	I	49	170	*8.2*	......	......	......	......	......	......
1939	III	319	314	*14.8*	148	7.1	266	12.6	......	......
	II	215	265	*12.6*	158	7.5	......	......	......	......
1940	IV	19	335	*15.7*	123	5.7	257	12.1	313	14.6
	III	28	297	*14.0*	129	6.1	238	11.3	......	......
	II	5	256	*12.0*	133	*6.3*	......	......	......	......
	I[3]	71	99	*4.8*	......	......	......	......	......	......

[1]Italic Figures are those used in preparing Figure 1.
[2]In this and later tables data for 1938 (Eschmeyer, 1940) are included for comparison.
[3]Fish taken from sinkholes

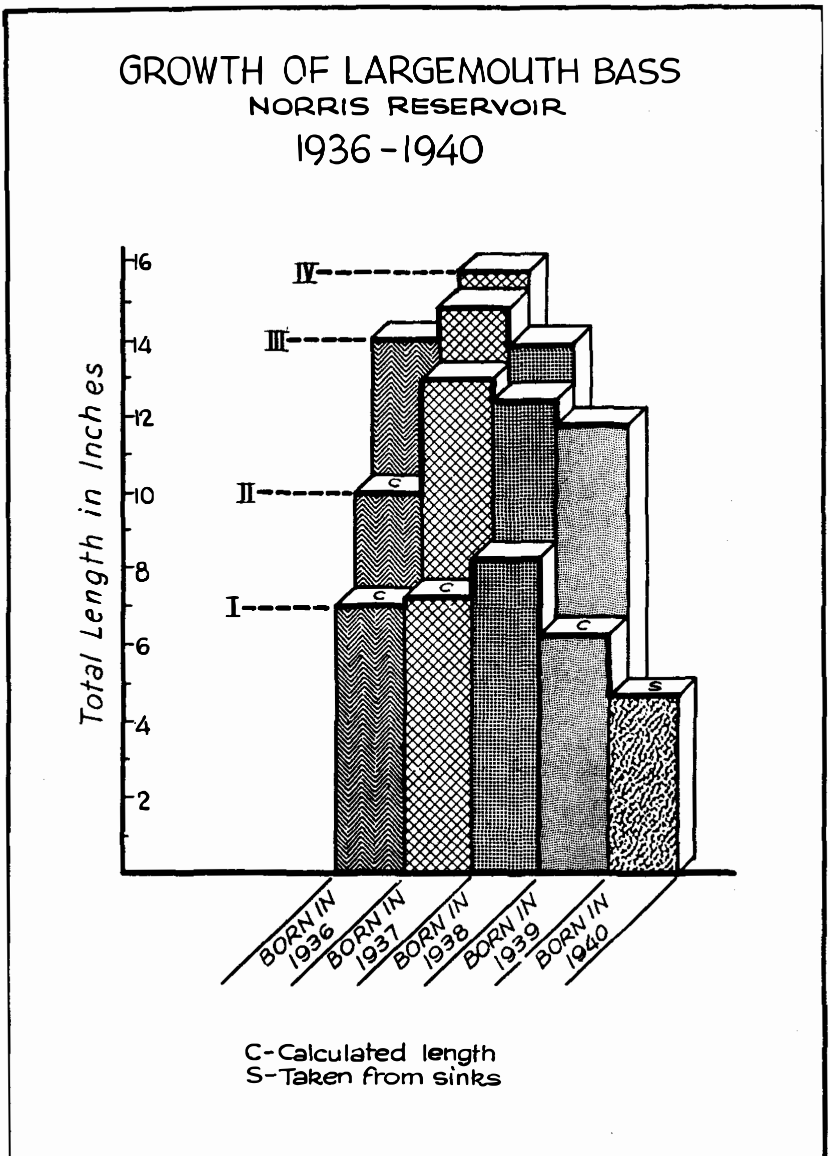
GROWTH OF LARGEMOUTH BASS
NORRIS RESERVOIR
1936-1940
Total Length in Inches
16
14
12
10
8
6
4
2
IV
III
II
I
C
S
BORN IN 1936
BORN IN 1937
BORN IN 1938
BORN IN 1939
BORN IN 1940
C-Calculated length
S-Taken from sinks

Figure 1

In 1936, however, there were very few predators of the young bass while in succeeding years the number of predators of the young was undoubtedly large. Largemouth bass hatched in 1939 were smaller in both their first and second years (1939 and 1940) than fish born the previous year, and a definite trend toward slower growth may be in progress. This decline in the rate of growth may be due to an increase in total population, to a decrease in food, or to both.

The least reliable data are those for the 1-year-old fish; those taken with plugs tend to be the largest of the age group; those taken by our personnel on small minnows in brush shelters seem to be intermediate; and those recovered from the sinkholes in which they were trapped by receding waters are apparently the smallest. The taking of a representative sample of 1-year-old fish is almost an impossibility. The yearlings from the sinkholes in 1940 averaged smaller than those of the preceding year. Measurements of fish taken from these sinks are not representative of the age group, but comparisons of them from year to year probably offers the best index of the growth of the young fish.

The trend of growth for the smallmouth bass closely parallels that for the largemouth. Fish born in 1937, the second year of impoundment, were of a larger average size for each age group than were those hatched in 1936 or in the years following 1937.

By 1940 few of the 2-year-old fish had attained legal length (11 inches). Of the fish examined at the docks in October and November, 1940, 60 were 4-year-olds, 42 were 3-year-olds, and 3 were 2-year-olds. Of sixteen 2-year-olds taken by our staff while fishing for crappies, only one was of legal length. The figures used in Table 4 for 1940 2-year-olds represent a simple average of the two groups.

TABLE 4. LENGTH, BY YEARS, OF SMALLMOUTH BASS FROM NORRIS RESERVOIR. TOTAL LENGTH IN INCHES, STANDARD LENGTH IN MILLIMETERS[1]

Year	Age group	Number of specimens	Standard length	Total length	Calculated lengths by years					
					I		III		II	
					Standard	Total	Standard	Total	Standard	Total
1938	IV	4	367	17.6	73	3.5	203	10.7	323	15.5
	III	72	304	*14.5*	112	*5.4*	224	*10.9*	......	......
	II	18	260	*12.5*	144	*7.0*	......	......	......	......
	I	3	136	*6.6*	......	......	......	......	......	......
1939	IV	62	342	*16.4*	100	4.8	207	9.9	290	13.9
	III	71	308	*14.8*	130	6.3	234	11.2	......	......
	II	34	251	*12.0*	112	5.3	......	......	......	......
1940	IV	60	346	*16.6*	130	6.2	237	11.4	307	14.7
	III	42	293	*13.9*	103	4.9	203	9.7	......	......
	II[2]	19	179	*8.7*	96	*4.7*	......	......	......	......

[1]Italic figures are those used in preparing Figure 2.
[2]Average for both legal and under-sized fish (see text).

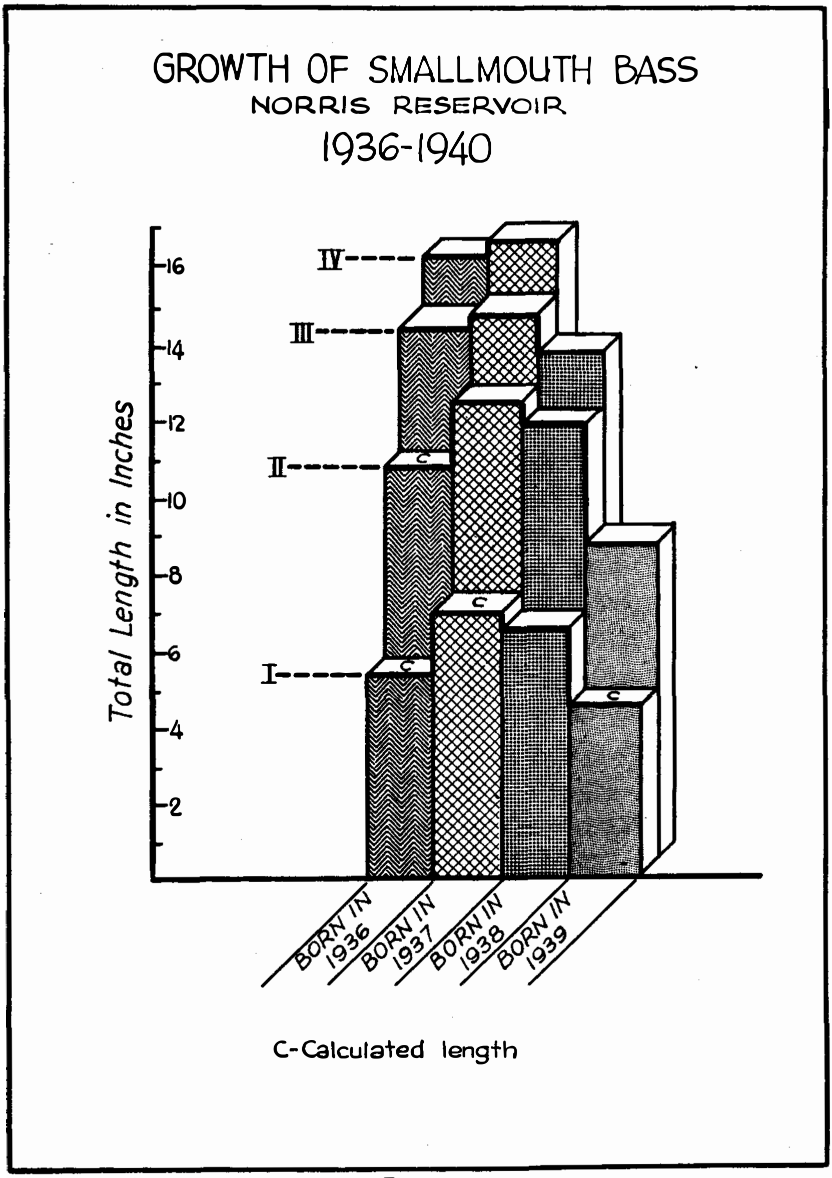
GROWTH OF SMALLMOUTH BASS
NORRIS RESERVOIR
1936-1940
Total Length in Inches
16
14
12
10
8
6
4
2
IV
III
II
I
C
C
C
C
BORN IN 1936
BORN IN 1937
BORN IN 1938
BORN IN 1939
C-Calculated length

Figure 2

The trend in growth is definitely downward, but the fish are still growing much more rapidly than in other waters (Wisconsin and Ontario) for which date on the growth of smallmouth bass are available.

In Norris Reservoir the smallmouth bass is second to the largemouth in the game fish catch, and represents a very substantial part of the total catch. In 1940 the catch consisted of about 54 per cent largemouth, 41 per cent smallmouth, and 5 per cent Kentucky bass. After five years of impoundment the smallmouth bass is still maintaining itself (without stocking) in Norris Reservoir, and there is little reason to believe that it will be replaced by the largemouth bass even though it is considered to be largely a stream fish in the southern part of its range.

Growth trends for the Kentucky bass differ somewhat from those for the other two species. The group hatched in 1937 was not the largest in average size, and the decline in rate of growth was not appreciable for the several age groups. For several groups the number of specimens was inadequate and may not reflect the true trend. No information is available on the growth of this species from other waters and comparisons therefore cannot be made; however, the Kentucky bass appears to be making a rapid growth in Norris Reservoir.

As with the smallmouth, the scarcity of 2-year-old Kentucky bass in the catch suggests that few of them now attain legal length by the end of the second growing season. The lengths and trend in size for the several years are shown in Table 5 and Figure 3.

TABLE 5. LENGTH, BY YEARS, OF THE KENTCKY BASS FROM NORRIS RESERVOIR. TOTAL LENGTH IN INCHES, STANDARD LENGTHS IN MILLIMETERS[1]

					Calculated lengths by years					
					I		II		III	
Year	Age group	Number of pecimens	Standard length	Total length	Standard	Total	Standard	Total	Standard	Total
1938	III	30	292	*14.0*	120	*5.9*	237	*11.5*	......	......
	II	16	238	*11.5*	145	*7.0*	......	......	......	......
	I	3	125	*6.1*	......	......	......	......	......	......
1939	IV	23	310	*14.7*	100	4.7	217	10.3	277	13.2
	III	40	273	*12.9*	102	4.9	207	9.9	......	......
	II	7	246	*11.8*	151	7.2	......	......	......	......
1940	V[2]	8	340	*16.0*	89	4.2	208	9.8	281	13.2
	IV	21	314	*14.7*	105	4.9	211	9.9	278	13.0
	III	32	270	*12.8*	98	4.6	198	9.3	......	......
	II	2	246	*11.3*	158	*7.2*	......	......	......	......

[1]Italic figures are those used in preparing Figure 3.
[2]Calculations for fourth year were 318 millimeters standard and 14.9 inches total.

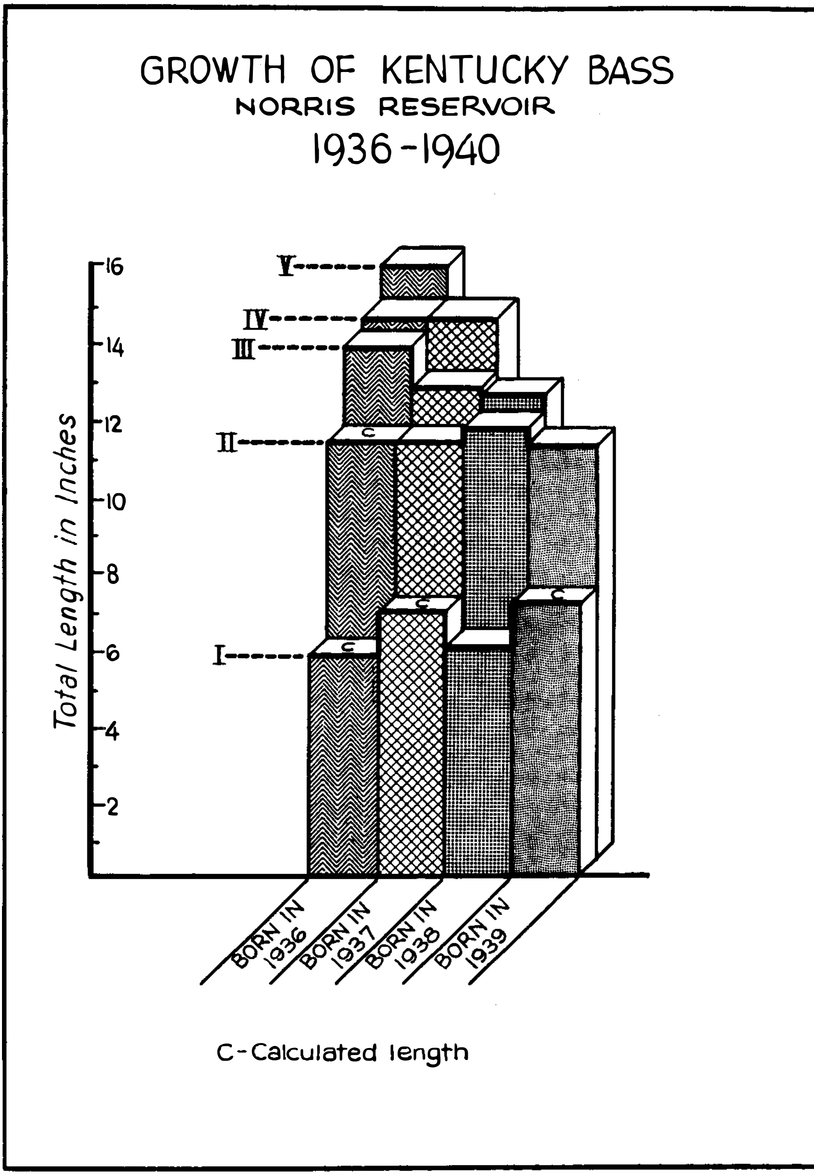
GROWTH OF KENTUCKY BASS
NORRIS RESERVOIR
1936-1940
Total Length in Inches
16
14
12
10
8
6
4
2
V
IV
III
II
I
C
BORN IN 1936
BORN IN 1937
BORN IN 1938
BORN IN 1939
C-Calculated length

Figure 3

The black crappie has had an interesting development in Norris Reservoir. In 1938 it was very seldom taken; in 1939 it represented 1 per cent of the catch and was limited in its distribution to the lower part of the reservoir (Eschmeyer and Tarzwell, 1941); and by 1940 it had spread farther, especially on the Powell River arm, but it was still not noted in the catch for the Clinch River arm above the forks and in upper Powell River. The young fish (1-year-olds), however, were taken on the Clinch River arm, and the species continues to spread. In 1940 it represented 8 per cent of the total catch (Eschmeyer, ms.).

The crappie is growing very rapidly and has already replaced the slow-growing bluegill as the major pan fish in Norris Reservoir. The difference in growth between the bluegill and the crappie is attributed to a difference in food habits. Insects are obviously few in a fluctuating, weedless reservoir, but small forage fishes are relatively abundant. The crappie, with fish prominent in its diet, can therefore be expected to grow much more rapidly than the insect-eating bluegill.

The crappies taken late in 1940 for growth determination include under-sized as well as legal-sized fish (legal length 8 inches).

A comparison of the growth of black crappie in Norris Reservoir (Table 6 and Figure 4) and in Reelfoot Lake (Schoffman, 1940) shows that the growth in Norris Reservoir is much more rapid. Schoffman's growth data for black crappie are:

Age in summers	Average length (inches)
3	7.8
4	8.9
5	9.6
6	10.4
7	11.7
8	13.6

TABLE 6. LENGTHS, BY YEARS, OF THE BLACK CRAPPIE FROM NORRIS RESERVOIR. TOTAL LENGTHS IN INCHES, STANDARD LENGTHS IN MILLIMETERS[1]

Year	Age group	Number of specimens	Standard length	Total length	Calculated lengths by years: I		II	
					Standard	Total	Standard	Total
1939	III	19	276	*13.5*	95	*4.6*	233	*11.4*
	II	89	234	*11.5*	135	*6.7*	......	......
1940	IV[2]	3	279	13.5	57	2.8	178	8.6
	III	17	257	*12.6*	113	5.6	220	10.8
	II[3]	83	180	*8.9*	64	*3.1*	......	......
	I[4]	48	87	*4.5*	......	......	......	......

[1]Italic figures are those used in preparing Figure 4.
[2]For the third year, calculated lengths were 251 millimeters standard, and 12.2 inches total length.
[3]Includes 14 illegal fish taken in brush shelters.
[4]Fish from brush shelters and sinks.

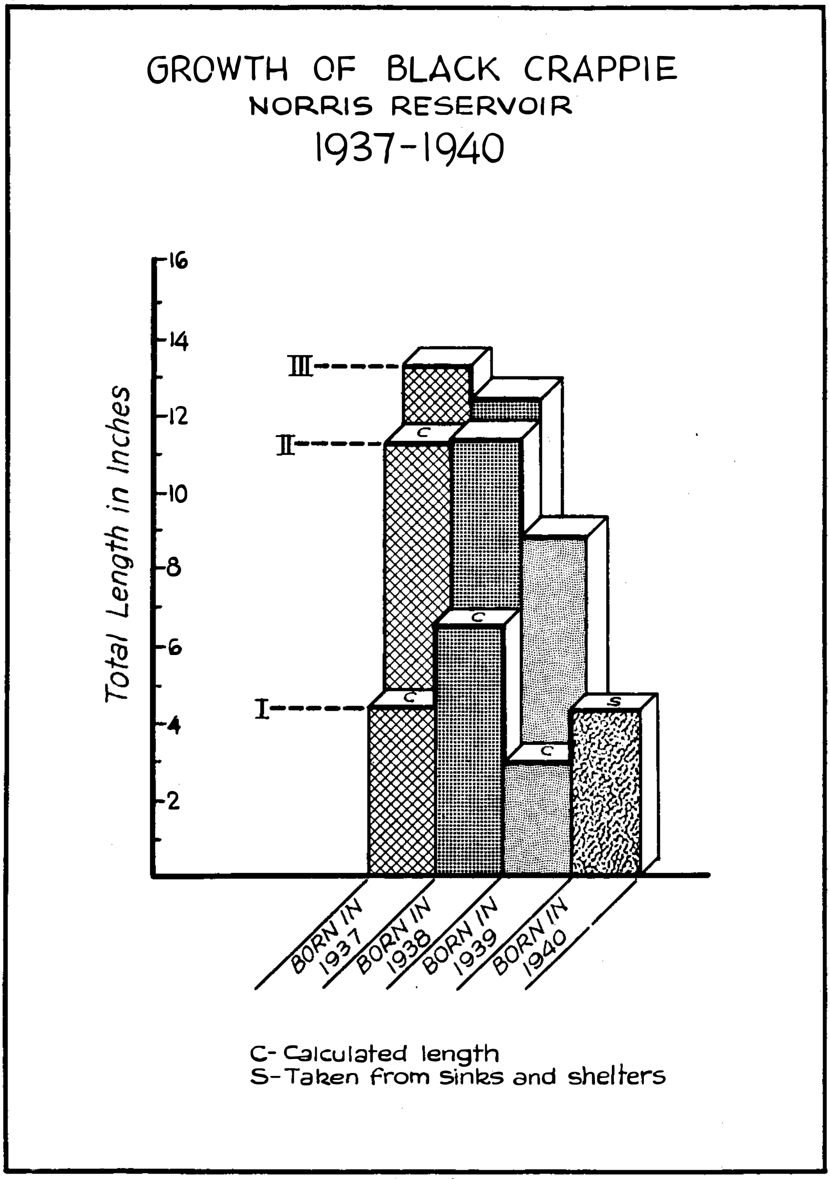
GROWTH OF BLACK CRAPPIE
NORRIS RESERVOIR
1937-1940
Total Length in Inches
16
14
12
10
8
6
4
2
III
II
I
C
C
C
C
S
BORN IN 1937
BORN IN 1938
BORN IN 1939
BORN IN 1940
C- Calculated length
S-Taken from sinks and shelters

Figure 4

In 1939 the 2-year-olds in Norris Reservoir averaged 11½ inches and the 3-year-olds, 13½ inches, and were comparable in length to Reelfoot Lake crappie, 7- and 8-years old, respectively.

In 1938 the walleye and sauger combined represented only about 3 per cent of the total fish catch. Walleyes greatly increased in the catch in 1939, representing about 9 per cent of the total catch that year. For 1940 the percentage was similar to that for 1939. Data for the 1940 growth are inadequate, but what information is available (Table 7) suggests a considerable decline in the rate of growth, even though the 14 young fish taken from a sinkhole late in 1940 were much larger than the calculated lengths for 1-year-old walleyes for previous years. It appears that this species reaches the minimum legal length of 15 inches by the end of the second growing season.

TABLE 7. LENGTH, BY YEARS, OF THE WALLEYES AND SAUGERS FROM NORRIS RESERVOIR. TOTAL LENGTHS IN INCHES, STANDARD LENGTHS IN MILLIMETERS

					Calculated lengths by years					
					I		II		III	
Year	Age group	Number of specimens	Standard length	Total length	Standard	Total	Standard	Total	Standard	Total
					(Walleyes)					
1938	III[1]	14	483	22.1	183	8.2	359	16.3	469	21.4
	II[1]	11	365	17.2	167	8.0	346	16.3	......	......
1939	IV	10	489	22.6	161	7.5	325	15.0	448	20.8
	III[1]	25	448	20.7	180	8.4	348	16.0	435	20.1
	III	25	416	19.3	183	8.5	339	15.7	......	......
1940	IV	11	481	22.2	185	8.6	359	16.6	447	20.1
	I	14[2]	224	10.5	......	....	......	......	......	......
					(Saugers)					
1939	II[1]	17	326	15.9	215	10.4	314	14.8	......	......
	II	21	318	14.8	222	10.4	......	......	......	......
1940	IV	6	379	17.6	174	8.0	306	14.2	353	16.5
	III	35	336	15.6	198	9.2	284	13.2	......	......
	II	5	293	13.7	171	8.0	......	......	......	......

[1]Had begun summer growth when collected.
[2]Fish taken from sinkholes.

In most instances for 1938 and 1939 growth determinations, the walleye had begun growth at the time the scales were collected. Where growth had begun, the calculated lengths, rather than the actual recorded lengths, indicate the size at the end of the growing season.

Even though the trend in the rate of growth is definitely downward, the walleye is still growing much more rapidly in Norris Reservoir than in other waters for which information is available.

The sauger is probably the least important of the game fish species in Norris Reservoir, although in 1940 it represented 3 per cent of the total catch, an increase of 1 per cent over the previous year. Information on the growth of this species in Norris Reservoir is presented in Table 7. Not enough records are available to indicate whether or not the growth rate is declining, nor are data available for comparison of the growth of this species in other waters. Little can be said therefore about the growth of the sauger, although the growth rate recorded for Norris Reservoir seems to be moderately rapid for this species.

An examination of the tables and graphs shows very definitely that the rate of growth of game fishes in Norris Reservoir is decreasing. During the first several years of impoundment the lake was presumably abnormally rich in basic food elements and rapid growth of a limited population was to be expected. After five years of impoundment the growth of all six species examined is still very satisfactory and is far more rapid than for fishes from other waters for which information on rate of growth is available.

Because the trend in growth was still downward at the end of the fifth growing season, the study fails to suggest at what point the curve of the rate of growth will "level out." Studies are to be continued.

The length of the growing period of largemouth and smallmouth bass was calculated to be about four months in 1939 (Jones, 1941). Further information was obtained on the length of the growing period in 1940 as well as on the amount of growth made at different times during the season.

The winter of 1939-1940 was an exceptionally severe one in east Tennessee. January, 1940, was the coldest January in the history of the Knoxville station of the U. S. Weather Bureau which is located only about 20 miles from Norris and which has been operating for about 70 years. During this winter all of Norris Reservoir except the lower few miles near the dam was covered with ice. The water in early January of 1941 was 49°; a year earlier it was near freezing. In 1940 bass did not begin to spawn until late in May. In the fall of 1940, temperatures at the Weather Bureau office were above normal each month. The growing season for fishes presumably started much later than ordinary but also extended into the fall later than usual.

Scale samples were collected each month during the summer and fall of 1940 at the docks from which fishes were taken for general growth determinations, except in August when few people fished (Table 8). These collections were made to determine the proportion of the season's growth that had been completed at the various periods. For several species the number of scales collected was inadequate and there is reason to believe that for some of the fishes, growth had not been completed by mid-November, when the study was terminated.

TABLE 8. PERCENTAGE OF THE SEASON'S GROWTH ATTAINED BY SEVERAL SPECIES OF GAME FISHES AT VARIOUS PERIODS OF THE GROWING SEASON, NORRIS RESERVOIR, 1940

Period[1]	Number of specimens	Average growth in millimeters	Percentage of growth completed	Number of specimens	Average growth in millimeters	Percentage of growth completed	Number of specimens	Average growth in millimeters	Percentage of growth completed
	Largemouth (II)[2]			Smallmouth (II)			Kentucky Bass (II)		
May 30......	80	0	0	12	0	0	5	0	0
June..........	63	0	0	7	10	10	....	....	....
July...........	18	10	15	6	22	21	....	....	....
August......	....	....	....	....	....	....	....	....	....
September.	16	55	81	27	68	66	15	58	61
October......	21	56	82	35	87	84	21	72	100
November..	7	68	100	7	103	100	11	72	100
	Largemouth (III)			Smallmouth (III)			Kentucky Bass (III)		
May 30......	93	0	0	21	0	0	19	0	0
June	117	0	0	32	1	2	6	0	0
July...........	41	0	0	7	3	6	3	2	5
August.......	....	....	....	....	....	....	....	....	....
September.	11	15	65	26	35	70	5	28	70
October......	13	20	87	47	37	74	10	31	78
November..	6	23	100	13	50	100	12	40	100
	Crappie (II)			Walleye (III)			Sauger (II)		
May 30......	39	0	0	37	4	9	23	4	7
June..........	42	1	3	8	15	34	10	10	17
July...........	21	22	67	12	23	52	5	31	53
August.......	....	....	....	....	....	....	....	....	....
September..	....	....	....	....	....	....	16	44	75
October......	16	33	100	8	30	68	25	48	81
November..	....	....	....	3	44	100	10	59	100

[1]Period indicated as May 30 includes also May 31 and June 1, the first three days of the season. In June, July, and September scales were collected during the latter half of the month; in October and November samples were taken at various times throughout the month.
[2]Age, in parentheses, of fishes at the beginning of growing season.

The data on growth at various times (Table 8), even though inadequate for several species, are interesting and suggest that the period of fast growth tends to be short. Some error may have been introduced as to growth during the first few months because of possible inability to differentiate between a full year's growth and the beginning of growth during the next season. The possibility of that error was, of course, much less for these fast-growing fishes than it would have been for slow-growing species. Because of rapid growth the error in interpretation is believed to have been very small. The 2-year-old bass had made more growth in June and July than the 3-year-old bass. The largemouth had a shorter growing season than the smallmouth, the crappie made much of its growth between late June and late July, and walleyes and saugers had a much longer growing season than any of the centrarchids. The information conforms to expectations. The early-spawning walleye and sauger may be expected to have a longer growing season than the bass; the crappie, which appears to spawn earlier than the bass and which apparently is most readily taken in early summer and late fall, is expected to have considerable early growth; and the smallmouth bass, more northern in distribution than the largemouth bass, would presumably grow for a somewhat longer season. In general, those fishes which tend to be northern in their distribution, i. e., those associated with cooler water, had a longer growing season than the more southern species.

The amount of growth made during any period depends to some extent on the water temperature, but it does not necessarily follow that growth is most rapid when the water temperature is at a maximum. For the walleye, for example, the water temperature (above the thermocline) was presumably too warm between late July and early October to encourage rapid growth during this period, for the fish averaged only 16 per cent of the season's growth in these months. During the same period the largemouth bass made about 67 per cent of their growth.

Few temperature readings were taken in Norris Reservoir in 1940. Those available (for a depth of 10 feet) are:

Date	Station	Temperature (Fahrenheit)
7/15	7	78
8/2	2	83
8/19	2	83
9/5	2	81
10/5	2	72

The information in Table 8 suggests that bass made their maximum growth between late July and mid-September, when water temperatures were above 80°; black crappie in late June and July, when water temperatures were in the seventies; walleyes in June, October, and November, with temperatures around the low seventies; and saugers in July. More exact information could not be given regarding the temperature at which growth is most rapid even if more temperature readings had been taken, because during the summer and fall the fishes tended to lie deep, either just above the thermocline, in it, or, where oxygen conditions were favorable, below it.

For the walleye and crappie, the periods of fastest growth coincided reasonably well with the seasons when these fishes were most readily caught. Fishing was poor, however, at the time the bass were growing most rapidly. The extent to which fish bite is therefore not entirely dependent on the amount of food consumed by them (assuming that when growth is greatest the feeding is also most intensive). One explanation for the failure of bass to bite well in midsummer is found in the fact that the amount of food available per fish is much greater in midsummer than at the opening of the season, because of the very heavy removal of fishes in June. According to our records, 44 per cent of the entire season's fishing was in June and 71 per cent of the season's catch was made during that month (Eschmeyer, ms.). Food for the adults was plentiful at the time of maximum growth and this may have adversely influenced "biting."

If growth was terminated by late November, the length of the growing season for adults of the several species was about as follows (Table 8):

Species	Length of Growing season
Largemouth bass	5 months
Smallmouth bass	6 months
Kentucky bass	5 months
Black crappie	5 or 6 months
Walleye	7 months
Sauger	7 months

The above figures are for 1940 only. The length of the growing season varies from year to year, depending on climatological conditions, especially temperature.

Lee's phenomenon, the apparent decrease in the calculated growth as determined from successively older groups of individuals, was noted for the Norris Reservoir fishes. This phenomenon has been discussed in some detail by Hile (1936), who considers possible reasons for its occurrence, and by other authors.

The extent to which calculated lengths differed from measurements is shown in Table 9. If Lee's phenomenon did not occur, and if the samples were adequate, the measured length and the one or more calculated lengths for a given species in a single age group should be identical. The information for Norris Reservoir fishes suggests that the greatest discrepancy occurs between the measured length and the first calculated length and that it is more pronounced for the first year's growth than for that of 2-year-old fish (growth during first and second years combined).

TABLE 9. COMPARISON OF MEASURED LENGTHS OF FISHES WITH CALCULATED LENGTHS FOR THE SAME YEAR CLASS ONE AND TWO YEARS LATER, NORRIS RESERVOIR. LENGTHS USED ARE TOTAL LENGTHS IN INCHES[1]

Species	Year class	Measured length	Calculated length	
			1 year later	2 years later
Largemouth	I in 1938	8.2	7.5	6.1
	II in 1938	13.0	12.6	12.1
	II in 1939	12.6	11.3	......
Smallmouth	I in 1938	6.6(3)	5.3	4.9
	II in 1938	12.5	11.2	11.4
	III in 1938	14.5	13.9	......
	II in 1939	12.0	9.7	......
Kentucky Bass	II in 1938	11.5	9.9	9.9
	III in 1938	14.0	13.2	13.2(8)
	II in 1939	11.8(7)	9.3	......
	III in 1939	12.9	13.0	......
Black Crappie	II in 1939	11.5	10.8	......

[1]Where the number of specimens used is very small, this number appears in parentheses.

For the six groups in Table 9 for which data are available for three seasons (one measured and two calculated) the average difference is 1 inch between the measured length and the calculated length of the same year class one year later, and only 0.4 inch between the first and second calculated lengths.

No attempt is made here to explain the reasons for Lee's phenomenon. The data are presented chiefly because they reflect on the accuracy of the age determinations. Had the phenomenon not been found to occur, the accuracy of the readings would have been seriously questioned by the authors even though, for most of the scales of these young, fast-growing fish, it did not seem to be especially difficult to determine the age.

SUMMARY

The average rate of growth was determined for six species of game fishes in Norris Reservoir for several years. By the fourth and fifth years of impoundment (1939 and 1940) the trend in the rate of growth tended to be downward, but the rate of growth of all six species during these years was still rapid compared with growth in other waters for which information is available.

For these six species (largemouth, smallmouth, and Kentucky basses; black crappie; walleye; and sauger) the approximate length of the growing season and the percentage of the season's growth attained at various times during the season were determined.

Lee's phenomenon, the apparent decrease in the calculated growth as determined from successively older groups of individuals, was noted for those species for which adequate growth information was available.

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DISCUSSION

DR. W. J. K. HARKNESS (Canada): I would like to ask if there is any evidence to indicate that fish are taken less frequently by angling—in the presence of an abundance of food—than I think you indicated just toward the end of your paper.

MR. JONES: We haven't made any studies on that. The mid-summer period is the time when the minnows in the lake would reach an edible size for the bass. Furthermore, sportsmen find, and we have observed that there are a great many more schools of small fishes near the surface and in the shallows during that mid-summer period.

DR. HARKNESS: It is the general contention among anglers that that is so, but it has always seemed to me that, from what evidence I have been able to accumulate, if fish are biting, the catch of anglers has no relation to the abundance of food. Fish are caught as readily with an abundance of food as they are with a scarcity of food, if the fish are biting.

DR. ESCHMEYER: I don't know how to explain that, with very limited food, some of your waters yield much better fishing than ours, but I see no other way to explain it.

DR. HARKNESS: We have a very positive correlation between the taking of food by fish and the taking of the fish by anglers. We know that in the northern lakes that some of the salmonoids definitely do not feed during certain temperature change periods, and during those times the anglers can not take the fish. The fishermen have attributed this to lack of food. We know, however, that they aren't taking any food at all during that time.

DR. ESCHMEYER: I know that Dr. Hazzard and I used to catch bluegills in Michigan at a certain temperature, and before that was reached we couldn't touch them. Obviously their food didn't change overnight. It would seem that if fish are not getting enough food, they should be hungry and bite better.

CHAIRMAN JACKSON: Do I understand you to say that temperature control has more to do with it than the abundance of food?

DR. ESCHMEYER: I believe it does, especially near spawning time. By and large, however, I can't help but feel that food has quite an influence. I don't know how else we can explain that the catch per hour doesn't correlate with the number of pounds of fish per acre.

MR. E. W. SURBER (West Virginia): I have been fishing three smallmouth bass streams now for several years, and yesterday I gave some figures that partly answer that question.

In the Shenandoah River the ratio of bass to forage minnows is high. The number of bass caught per fisherman hour was one bass in every 3⅓ hours. In the South Branch of the Potomac the catch was about one bass to every 10 hours; in the Cacapon River it was one bass in every 12½ hours.

In the Shenandoah River, forage minnows are abundant, but I would much rather fish the Shenandoah River than the other two rivers, although the bass are more abundant in the latter.

Another point is that the bass yield per acre in the Shenandoah River is less than in these other rivers, yet the bass caught per fisherman hour is greater. That seems to indicate that the bass in the river with the largest number of forage fishes, that is the largest amount of food bite better than in these other streams.

MR. H. S. SWINGLE (Alabama): We have two ponds which we use experimentally, within a half mile of each other. One of them had a stunted population of fish, and the fish were all hungry; the total weight that pond produced was 150 pounds per acre. In the other pond, which we fertilized, the weight got up to 600 pounds per acre; the fish had plenty to eat, but you could catch all the fish you wanted.

We have always found that where we have more fish in a pond, we can catch larger numbers. We would be wasting our time by using fertilizer to produce more fish, if what Dr. Eschmeyer says is true.

OBJECTIVES FOR INVESTIGATIONS FUNDAMENTAL TO A LAKE MANAGEMENT PROGRAM

DR. O. LLOYD MEEHEAN
U. S. Fish and Wildlife Service, Welaka, Fla.

Any lake management program must be based upon sufficient concrete knowledge to make it workable. Where that information is lacking it must be acquired. In 1938, when a cooperative program for lake management was set up with the U. S. Forest Service on the Ocala National Forest, in Florida, it was realized that the basic data needed must be collected.

Because of a farsighted agreement with the State Commission of Game and Fresh Water Fish, it is possible to open and close lakes within the forest with very little delay. A series of lakes was selected within the management area for the proposed studies. Later it was found that other lakes would have to be used and some that had been closed for stocking will remain closed for such experimental work as is necessary to promote the basic studies for the management program.

Under these conditions the knowledge that can be acquired is limited only by personnel, by facilities for collecting and digesting the information, and by the ingenuity used in acquiring it. To promote such a research program a few definite objectives should be defined. These may be modified or expanded as information is gathered.

Our first objective should be to classify lakes of the area according to food grade and/or carrying capacity. Trout streams are rated as to food grade but the validity of this approach for lakes still remains to be determined. In view of my experience in fertilizing ponds where bass are being reared, there is still some doubt in my mind as to the value of food-grade classification. However, it serves as an avenue of approach to the problem and allows one to gain a better knowledge of conditions within the bodies of water.

These investigations of the Ocala lakes involve physical, biological, and chemical studies of a representative series over a period of at least one year, and include lakes in various stages of maturity. Work has been completed on eleven so far.

The physical study should include making a plane-table map of each lake and an accurate determination of the areas covered with aquatic vegetation. All lakes should be sounded thoroughly to learn the bottom contour and to calculate the average depth.

The most important chemical studies include determination of hydrogen-ion concentration and dissolved oxygen content of both top and bottom layers. Measurements of alkalinity and acidity as well as of temperatures also should be included. These tests indicate the presence or absence of a thermocline, and the suitability of the water for various species of fishes.

Biological information mainly involves the bottom organisms and plankton. For the former the total weight and number of organisms should be determined per unit area of bottom. With the plankton the weight of organic matter in the centrifuge and plankton net is important. The value of quantitative studies of species is debatable.

There are certain other determinations which may be of importance, but their value still remains to be ascertained. These include chemical analysis of bottom deposits, determination of the amount of dissolved organic matter in the water and of the amount of colloids present, and quantitative studies of bacteria. The work of Birge and Juday and of Waksman indicate that these have an important bearing on the fertility of a body of water, but further study is necessary to their practical application. If the investigations outlined are carried over a sufficient period of time, which should be not less than one year, they will give an adequate idea of the fertility of a lake.

The biological and chemical information may be definitely related to the standing population. Hence the next objective should be population studies. On the Ocala forest these have been started where the biological and chemical studies are more or less complete and will extend over a considerable series of lakes that vary in size and maturity. Whether or not there is a relationship between the bottom fauna or plankton and population remains to be seen. Only when a large enough series has been studied can we hope to determine this point.

This objective may be accomplished by one of two methods. Samples of the population in various areas may be collected, marked, and released to be sought again after a specified period. The ratio of marked to unmarked fish may be determined and the total populations calculated. This is not applicable to bass because of the difficulties involved in their capture.

A more accurate method is a population count in which the whole population is killed, all the fishes measured and weighed, and the numbers of the various species determined. In the Ocala Forest even the soft shell turtles are killed by rotenone and we have found that they have an important bearing, along with other predators, on the standing populations.

As a result of such investigations, we will accumulate knowledge of the amount of food present and of the populations which it supports. This should give a clear idea of carrying capacity. After removal of all fishes, the lakes may be restocked with known populations and additional knowledge gained.

Even then, however, we shall still be far from having accurate information regarding actual productivity in terms of game fish. That can be determined only by removing a crop from the lakes. The rates of cropping or removal may be arbitrary or they may involve maximum numbers. We believe that more than the standing population of legal fish can be removed, since intermediate sizes will soon replace the larger ones eliminated.

Cropping may be done in one of two ways: through managed public fishing, much as it is being done in other sections of the country, or by experimental fishing either with nets or hook and line.

In the former case a thorough creel census should be maintained over a period of years. The population trend for game fishes may then be recognized by the shift from year to year in the average size, number of fishes per angler, and the amount of fishing effort required. By combining this knowledge with the results of growth studies through scale readings, an accurate idea may be obtained of the crop capacity of the body of water.

On the Ocala Forest, the creel census is impracticable as the extent of fishing is not enough to yield the proper information. Here croppoing will be done systematically with nets or with large numbers of hooks and lines. These data should yield information regarding the number of fishes that may properly be removed from lakes of the different food grades, with different populations, or of different stages of maturity.

Intimately connected with this work, but having a much wider application than to the lakes of merely this area, are studies of the value of stocking. In a well rounded management program we must know whether to stock at all, and if stocking is indicated, we should have a definite idea of the number and size of fingerlings to plant in a unit area. Appraisal and management of a stocking program can only be satisfactorily made after a period of years when information regarding the previously-mentioned objectives has been gathered and digested.

Some of the methods usually applied cannot be used in Florida. The age markings on the scales of Florida bass are not so clear as they are even on those of South Carolina. Clipping the fins for identification has been unsuccessful in this region. The loss of these tools complicates the problem of marking or identifying stocked fish. We have been able to insert belly tags in fingerling bass from about 4 inches in length and upward. Apparently this can be done only under ideal conditions, but as we gain experience we may be much more successful. It may be that some method will be worked out for marking fingerlings of the smaller sizes which are more prevalent in our hatcheries.

Marked fingerlings may be stocked in bodies of water at different rates per acre. Later the populations may be killed off in these lakes to determine the survival of the marked fish. It is hoped that these fingerlings may yield information concerning survival and rate of stocking which may be valuable. This information may also be correlated with the food grade and the degree of maturity of the lake and with standing populations.

The final objective in the program involves the determination of the fishing load for the various lakes within the Forest area. Fortunately or unfortunately, fishing is light on the Ocala because of the number of accessible lakes in the surrounding region. Except on one or two popular lakes in the forest, the value of a creel census is questionable. The technique for such studies has been discussed at length in various publications over a period of years and is familiar to all. With a knowledge of the fishing load and the productiveness of the lake, the crop can be managed intelligently.

This whole Ocala program is designed to place lakes in some classification type, to determine what populations each type of lake may be expected to support under ordinary conditions, how heavily the lake may be fished according to this fertility, and finally, how many and what size bass fingerlings should be stocked per unit area under varying conditions.

There are other data that might be gathered as the program expands, including information on the improvement of productivity by modification of populations, on the effect of fertilizers on the standing population and on productivity, on the digestion of organic deposits in lake bottoms to convert them to fish flesh, and on a number of related subjects. We have discussed the problem from the standpoint of the Ocala National Forest, but it is basic to lake management anywhere.

DISCUSSION

DR. H. S. DAVIS (West Virginia): I think it might be well to emphasize—a little more than Dr. Meehean has done—the importance of having a place in which to conduct this sort of investigation. I don't know of any other section of the country where you could get an equal number of lakes, close any of them for a period of years, and not have the anglers and sportsmen up in arms.

These lakes, as Dr. Meehean said, are turned over to us for experimental work—closed entirely to fishing—and we can handle them as we please. After all the fish in a number of lakes have been killed off and the original population studied, then we can stock the lakes so as to reconstruct any type of population we wish, and, later, determine the results. I think it is very fortunate that there is not the heavy fishing demand there that we find in some other areas, and that we do not have to depend upon a creel census, because a creel census necessarily is more or less incomplete.

Here we can do our own cropping, and remove every fish from a lake, or any percentage that we wish, and, in fact, do anything we would in an ordinary hatchery pond, but with the advantage that the original conditions are natural.

In the Ocala National Forest in Florida I feel that we have an exceptional opportunity to carry on field studies from which we can gain the maximum amount of information.

MR. L. D. LAMB (Texas): I would like to ask Dr. Davis about one thing that stops us in eastern Texas—the problem of obtaining the permission of the Forest Service to do that sort of work.

DR. DAVIS: In the Ocala case, the permission comes from the State, and not the Forest Service.

MR. LAMB: That explains the trouble we have had, since, under our setup the State has practically nothing to do with waters inside the limits of the national forests.

DR. THOMAS H. LANGLOIS (Ohio): I think the type of investigation outlined by Dr. Meehean is very desirable, and certainly should be extended as rapidly as possible. I would like to make one suggestion, however.

Frankly, I don't know Florida conditions, and I am presuming that conditions there are better than in the lakes in Ohio, on account of the advantages of higher temperatures and longer seasons. It is certainly becoming apparent in our Ohio lakes and reservoirs that the problem is not one of the fishes we can remove in order to get the maximum yield, or what stocking procedures may be necessary to keep up such a yield, but it is really a question of how little fishing a lake can stand and still maintain a fairly effective productivity. Perhaps one or two of these lakes could be set aside for an investigation of that point.

DR. MEEHEAN: I think it is true that all of the lakes in the Ocala area are under-fished.

CHAIRMAN JACKSON: Might I ask Dr. Langlois whether there are any lakes in the heavily populated State of Ohio that are under-fished?

DR. LANGLOIS: I should say we have. The results are obvious in the populations of stunted fishes. The reports of catches of under-sized bluegills in innumerable quantities are very indicative of under-fishing. Anything we could do to increase the intensity of fish removal from these reservoirs would definitely improve the average size of the catch.

MR. JOE HOGAN (Arkansas): Have you ever tried to put a tag on small fingerlings for marking, or has anybody else? Is it satisfactory?

DR. MEEHEAN: Mr. Nesbitt has tried it, and he said the most satisfactory marking was with ink and that it was legible for a period of approximately six months.

MR. LAMB: We tried that in Texas, as well as various ways of tagging, but nothing worked.

THE USE OF FERTILIZER FOR CONTROLLING THE POND-WEED, *NAJAS GUADALUPENSIS*

E. V. SMITH AND H. S. SWINGLE
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Najas guadalupensis is one of the most objectionable and widely distributed weeds in clear-water ponds of Alabama. The plant is rooted in the pond floor, and its slender stems, bearing narrow leaves, fill the pond where the water is 12 feet or less in depth.

It has no value as a fish food, and it offers such a good hiding place for small fishes that the pond soon becomes over-crowded and a stunted population results. It chokes the pond to such an extent that boating is difficult and fishing is almost impossible during the greater part of the year. Thus, it is evident that this species is an undesirable weed. Numerous Alabama pond-owners, including some of those who had bought the plant from various dealers to improve fishing, asked the Alabama Agricultural Experiment Station to recommend means of eradicating it from their ponds.

A review of the literature showed that various methods for eradicating different pond weeds had been used. Martin and Uhler (1939) discussed the important mechanical methods of controlling aquatic and marsh vegetation. These methods, however, are not adapted to the eradication of Najas from ponds. Surber (1931) used sodium arsenite for controlling submerged aquatic vegetation but the fact that this chemical is very poisonous to man and livestock makes its general recommendation undesirable.

Since neither mechanical methods nor poisoning seemed suitable, an attempt was made to develop some other means. The common observation that Najas does not grow in ponds that are muddy most of the year suggested that it might be controlled by shading with algae, either filamentous or plankton, provided a sufficiently dense growth of these organisms could be induced. For several years Swingle and Smith (1938, 1939) have been recommending the use of a complete commercial fertilizer for increasing the productivity of ponds by increasing plankton production but the use of fertilizer in weedy ponds was not advised, however, for fear that it would encourage rather than retard the growth of weeds. Beginning in the fall of 1938, fertilizer experiments were conducted in Najas-inhabited ponds in an effort to control Najas as well as to increase fish production.

Three ponds, 18, 4, and 2 acres in area, were used in the 1939 experiments. They were old gravel pits supplied with water from artesian wells. They were so badly infested with Najas (Figure 1), that boating and fishing were almost impossible.

Fertilizer was applied in August and September, 1938, and in April, May, June, July, and October, 1939—a total of seven applications. Each consisted of 40 pounds of ammonium sulfate, 60 pounds of 16 per cent super-phosphate, 5 pounds of muriate of potash, and 15 pounds of dolomite per acre.

The fertilizer was broadcast over the entire surface of each pond, especially over areas occupied by Najas. This procedure was diametrically opposed to an earlier recommendation in which it was advised that no fertilizer be applied over weed beds for fear of encouraging their growth. It differs from the method of application in weedless ponds where the fertilizer is applied along the edges in water 3 to 5 feet deep.

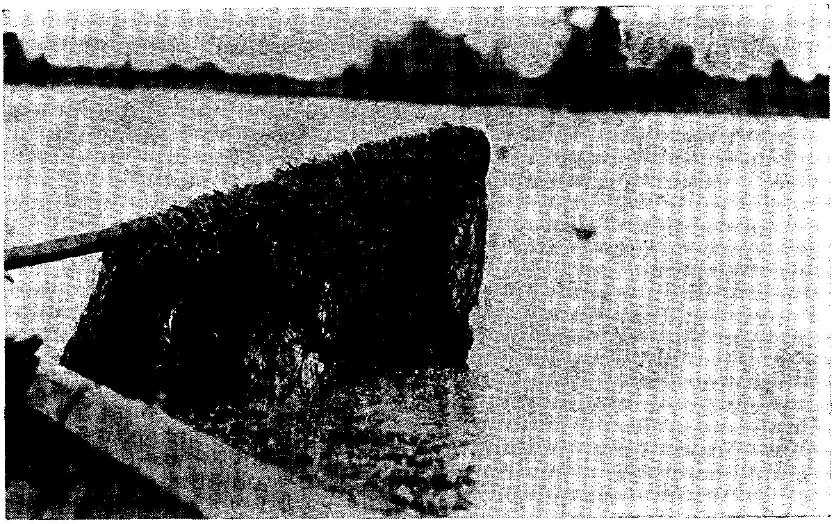

Figure 1. Najas may fill the pond so completely that boating and fishing are difficult or impossible.

The fall and early spring applications of fertilizer induced a dense growth of filamentous algae, principally Spirogyra and long-filamented species of Oedogonium (Figure 2). The algae grew in close association with the Najas, wrapped it up, weighed it down, and screened it from the light. All the Najas in the ponds appeared to be covered with algae by the middle of April. Although specific identifications of the algae were not made, it is evident that they were winter annuals since they disappeared from the ponds early in May. Most of the Najas appeared to be dead or dying by the time the filamentous algae disappeared, and the water of the ponds turned green as the result of a heavy growth of phytoplankton. These microscopic plants replaced the filamentous algae in preventing sunlight from reaching the submerged Najas. The ponds stayed green during most of the remainder of the growing season.

As the Najas plants became weakened, their stems broke near the base and great mats of the dead or dying weed were floating at the surface of the ponds towards the end of June. The floating Najas decomposed and most of it had disappeared by the middle of July. It was feared that the rapid decomposition of a large quantity of organic matter would lower the oxygen concentration to a critical point, but no bream, crappie, or bass died as the result of oxygen depletion. Chemical analyses indicated that an abundance of dissolved oxygen

Figure 2. Najas covered with filamentous algae and beginning to decay.

was present even during the period of most rapid decomposition of the Najas.

A heavy scum of blue-green algae collected over the protected areas of the largest pond as the Najas decomposed, but it soon disappeared. The old, black organic matter that had accumulated on the bottom during previous years came to the surface and decomposed.

Najas 4 to 6 inches tall was found growing in water to a depth of 4 feet early in August. The phytoplankton apparently formed a screen sufficiently dense to prevent much light reaching the Najas and at the end of the growing season the weed was present only in the shallowest water at the edges of the ponds.

All ponds were fertilized again during 1940. Najas, however, reappeared only in the largest pond. The series of changes in this pond in 1940 followed very closely that recorded in 1939. Najas became heavily covered with filamentous algae, Oedogonium being the dominant genus. The filamentous algae disappeared and were replaced by phytoplankton; concurrently, the Najas broke loose and floated in large masses which gradually decomposed. A scum of blue-green algae appeared as the Najas decomposed but soon disappeared. Phytoplankton kept the pond green the remainder of the season and no Najas could be found in November. It is interesting and probably significant that filamentous algae did not grow in the two smaller ponds that lacked Najas in 1940; these ponds maintained such a dense growth of phytoplankton, however, that the water appeared dark green throughout the season.

Two other ponds were fertilized in an effort to control Najas in 1940. One was a 25-acre pond that received water from a large spring, and the other, 19 acres in area, was built on a small stream that drained a Sumter clay (alkaline) watershed.

The 25-acre pond was drained in the fall of 1939 because it was choked with weeds and the fishing was poor. It was hoped that most of the weed would die while the pond was dry, but this did not occur.

The pond was restocked in the fall of 1939, and was fertilized with a complete commercial fertilizer during the spring and summer, 1940. The water and bottom of this pond apparently were very poor and the early applications of fertilizer were not so efficacious in destroying the Najas as they were in the first ponds. By September, the Najas was covered with filamentous algae, principally Oedogonium. Most of the Najas and filamentous algae disappeared before January 1, 1941. A dense growth of phytoplankton imparted a dark green color to the water in January.

Fertilization of the 19-acre pond was started in March, 1940. Each of the first few applications consisted of 100 pounds of commercial 6-8-4 (N-P-K) fertilizer plus 10 pounds of nitrate of soda, the nitrate of soda being eliminated from later applications. A total of 12 applications was made during the year. It is probable that the clay bottom "tied up" much of the phosphorus of the early applications.

Species of Oedogonium and Spirogyra having long filaments did not grow so readily in this pond as they did in the other ponds that were fertilized for Najas control. The principal filamentous algae was a short-filamented species of Oedogonium, sessile on the leaves and stems of Najas. Very frequently the Najas was covered by Desmidaceae such as Cosmarium, these organisms forming a heavy flocculent covering over the Najas. In addition, phytoplankton distributed through the water aided in shading the weed. The Najas began to break loose and float early in the summer, and floating masses of decaying Najas were present in the pond during the remainder of the season. Most of the pond was free of the weed in November.

Fertilization of the last two ponds is being continued in an effort to complete the eradication of Najas from them. Actually, it is futile to expect to eradicate permanently Najas from any pond by a single year's fertilization; a farmer might just as well expect to eradicate weeds from his cornfield by a single year's cultivation. Continued fertilization of the pond not only results in control of Najas, but also in greater fish production and better fishing. The use of fertilizer is one method of weed control that not only destroys an objectionable pond weed, but also increases the abundance of fish food, increases the rate of growth of fishes, and improves fishing. Microcrustacea and insect larvae were very abundant about masses of decaying Najas; these organisms are the principal food of bream and young crappie and bass. As the weeds decayed, the hiding places for small fishes decreased and the food for bass and crappie became, in effect, more plentiful.

The greatly increased food supply soon was reflected by a great increase in the number and size of the fishes caught. At the beginning of these experiments, the Najas-filled ponds furnished poor to moderately good fishing; they now rank among the best fishing waters in the state.

SUMMARY

1. Najas has been controlled in five fish ponds in Alabama by the use of inorganic fertilizers.

2. The fertilizer induces a heavy growth of algae, either filamentous or plankton, which apparently shades out the Najas.

3. The production of fish food, the growth of fish, and the ease of fishing are improved by the use of fertilizer for the control of Najas.

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DISCUSSION

MR. E. W. SURBER (West Virginia): This discussion of the use of fertilizers in the control of aquatic vegetation is of particular interest to me, because during the past summer we had two ponds among our series of experimental ponds at Leetown in which we used the combination of ammonium sulfate, super-phosphate, and muriate of potash, omitting the lime because our soil at Leetown has plenty of it. In neither of these two ponds was there a dense growth of submerged aquatic vegetation. We used the fertilizer at the rate of 30 pounds per acre, and with the feather-edge type of pond we had an early development of Spirogyra, followed by Oedogonium. The original growth of Spirogyra was very dense. We ordinarily get a heavy growth of Chara, also *Potamogeton filiformis*, and another fine-leaved species.

When we drained one pond in the fall, it was very easy to remove the fish. We used your fertilizer in the other pond, and we had a very good plankton production. About the last of June, the water net (*Hydrodictyon*) began developing on the surface of the pond, and almost completely covered it. This growth remained for a considerable period of time, long enough to prevent the development of any submerged aquatic vegetation.

Thus the use of that fertilizer prevented the growth of submerged aquatic vegetation and made the pond easy to drain.

We had other ponds fertilized with cottonseed meal, sheep manure, and superphosphate, and all of them developed a very dense growth of Chara which we had to rake up when we drained the ponds in the fall.

The indications are that fertilizer control will be of great importance to fish culture in the future.

MR. JOE HOGAN (Arkansas): We have been fertilizing for about ten years and we now use about 28 tons a year at the hatchery. By starting early in the spring, we can hold our vegetation down. If you start in the middle of summer or late summer and kill out the full season's growth of aquatic plant life, you are apt to do some damage. I would advise the gentleman to "keep his bags packed" if he kills out the full crop of vegetation at that time.

MR. SMITH: Do you use an organic fertilizer?

MR. HOGAN: We use cottonseed meal.

DR. O. R. MEEHEAN (Florida): For a number of years we have been using fertilizer in our propagating ponds, and I might say that any method that will maintain a water bloom will prevent the growth of submerged vegetation, provided the water bloom is developed early enough in the year.

This last season we had one pond in which we used inorganic mixtures. There was a considerable sunfish population in it. It developed a very luxuriant growth of Najas, but about the middle of the summer, the Najas began to die. Then came a heavy rain, making the water become slightly acid, which killed off the Najas, but also killed a large proportion of the fish through reduction of dissolved oxygen in the water.

There were three other ponds in the series, one of which was fertilized with inorganic fertilizer and two with cottonseed meal. The latter two had a luxuriant growth of phytoplankton; none of those ponds developed any large amount of submerged vegetation.

MR. S. H. LAMB (Mississippi): I didn't understand how many pounds of the 6-8-4 fertilizer you used per acre.

MR. SMITH: We used 100 pounds; it was the 6-8-4 mixture, with 10 pounds of nitrate of soda added.

MR. A. D. ALDRICH (Oklahoma): I would like to ask about the control of the emergent types of plants which I believe were shown on a slide. Can you fertilize enough through the winter—before those plants get started—to have the same effect on them?

MR. SMITH: I don't think so, because there is too much food stored in their rootstocks. We used that slide because it illustrated the fact that people buy all sorts of weeds and plant them in their ponds, and then want to get rid of them later on. Spatter-dock was controlled in that pond by cutting the leaves about five times during the summer, thus starving the rootstocks to death.

CHAIRMAN JACKSON: *In the absence of the author, Wilfred A. Lyall, the next paper will be read by C. N. Feast, Director, Colorado State Game and Fish Commission.*

PROBLEMS OF FISH MANAGEMENT ON GRAND MESA NATIONAL FOREST IN COLORADO

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The Grand Mesa, for which the Forest is named, is a lava-capped tableland approximately 10,000 feet in elevation located in western Colorado. It has an area of about 53 square miles. Situated on it and the surrounding benches are some 225 ponds, lakes, and reservoirs. These waters vary from one to several hundred acres in area. The mesa on most sides ends abruptly in a lava rim several hundred feet in height, which forms a barrier to roads and trails, except where it has eroded and broken away. Below the lava rim, the topography is steep and broken and drops rapidly to the Colorado River and the Gunnison River valleys, 5,000 feet below the general top of the plateau.

In the foothills and river valleys, intensive irrigation agriculture is practiced. For the most part the arable land is developed to the full extent permitted by the water supply, much of which tumbles down from the mesa. As a consequence of the strong demand for water, nearly every available storage site has been utilized, with the result that in the spring the Grand Mesa is attractively dotted with small to large lakes. By fall, however, the reservoirs are completely drained and the reservoir-lakes lowered to their former natural levels.

It is with these reservoirs that this paper is concerned. Due to their value for trout-fishing and to the cool climate of the mesa offering relief from high temperatures in the valleys, the intensity of fishing is very heavy; so much so, in fact, that for some years the quality of fishing has steadily declined. For this reason and due to the unique position of the mesa in the region's tourist business, a creel census of the take from several of the principal lakes was undertaken during the summer season of 1940.

The survey also comprised a general study of the physical, chemical, and biological conditions as well as a detailed study of all trout taken by the fishermen. The research upon physical conditions included study and classification of depth, area, variation of shoreline as a result of stored water release, and other general characteristics. Biological observations were made on the volume of food on the bottom, along the shoreline, and free-swimming. Chemical studies included readings of temperature, oxygen concentration, and bound and free carbonates at various levels. As these lakes have outlet dams that deepen them during part of the summer and subsequently drain back to their normal levels, a portion of the study was to determine whether this factor had an appreciable effect on trout production.

Measurements indicated that the volume of food in these reservoirs was probably above the average for Colorado lakes. Plankton hauls with a Birge closing net and bottom samples with Ekman dredge were taken. There were too few samples for an adequate biological analysis, but the shoal, terrestrial bottom, and plankton volume studies indicated that a production of around 1,000 pounds per acre could be expected in most of the waters that were studied intensively.

Physical characteristics of the lakes studied are summarized in the following table:

	Depth in Feet			Area in Acres		
Reservoir-Lake	High	Low	Difference	High	Low	Difference
Mesa	17	6	11	30	20	10
South Mesa	19	12	7	12	7.5	4.5
Lost	25	18	7	3.3	2.6	0.7
Island	81	70	11	160	145	15
Ward	70	55	15	75	65	10
Alexander	51	44	7	33	26	7

It is apparent that the depths and areas are varied considerably as the result of storage and drainage. The flooding, however, is a rather temporary condition. The lakes are refilled from water released by the melting snows during May and June. Water withdrawal is often started by the end of June and is accelerated during July so that many of the reservoir-lakes are drawn down to the outlet pipes by the end of August. Consequently the water level corresponds to the natural lake level for about eight months of the year. The flooding is so brief that those portions of drained bottom having soil produce a stand of weeds and grasses after the water recedes. Some of the plants, as short-awn foxtail (*Alopecurus aequalis*) are perennial and their natural cycle is scarcely disturbed.

The outlets are so constructed that only the upper layers of the lakes may be drained, hence unfavorable results might be expected from regular removal of the oxygen-rich upper strata. Again, the change in lake level being of short duration it seemed that during the windy fall months and times of temperature and density changes that the lakes would satisfactorily reoxygenate.

Considering most physical conditions observed, spawning possibilities favored the eastern brook trout as during the time of their spawning in the fall, the lakes had reestablished their normal state. Due to the draw down, conditions were not so favorable for the spring-spawning species, including the rainbow and the black-spotted native trout. Trout spawning during the spring must contend with a constantly rising water level and inundation of feeder streams.

With the aid of CCC enrollees a check was made of fisherman effort and success and sufficient data were obtained upon which to calculate the information on a seasonal basis. By this means the following figures were derived:

Reservoir-Lake	Fishermen per acre	Fish per man hour	Fish per fisherman	Pounds per acre	Total pounds
Mesa	103	1.3	3.2	106	2,120
South Mesa	115	1.0	3.0	106	795
Lost	132	.65	2.6	90	235
Island	14	2.1	6.5	43	5,250
Ward	23	1.4	3.0	16	1,140
Alexander	38	.42	.9	17	440

Weighting yields in proportion to intensity of fishing about 100 pounds per acre are produced and that yield is considered satisfactory.

In general, the fishes taken were predominantly eastern brook trout under 10 inches in length. The Colorado legal size is 7 inches. The percentage of catch and the median length of the fishes in inches by species was:

Reservoir-Lake	Eastern brook		Rainbow		Native	
	Per cent	Length	Per cent	Length	Per cent	Length
Mesa	89	8.9	11	8.7	....	....
South Mesa	72	8.8	28	8.2	....	....
Lost	81	8.5	19	8.4	....	....
Island	23	9.6	49	9.5	28	9.5
Ward	95	8.2	5	9.2	....	....
Alexander	23	11.8	77	9.7	....	....

Results indicate that most trout are being caught when comparatively young, or soon after they have attained legal size. Age determinations based on scale readings verify this point, as shown by the age classes recorded below:

Species	7 inches	8 inches	9 inches	10 inches	11 inches
Eastern brook	2	2	3	[illegible]	4
Rainbow	2	2	3		3
Native	2	2	3		4

This tabulation indicates that most of the fishes caught being between 8 and 9 inches in length, are about 2 years of age. Obviously this means the trout are being harvested almost as fast as they attain legal size.

From all observations, the eastern brook trout seems the best producing species in these waters. Some comparison can be made for Mesa and Ward Lakes as follows:

Reservoir-Lake	Eastern brook		Rainbow		Native	
	Plant	Take	Plant	Take	Plant	Take
Mesa (2-year plant)	57.7%	89.0%	28.1%	11.0%	14.2%	0.0%
Ward (4-year plant)	36.0%	95.4%	39.0%	4.6%	25.0%	0.0%

Comparing the yield with other lakes in Colorado where preliminary studies have been made, it can be stated that the yield of the Grand Mesa Lakes is satisfactory and probably represents the maximum possible, considering past plantings and factors affecting reproduction. It is apparent that if better fishing is desired, forced stocking of legal-sized trout must be resorted to.

It is planned to continue this study by carrying on inventories and censuses as well as by planting tagged legal-sized fishes as controls.

DISCUSSION

DR. H. S. DAVIS (West Virginia): There are one or two questions that I would like to ask, although I don't know whether Mr. Feast can answer them, as he did not prepare the paper.

Were these fishes marked in any way? The author gave the percentage of take of the stocked fish.

MR. FEAST (Colorado): That is one thing I mentioned yesterday and I believe it should be clarified. That percentage of the catch may be from natural reproduction or it may have been from fishes that had been planted—there is no way of telling that.

In order to determine that factor, they got several thousand fishes from us last summer, from 2 to 7 inches in length, and removed their ventral fins—cutting them off as short as possible. Tags were placed on the jawbones of the larger specimens. Even so I don't believe we could say definitely that the fish caught had been planted.

DR. DAVIS: The yield cited is very high for that type of water. Would you consider that as an average production, or as the maximum?

MR. FEAST: A study was made last summer by the Colorado Game and Fish Department on 26 ponds and lakes of various sizes, over which we had methods of control, also on one or two other lakes where we determined the population and results by related formulae, and we found that the apparent production of these 20-some lakes was about 102 pounds to the acre.

DR. PAUL R. NEEDHAM (California): We have results for lakes in California that may be interesting for comparison. On one—near the south end of Lake Tahoe—over a 3-year period we obtained a production of, roughly, about 21 pounds per acre. I was amazed, as Dr. Davis was, with the extraordinarily high production of those Colorado Lakes.

By the way, at what elevation are those lakes, Mr. Feast?

MR. FEAST: Ranging between 9,000 and 9,500 feet. Regardless of the depth of these lakes—three of them were only 17 to 20 feet deep—it seems there was a very definite similarity of yield when you worked it out on a fisherman-per-acre basis.

The highest yield, I believe, was in a lake at the foot of Pike's Peak, at an elevation of about 10,200 feet. It was about a hundred acres in area, impounded by a steel-faced dam constructed for the purpose of water supply, and 66 feet in depth. One summer that lake produced 215 pounds per fisherman per acre of brook trout, averaging between 9 and 16 inches in length. That was the highest producing lake we had on record.

I would like to mention also that among these 20-some bodies of water we studied, a good share of them were really not lakes but ponds, that were built either by the Forest Service or by the State Game and Fish Department or sportsmen's organizations, and they varied in size from 1, 2, 3, up to 25 and 30 acres. Those we studied had outlets designed so that they could be drained and the fish captured. About 100 pounds per acre was a close average of the production of these lakes, in which fish were placed and held until they reached a larger size before being liberated.

DENSITY CURRENTS IN IMPOUNDED WATERS—THEIR SIGNIFICANCE FROM THE STANDPOINT OF FISHERIES MANAGEMENT

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At the Baltimore meeting of this section, I discussed (Wiebe, 1938) the distribution of dissolved oxygen in Norris Reservoir. At that time it was pointed out that, although the thermal stratification in this reservoir was of the usual type, the vertical distribution of dissolved oxygen differed from that commonly found in natural lakes that are subject to thermal stratification (Birge and Juday, 1911).

It is generally known that, after thermal stratification has become established, the waters of a natural lake present three well-defined vertical strata: (1) The epilimnion or surface stratum, with high dissolved oxygen content, decrease in temperature, and dissolved oxygen with increase in depth gradual; (2) the thermocline, rapid decrease in temperature with increase in depth, the dissolved oxygen may or may not decrease rapidly as the depth increases; and (3) the hypolimnion or bottom layer in which the temperature and dissolved oxygen both decrease gradually with increased depth and the dissolved oxygen may be completely used up. The absolute concentration of dissolved oxygen in all three strata is determined, in large measure, by the trophic status of the body of water. Thus, the hypolimnion of a eutrophic lake may be stagnant, while the corresponding region of an oligotrophic lake still shows a relatively high concentration of dissolved oxygen.

The waters of Norris Reservoir present four well-defined vertical zones with respect to dissolved oxygen during the period of thermal stratification in contrast to the three zones defined above: (1) A well-aerated surface stratum; (2) a zone of stagnant water, generally within the thermocline; (3) a second stratum of water rich in dissolved oxygen below the thermocline; and (4) a bottom layer of stagnant water. The depths at which strata (2) and (4) occur and the thicknesses of all four are subject to considerable variation (Wiebe, 1938).

At the Baltimore meeting the atypical, vertical distribution of dissolved oxygen in Norris Reservoir was explained on the basis of the occurrence of sub-surface or density currents. An alternate explanation was suggested by the work of Birge and Juday (1911), namely, that the depletion of dissolved oxygen in the intermediate layer of stagnant water (stratum (2) above) was caused by the decay of dead plankters dropped from the epilimnion and trapped within the thermocline because of the greater density of the water. Studies on the biochemical oxygen demand (Wiebe, 1939) and of the abundance of the plankton (Jones, ms.) showed that biological processes near the head of the reservoir were of a magnitude to cause complete stagnation of the water in that region. These observations also showed that such conditions did not prevail throughout the reservoir as a whole. Hence, the distribution of this stagnant water at its density level throughout the entire reservoir could not be explained on the basis of the results of Birge and Juday in Wisconsin. The presence of sub-surface or density currents, however, would explain how stagnant water could be transported to a point 40 miles distant from its place of origin. Thus, after considering all the aspects of this case very carefully, we have decided that density currents are responsible for the atypical distribution of dissolved oxygen in Norris Reservoir.

No measurements of density currents have been made; moreover, indirect evidence suggests that they are of such low magnitude that they could not be measured accurately with any current meter now available. (Such currents have been measured in Lake Mead, Vetter *et al.*, unpublished.)

A tentative definition of a density current has been suggested by Knapp.[1] "A density current is a gravity flow of a fluid within a medium of the same phase." This definition includes the flow of gases in gas and liquids in liquid. In the case of liquids, both miscible and immiscible components are included. The definition does not at this stage limit density differences, but considers flows to be density currents only when the difference is relatively small.

In Norris Reservoir, density currents are due to differences in the density of the water in the reservoir and of the inflow from tributaries. These are due to differences in: (1) Temperature (Wiebe, 1940); (2) concentration of electrolytes, especially carbonates; and (3) silt content (Wiebe, 1939a).

The formation, as well as the permanency, of density currents does not depend exclusively upon differences in density. Volume of flow, velocity, and the shape of the reservoir are also of significance. A reservoir that is relatively deep, long and narrow favors the development of density currents. It was because I appreciated this dimensional relationship that I predicted that other reservoirs that had dimensions similar to those of Norris Reservoir would develop density currents. During the summer of 1940 we have had an opportunity to check this prediction.

[1] "Density Currents," a paper presented for the round-table discussion on the role of hydraulic laboratories in geophysical research, 1939.

Norris Reservoir (*Tenn.*)—Very little work was done on this reservoir during 1940, but the few observations made showed that density currents were present. This is indicated by the abrupt changes in the content of dissolved oxygen as recorded in Table 1.

TABLE 1. DISSOLVED OXYGEN CONTENT AT VARIOUS DEPTHS IN NORRIS RESERVOIR SEPTEMBER 4 AND 5, 1940

	Powell Station No. 1*		Clinch Station No. 4*	
Depth	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.
1	7.65	82.00	7.47	81.00
5	....	81.00	....	80.00
10	7.83	80.75	7.65	79.75
15	7.65	80.50	7.47	79.25
20	7.65	80.00	7.29	79.00
25	7.19	79.50	6.75	78.00
30	6.30	75.75	6.30	73.75
35	3.96	71.50	4.05	71.25
40	1.80	67.75	2.25	66.00
45	2.34	63.00	1.80	61.75
50	3.24	59.00	2.25	57.50
60	3.96	54.25	4.23	53.75
70	4.86	52.00	4.14	52.25
80	5.31	50.75	....	....
90	5.40	49.00	....	....
100	5.13	47.00	....	....

* Incomplete series.

Hiwassee Reservoir (*N. C.*)—This reservoir was first impounded during the winter of 1939-1940. The shape of it is very similar to that of Norris—relatively long, deep, and narrow.

Observations on this reservoir were started in July and were continued at infrequent intervals throughout the summer. The results of oxygen and temperature determinations on Hiwassee Reservoir are summarized in Tables 2 and 3. An examination of these tables indicates the presence of a stratum of relatively stagnant water beneath a well-aerated surface layer and underlaid by a second zone of well-aerated water. The table for July indicates the presence of thermoclines in the 20- to 25-foot stratum, the 40- to 45-foot stratum, and in the 55- to 60-foot stratum behind the dam. The occurrence of multiple thermoclines has also been observed on Norris Reservoir and is definitely related to density currents.

The presence of density currents in Hiwassee Reservoir is further indicated by a stratum of turbid water extending from near the head of the reservoir to the dam at a depth of from 25 to 45 feet below the surface. It is identical with the layer of stagnant water.

Lake Herrington (*Ky.*)—Through the cooperation of Major James Brown and M. E. Clark of the Kentucky Fish and Game Division, the writer was able to make some observations on Lake Herrington in Kentucky. This reservoir, too, is relatively long, narrow, and deep, and

TABLE 2. DISSOLVED OXYGEN CONTENT AT VARIOUS DEPTHS IN HIWASSEE RESERVOIR, JULY 10 AND 11, 1940[1]

Depth	Station No. 1		Station No. 2		Station No. 3		Station No. 4		Station No. 5		Station No. 6		Station No. 7	
	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.
1	7.17	78.75	7.17	77.75	7.13	78.50	7.13	81.75	7.36	80.00	7.14	77.00	7.36	76.00
5	....	77.75	....	77.50	....	77.50	....	79.75	....	76.25	6.09	75.75	7.24	73.25
10	7.06	77.00	7.06	77.00	7.01	76.00	6.79	76.25	7.02	75.25	5.87	74.50	6.78	71.50
15	7.06	76.00	6.94	76.00	6.44	75.50	6.56	75.25	5.44	74.50	5.40	72.50	6.90	68.50
20	6.83	75.25	6.27	75.50	5.63	74.50	6.21	73.00	3.79	72.00	5.18	71.75	6.78	68.50
25	5.04	71.00	1.68	72.00	3.91	71.25	3.91	70.75	4.60	71.00	4.60	70.75	6.66	69.00
30	2.13	70.00	2.46	70.50	3.91	70.00	3.79	70.00	5.18	70.00	4.84	70.25	....	....
35	1.79	69.00	2.69	69.50	3.68	69.25	3.79	69.00	5.18	69.75	5.75	69.00	....	....
40	2.91	67.75	2.69	67.75	3.11	68.00	3.91	68.00	5.18	68.50	5.75	68.00	....	....
45	4.03	65.00	3.02	65.25	3.23	66.00	2.98	65.25	4.72	67.00	5.75	66.50	....	....
50	4.36	63.00	3.13	62.50	3.45	63.50	3.57	63.25	1.60	64.25	4.96	66.25	....	....
55	....	62.00	....	60.25	3.57	61.00	....	....	....	....	....	....	....	....
57.5	....	60.50	....	....	....	....	....	....	....	....	....	....	....	....
59	....	60.00	....	....	....	....	....	....	....	....	....	....	....	....
60	4.92	58.50	5.26	58.50	....	....	3.57	58.25	1.15	58.50	....	....	....	....
65	....	....	....	....	4.48	57.00	....	....	....	....	....	....	....	....
70	5.26	56.00	5.26	56.50	....	....	4.60	56.25	....	....	....	....	....	....
71	....	....	....	....	....	....	....	....	1.15	56.25	....	....	....	....
75	....	....	....	....	5.52	56.00	....	....	....	....	....	....	....	....
80	4.26	55.00	5.48	55.75	....	....	4.48	55.50	....	....	....	....	....	....
85	....	....	....	....	5.06	55.00	....	....	....	....	....	....	....	....
90	4.37	54.25	5.26	55.00	....	....	4.48	54.75	....	....	....	....	....	....
95	....	....	....	....	4.72	54.25	....	....	....	....	....	....	....	....
100	4.70	53.75	5.26	54.00	....	....	2.53	54.00	....	....	....	....	....	....
105	....	....	....	....	4.60	53.50	....	....	....	....	....	....	....	....
110	5.15	53.00	5.26	53.00	....	....	0.11	53.50	....	....	....	....	....	....
115	....	....	....	....	3.68	53.00	....	....	....	....	....	....	....	....
118	....	....	....	....	....	....	0.00	53.00	....	....	....	....	....	....
120	5.15	52.00	5.04	52.25	....	....	....	....	....	....	....	....	....	....
125	....	....	....	....	1.72	52.25	....	....	....	....	....	....	....	....
130	5.37	51.00	4.59	51.50	....	....	....	....	....	....	....	....	....	....
135	....	....	....	....	0.11	51.75	....	....	....	....	....	....	....	....
140	5.15	50.00	4.13	50.25	....	....	....	....	....	....	....	....	....	....
145	....	....	....	....	0.00	50.50	....	....	....	....	....	....	....	....
150	4.81	47.00	3.58	48.50	....	....	....	....	....	....	....	....	....	....
160	4.14	46.25	2.35	46.75	....	....	....	....	....	....	....	....	....	....
170	3.92	45.00	2.35	45.75	....	....	....	....	....	....	....	....	....	....
180	3.92	44.50	0.11	44.75	....	....	....	....	....	....	....	....	....	....
190	2.35	43.75	....	....	....	....	....	....	....	....	....	....	....	....
193	....	....	0.00	45.25	....	....	....	....	....	....	....	....	....	....
200	2.58	43.25	....	....	....	....	....	....	....	....	....	....	....	....
210	2.58	43.25	....	....	....	....	....	....	....	....	....	....	....	....
220	2.58	43.00	....	....	....	....	....	....	....	....	....	....	....	....
230	1.13	43.25	....	....	....	....	....	....	....	....	....	....	....	....
241	0.04	43.50	....	....	....	....	....	....	....	....	....	....	....	....

[1]These data furnished by A. Ross Britton of the TVA Biological Readjustment Division.

TABLE 3. DISSOLVED OXYGEN CONTENT AT VARIOUS DEPTHS IN HIWASSEE RESERVOIR, AUGUST 7 AND 8, 1940[1]

Depth	Station No. 1		Station No. 2		Station No. 3		Station No. 4		Station No. 5		Station No. 6		Station No. 7	
	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.
1	7.27	83.25	7.32	83.25	7.20	85.00	7.16	83.50	7.20	82.25	7.08	82.25	7.20	81.25
5	....	83.00	....	82.00	....	83.25	....	83.00	....	82.00	....	82.00	....	81.00
10	7.38	82.75	6.42	81.50	6.76	82.75	7.80	82.25	7.32	82.00	6.96	81.75	7.08	80.00
13	....	....	....	....	....	....	....	....	....	....	....	....	7.08	79.25
15	6.31	82.50	6.42	81.00	6.52	81.00	5.98	82.00	6.84	81.25	6.72	81.25	....	....
17	....	....	....	....	....	....	....	....	....	....	....	....	6.96	78.00
20	6.31	77.50	6.42	76.25	6.28	78.00	5.16	78.75	6.24	78.00	6.24	78.00	....	....
25	1.50	74.75	5.78	73.00	4.92	75.00	4.32	76.00	3.00	76.00	5.16	76.00	....	....
30	0.32	72.00	1.18	71.00	2.52	73.50	3.36	73.00	2.76	73.50	4.32	74.00	....	....
35	0.32	70.75	1.18	70.00	2.52	71.25	3.36	71.50	3.12	71.25	2.40	71.75	....	....
40	0.53	70.00	1.60	69.25	2.64	70.25	3.36	70.50	4.08	70.75	1.80	70.50	....	....
45	0.64	69.50	1.60	68.75	2.28	69.75	3.24	69.75	4.08	70.00	0.36	69.75	....	....
50	1.50	68.75	1.28	67.75	2.16	68.75	2.52	68.50	3.48	68.75	....	....	....	....
60	1.71	66.50	1.71	66.50	1.80	66.25	2.64	66.25	2.16	66.75	....	....	....	....
70	2.35	63.00	2.03	63.00	1.68	63.00	2.52	63.00	0.36	64.75	....	....	....	....
80	3.42	60.00	3.32	58.50	1.80	60.00	1.92	59.25	....	....	....	....	....	....
90	4.38	57.50	4.17	56.25	2.76	58.00	1.44	57.25	....	....	....	....	....	....
100	4.71	56.00	4.81	55.00	4.08	56.25	0.96	56.25	....	....	....	....	....	....
110	4.71	55.25	4.71	54.50	3.12	55.75	....	....	....	....	....	....	....	....
115	....	....	....	....	....	....	0.00	56.00	....	....	....	....	....	....
120	4.50	54.75	4.17	54.00	1.08	55.00	....	....	....	....	....	....	....	....
130	4.07	54.00	3.64	53.00	0.12	54.25	....	....	....	....	....	....	....	....
140	4.07	53.00	3.10	52.25	....	....	....	....	....	....	....	....	....	....
144	....	....	....	....	0.00	53.50	....	....	....	....	....	....	....	....
150	3.85	52.00	2.35	51.75	....	....	....	....	....	....	....	....	....	....
160	3.10	50.75	0.85	51.00	....	....	....	....	....	....	....	....	....	....
170	2.03	48.25	0.10	49.00	....	....	....	....	....	....	....	....	....	....
180	1.60	45.75	0.00	46.25	....	....	....	....	....	....	....	....	....	....
190	0.86	44.25	0.00	46.25	....	....	....	....	....	....	....	....	....	....
200	0.75	43.75	....	....	....	....	....	....	....	....	....	....	....	....
210	0.75	43.75	....	....	....	....	....	....	....	....	....	....	....	....
220	0.75	43.75	....	....	....	....	....	....	....	....	....	....	....	....
230	0.64	43.75	....	....	....	....	....	....	....	....	....	....	....	....
241	0.00	44.00	....	....	....	....	....	....	....	....	....	....	....	....

[1]These data furnished by A. Ross Britton of the TVA Biological Readjustment Division.

the shores are even steeper than those of Norris. In this instance only two vertical series of dissolved oxygen and temperature determinations were made. One series of samples was taken approximately 4 miles above the dam where the total depth of the water was 180 feet. The second series was taken toward the head of the reservoir where the depth was 44 feet. The results are recorded in Table 4. An examination of the data shows a definite break in dissolved oxygen content between the depths of 15 and 20 feet. The dissolved oxygen reaches a minimum of 0.26 parts per million at 30 feet. Below this depth the concentration of dissolved oxygen again increases until it reaches 6.76 parts per million at 80 feet, and then remains practically constant to a depth of 160 feet. Table 4 also reveals the existence of a thermocline, the break in temperature occurring between the depths of 15 and 20 feet as with the dissolved oxygen. The change in temperature between the depths of 15 and 20 feet amounts to 8½° F.

TABLE 4. DISSOLVED OXYGEN CONTENT AT VARIOUS DEPTHS IN HERRINGTON LAKE, KENTUCKY, AUGUST 12, 1940

	Station No. 1		Station No. 2	
Depth	D. O. p.p.m.	Temp. °F.	D. O. p.p.m.	Temp. °F.
1	9.75	83.00	6.50	83.00
5	....	83.00	....	82.50
10	10.40	82.50	6.24	82.25
15	10.92	81.50	....	81.00
20	5.20	72.00	0.52	75.00
25	0.52	66.00	0.00	69.00
30	0.26	60.00	0.00	63.00
35	0.065	56.25	0.00	59.00
40	2.21	54.25	0.00	56.00
44	....	....	0.00	56.00
45	....	53.00	....	....
50	3.77	52.25	....	....
60	4.94	51.25	....	....
70	6.50	50.00	....	....
80	6.76	49.50	....	....
90	6.63	48.50	....	....
100	6.76	47.25	....	....
110	6.63	46.25	....	....
120	6.76	45.50	....	....
130	6.76	45.00	....	....
140	6.63	45.00	....	....
150	6.63	45.00	....	....
160	6.50	44.50	....	....
170	0.91	44.50	....	....
180	0.13	45.00	....	....

If the interpretation that has been advanced to explain the atypical, vertical distribution of the dissolved oxygen in Norris Reservoir is valid, then the same interpretation should hold for the atypical, vertical distribution of dissolved oxygen in Hiwassee Reservoir and in Lake Herrington. In other words, the observations on these bodies of water confirm the statements made elsewhere in this paper that density currents may occur in any reservoir that is shaped similar to Norris.

In addition to the above data, I have a note from L. F. Miller of this division from Decatur, Alabama, reporting the occurrence of a stratum of turbid water between the depths of 50 and 70 feet in Wilson Reservoir on July 16, 1940. On this particular date the water in Wilson Reservoir was clear to a depth of 50 feet and also below a depth of 70 feet. This stratum of turbid water was caused by a discharge of turbid water from Wheeler Reservoir. This discharge occurred during a cool spell and this water was of a temperature lower than that of the upper stratum of Wilson Reservoir. This layer of turbid water in Wilson Reservoir was very temporary, however, because of the large volume of water passing through the reservoir. This bears out the statement made in earlier reports on this subject, "that the permanency of the density current or of a stratum of water carried by a density current depends not only on the differences in density of the strata involved, but also on the volume and velocity of water movement."

Observations on Norris Reservoir have shown that the game fishes, bass, pike, and crappie orient themselves with respect to the stratum of stagnant water caused by density currents. During a wet summer, when the entire reservoir below a depth of 30 feet becomes stagnant as the result of the movement of large volumes of water below the surface, the game fishes tend to be concentrated in the surface water. This was the case in 1938. During 1939, when the stratum of stagnant water caused by density currents extended only about half the entire length of the reservoir, surface fishing was good in the upper sections of the reservoir where the fish were forced into the well-aerated but relatively warm surface water by the stratum of cooler, stagnant water. In the lower sections of the reservoir surface fishing was poor, but fishes were caught consistently at an approximate depth of 35 to 45 feet. The fishes stayed at this depth because oxygen was available at all depths and, hence, they reacted to differences in temperature and selected the temperature range that suited them best.

It must not be inferred from what has been said in the above paragraph that the orientation of the fish to this stratification is very precise. As already indicated, the stratum of stagnant water has a temperature that the fish prefer to the higher temperature of the well-aerated surface water. The result is that fish invade this stratum of stagnant water, even though it frequently leads to their destruction. It is not at all uncommon during the late summer to find apparently healthy adult bass and pike floating on the surface of the Norris Reservoir. These are fishes that have invaded the stratum of stagnant water, have lost their equilibrium due to the lack of oxygen, and have been brought to the surface by the buoyancy of the water. While the concentration of oxygen at the surface is ample to support fish life, it is not high enough to revive those fishes that have lost their equilibrium while in the stratum of stagnant water.

The loss of fish in Norris Reservoir, caused by the above condition, was most severe during the summer of 1937, when such a stratum of stagnant water existed throughout the entire reservoir from July through October.

It is possible that density currents may affect the productivity of a reservoir. This has not yet been demonstrated by any specific data, but it seems a logical conclusion to be drawn from the facts relating to the formation of density currents. In drawing this conclusion it is assumed that the incoming water, especially where it is highly turbid, may contain an appreciable amount of plant nutrients. If the incoming water, under such conditions, was spread over the surface of the reservoir it might increase the production of bacteria, phytoplankton, and zooplankton, and thus enable the body of water to support a larger population of small fishes or permit a given population to grow more rapidly. If this incoming water, however, moves as a density current below the zone of photosynthesis, this incoming nutrient material has no chance to enter into the economy of the reservoir and will pass through the reservoir without exerting any beneficial influence. In some instances, as in the case of Norris Reservoir, density currents have been detected as much as 60 to 80 feet below the surface. Our data on transparency of water in Norris Reservoir indicate that this is well below the photosynthetic zone. As stated at the beginning of this paragraph, the effect of the movement of the incoming water as a density current upon productivity has not yet been demonstrated, but it seems logical to assume that the productivity of Norris Reservoir would be increased if all of the incoming water would remain within the reach of the sun's rays.

CONCLUSION

The data presented in this paper show:

1. That density currents occurred in Norris (Tennessee), Hiwassee (North Carolina), and Wilson (Alabama), Reservoirs, and in Herrington Lake (Kentucky).

2. These data bear out the prediction that if a reservoir has a certain shape, density currents of a greater or lesser degree of permanency will be formed.

3. Density currents are, in all probability, much more common than has heretofore been realized.

4. Sub-surface strata of stagnant water formed by density currents exert an effect upon the vertical distribution of fishes and contribute to fish mortality.
5. Density currents may affect productivity.

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DISCUSSION

DR. THOMAS H. LANGLOIS (Ohio): I would like to ask a question, Mr. Chairman. In an earlier paper, Mr. Jones showed that the 1937 growth of largemouth bass was greater than in subsequent years, and I have been wondering whether there is some correlation between the 1937 mortality you mentioned and this excess growth for that year.

DR. WIEBE: That could be; of course there is another thing possible, too. In 1937 it may be that the shad population reached such a size that the game fishes really had plenty of food.

DR. LANGLOIS: I have been looking over these charts and wondering. Although they show a very definite decline in subsequent years—the same thing has been observed in Lake Erie, for instance—the rate of growth was rapid the first year. In Lake Erie, in some years the growth of walleyed pike is rapid the first year, then there is a series of poor years. You mentioned the phenomenon of stagnation—it may be due to heavy rainfall in some years.

DR. WIEBE: I believe we should be cautious in saying that the decline represents a definite trend. For some reason there may be a good spawn, or there may be plenty of fry to feed on in a given year. I don't think we should predict—on the basis of growth—that five years hence the growth at Norris will be 25 per cent less than it is today.

MR. L. D. LAMB (Texas): Along that same line, Dr. Wiebe, we have one lake (Dallas) where, for a short time after it was constructed, we had good fishing. Then the large fishes were taken out of it and for a period of about three years we didn't have any fishing to amount to anything, and the fish that were caught were either in unusually large or small sizes. Recently, within the last year or so, it has again become balanced and shows a definite trend toward producing better fish, and we are getting the intermediate sizes of all types. This lake is now about 14 years old.

DR. R. W. ESCHMEYER (Tennessee): Another factor which I think has been underrated is the effect of temperature. Checking on the time when growth is made, we are satisfied that the length of the growing season may vary as much several months as from one year to another. A difference in the length of the growing season probably would be reflected in a difference of rate of growth of the fishes. I believe that seasonal variations in temperature may be a lot more important than we have realized and that it is certainly a factor in the differences in rate of growth.

DR. WIEBE: In that connection I would like to say that plant physiologists stress the importance of the quantity of temperature received over a season, and I think that is what Dr. Eschmeyer has in mind. That is, you may have a very hot or short summer but the total number of degrees of temperature that water has received since it was at its minimum temperature will determine the amount of growth for that season. I think we should pay more attention to the sum of temperatures than to the absolute temperature.

DR. LANGLOIS: Mr. Chairman, I have one more comment; they are dealing with new reservoirs in this T.V.A. area. We have a few new reservoirs in Ohio, and some of them have been fished rather in tensively with nets in removing the fishes for planting in other waters. There has been a general tendency to try to safeguard fishes in newly impounded waters for two, three, or four years before permitting fishing, to build up the stock. In one of these Ohio reservoirs we started fishing without waiting for that time lapse, and it looks as though we had got in on the early peak. I think you found the peak of production to be the second year at Norris, didn't you? We did, too, and we have been fishing very intensively. It looks as though we were able to get a better sustained yield by beginning right away—when the peak is on, during the second year—and continuing an intensive fishing operation year after year.

I think the rate of turnover has a great deal to do with our productivity. I suspect that before we get through, we may be trying to influence our fish populations a lot more by withdrawals from stocks at critical periods than by additions to them.

A PRELIMINARY REPORT ON THE CENSUS OF COMMERCIAL FISHING IN TVA IMPOUNDMENTS

PAUL BRYAN AND DR. CLARENCE M. TARZWELL

Tennessee Valley Authority, Decatur, Ala.

The Biological Readjustment Division of the Tennessee Valley Authority undertook a census of setline or commercial fishing in Wheeler, Wilson, and Pickwick Reservoirs in the spring of 1940. The purpose was to determine the catch of food and coarse fishes, the relative abundance of the different species, and the economic importance of commercial fishing in the Valley. This commercial census was taken also for the purpose of determining the average income of those engaged in fishing, the cost of their equipment, the number of people dependent entirely or in part on fishing, and the views of the fishermen on regulations, licenses, and netting. The latter is important as in Alabama commercial fishing is by setline only whereas in Tennessee and Mississippi nets also are used.

The fishermen counts that were started on the lower reservoirs in the spring of 1940 were of value in connection with the commercial census, as they assembled information also on the location of fish-holding boxes used by the commercial fishermen. After contact was made with one fisherman, the names and whereabouts of others in the locality were readily obtained. As the census was to be taken on a voluntary cooperative basis, the first step was to gain the confidence of the fishermen and then explain the purpose of the census and how it could aid them. A special form was prepared for recording the total catch and the number and weight of each species of fish taken on each day of the month. A folder containing a number of these forms was distributed to each fisherman and the method for filling them out was explained and demonstrated. After the first interview, frequent visits were made to keep up interest, to aid the men in filling out the forms, and to collect completed forms at the end of the month. Some fishermen were interviewed in their homes and others at their work. Contact at the home proved to be the best method as the records were usually kept there. An attempt was made to have the fishermen mail in the forms, but this did not prove satisfactory. It was found that monthly or more frequent checking brought the best results, as with longer lapses of time the fishermen became lax in keeping records.

Seven hundred and seventy-four monthly commercial fishing records, reporting a catch of some 386,000 pounds of fish, were obtained on the lower three reservoirs from April to December of 1940. It is estimated that these records covered about half of the fishing on the reservoirs for this period. The number of records for each reservoir per month, the average catch per month, and the calculated total catch are listed in Table 1.

Thus a substantial sample of the fishing for each reservoir was obtained. The best was for Wheeler, where records were procured on about 62 per cent of the fishing. Reports were obtained on approximately 25 per cent of the fishing on Wilson, and 54 per cent on Pickwick reservoirs. Four hundred and twenty records were collected on Wheeler Reservoir, 97 from Wilson, and 257 from Pickwick. The average monthly catch for the period of the census was 615 pounds for Pickwick, 519 pounds for Wilson, and 424 pounds for Wheeler. The average monthly catch for all of the reservoirs was about 500 pounds. One reason for the larger average catch for Pickwick was that nets were permitted in the lower part of this reservoir, which is in the States of Mississippi and Tennessee.

Records were kept of fishermen who did not turn in reports, as well as of those who did. From these records an idea was obtained of the total number fishing on each reservoir per month. Assuming that those who did not submit reports had about the same average catch as those who did, it was calculated that the catch amounted to about 288,000 pounds on Wheeler Reservoir, 207,000 pounds on Wilson, and 304,000 pounds on Pickwick, or a total of nearly 800,000 pounds of fish. Including the fishes consumed by the families of the fishermen, which were

TABLE 1. SUMMARY, BY MONTHS, OF THE COMMERCIAL FISHING ON WHEELER, WILSON, AND PICKWICK RESERVOIRS DURING 1940

Month	Wheeler Reservoir					Wilson Reservoir					Pickwick Reservoir				
	Records secured	Pounds of fish reported	Average pounds per month	Total number of fishermen	Total pounds caught	Records secured	Pounds of fish reported	Average pounds per month	Total number of fishermen	Total pounds caught	Records secured	Pounds of fish reported	Average pounds per month	Total number of fishermen	Total pounds caught
April	66	18,293	277	85	23,500	10	6,967	697	50	34,900	....	....	....	....	
May	80	36,046	450	120	54,000	15	10,319	688	55	37,800	88	36,020	409	110	45,000
June	68	30,765	452	90	40,700	12	8,984	749	50	37,500	59	38,703	656	90	59,000
July	60	33,663	561	80	44,900	15	7,521	501	50	25,100	45	31,471	699	75	52,400
August	53	24,935	470	80	37,600	11	8,220	747	50	37,400	23	21,346	928	70	65,000
September	38	18,608	490	100	49,000	17	3,857	227	35	7,900	16	17,612	1.101	40	44,000
October	25	8,494	340	60	20,400	9	2,709	301	35	10,500	18	9,807	545	30	16,400
November	23	5,784	251	40	10,000	7	1,448	207	35	7,200	4	1,955	489	30	14,700
December	7	1,423	203	40	8,100	1	339	339	25	8,500	4	1,039	260	30	7,800
Totals	420	178.011	424	695	288.200	97	50,364	519	385	206,800	257	157.953	615	475	304.300

not recorded in the monthly reports, the total estimated catch from these reservoirs exceeds 900,000 pounds.

The relative abundance of the different species in the catch (Table 2) varied somewhat for the different reservoirs. Carp were well represented in the catch from all of the reservoirs and were predominant in that from Pickwick, comprising 42 per cent of the total. If the fishermen on Wheeler and Wilson Reservoirs had not made a special effort to avoid taking carp, it is probable that this species would also have dominated the catch from these reservoirs. Fishermen reported that carp were very abundant in Wilson Reservoir and that they could catch them in large numbers whenever they desired or could get a market for them. Carp were also abundant in Wheeler Reservoir and seem to be increasing. Yellow cat were predominant in the catch from Wheeler Reservoir, with carp ranking second and blue cat third. The yellow cat were also predominant in the catch from Wilson Reservoir, with blue cat ranking second and carp third. As a group the catfishes were the most valuable and they were predominant in the catch from all of the reservoirs, comprising 61 per cent of the catch from Wheeler, 79 per cent from Wilson, and 44 per cent from Pickwick.

TABLE 2. COMPOSITION OF THE 1940 COMMERCIAL CATCH FROM WHEELER, WILSON, AND PICKWICK RESERVOIRS

	Percentage of the weight of the total catch represented by each species								
Reservoir	Carp	Buffalo	Dogfish	Drum	Channel Cat	Blue Cat	Yellow Cat	Bullhead	Others
Wheeler	28	2	....	8	6	20	35	1	....
Wilson	14	2	....	1	10	32	37	....	4
Pickwick	42	5	....	7	4	22	18	....	1

According to the fishermen, drum and buffalo were not so abundant as before impoundment. Drum comprised the smallest percentage in the catch from Wilson, the oldest of the reservoirs. This species was, in general, in poor condition in the lower parts of the reservoirs and seemed to be decreasing in numbers. This is probably due to the fact that their chief food supply, the mollusca, has been greatly reduced or destroyed in the lower parts of the reservoirs due to silting. In the upper or river sections of the reservoirs, where there is sufficient current to keep the original river bottom clean, drum are still fairly abundant. The fishermen were unanimous in the opinion that carp and sturgeon were increasing.

In addition to the forms for recording the catch, a questionnaire was given to the fishermen for the purpose of collecting data on the number of persons wholly dependent on fishing; the number partially dependent on fishing; the percentage of their income derived from fishing and their other occupations; the quantity of fish consumed by the family of each fisherman; the number of persons in the family; the amount of fishing gear used; its value and the yearly outlay for gear; the baits used each season and the favorite baits for each species; the largest fish taken; the prices paid for the different species of fish; where they were sold; and the attitude of the fishermen toward netting and other fishing regulations.

One hundred and sixty-nine questionnaires were turned in by the fishermen. They represented about 60 per cent of those who fished on the lower three reservoirs and should serve as a representative sample. Of the questionnaires received, 93 were from Wheeler Reservoir, 23 from Wilson, and 53 from Pickwick. Among those who filled out the questionnaire, 43 per cent were entirely dependent upon fishing for a living and the other 57 per cent were partially dependent but had some other source of income. Among those with another source of income were 26 farmers, 24 day laborers, 3 ministers, 2 trappers, 2 blacksmiths, 3 school boys, and one each of the following occupations: bridge-tender, house-mover, mechanic, merchant, miner, dairyman, and boat dock operator. Five were engaged in both farming and trapping, 2 ran boat docks in addition to being day laborers, 19 were on the WPA, and 5 were on direct relief.

The fishermen who derived their entire income from fishing supported 287 persons, and those who devoted part of their time to fishing contributed to the support of 520 persons. From the data supplied in the questionnaire, it was calculated that 230 from the latter group were entirely supported by revenue derived from fishing. On the assumption that the same conditions applied to those from whom no questionnaires were available, it was calculated that setline fishing on the lower TVA reservoirs is the sole means of support for 860 persons, and that it supports wholly or in part 1,340 persons. In addition to being a reliable source of income for the fisherman's family, the fishing also provides one of their most important foods, the average yearly consumption by each family being estimated at 507 pounds. From this average it is calculated that families of fishermen along the lower three reservoirs consumed over 140,000 pounds of fish in 1940.

The equipment of the setline fishermen consists of lines and hooks, boats, live boxes, landing nets, and paddles. Each fisherman has from three to five lines. The average line is 400 feet long and has 100 hooks. The average yearly cost for the fisherman's equipment along the lower reservoirs is:

Lines	$50.00
Boats	7.00
Live boxes	3.00
Landing nets	4.00
Paddles	1.65
	$65.65

The average monthly catch of fish from the lower three reservoirs is about 500 pounds, excluding those eaten by the families of the fishermen. Those whose sole occupation is fishing have a considerably larger average monthly catch. Some of the more ambitious fishermen catch 1,000 pounds of fish per month, and it is estimated that the annual income of those who fish for a living is about $600. This averages $150 per year per man, woman and child supported, in addition to the value of the fishes eaten.

Most of the fishes are sold to peddlers who collect them three or four times a week. Catfishes and drum bring 10 cents a pound, buffalo from 3 to 10 cents, and carp 2 to 10 cents, depending on the season. During the summer months there is little demand for carp. The greater part of the catch is consumed within a radius of less than 50 miles of the reservoirs. Most of the fishermen live within a mile of the reservoirs, although some live at distances of from 7 to 8 miles. Some fishermen dispose of their catch by barter. In such instances fishes are exchanged for anything the fisherman or his family can use.

On the average the fishermen go over their lines three times a day. When several lines are operated, a great deal of bait is required. Although shad and cutbait are used throughout the year, there are some seasonal changes in the bait used, due to changes in the preference of the different species of fish and to the seasonal abundance of certain baits. In addition to the baits used the year round, the following baits are used in the different seasons: In winter, minnows, soap, and crayfish; in spring, small carp, worms, crayfish, table scraps, raw meat, spoiled meat, and soap; in summer, small carp, cutbait, grasshoppers, catalpa worms, and doughballs; and in the fall, grasshoppers, doughballs, chitterlings, and clams. Some preference is shown for certain baits by the different species of fishes. Carp prefer doughballs but will take almost anything including shad and minnows. The preference of the other fishes are as follows: buffalo, spoiled crayfish; drum, crayfish and worms; channel and blue cat, shad, cutbait, grasshoppers, and worms; and yellow cat, shad, small carp, and cutbait.

Some large fishes have been taken in the reservoirs. The weights of the largest reported to date are: spoonbill sturgeon, 35 pounds; sturgeon, 25; dogfish, 8; drum, 42; carp, 45; channel cat, 28; blue cat, 115; and yellow cat, 142, pounds.

The commercial fishermen's greatest problems are getting a sufficient supply of suitable bait, disposing of carp in the summer and fall, and keeping the fishes alive during warm weather until they can be marketed. Shad, the bait that it is used the year round, are readily available to fishermen who live near the dams where the shad congregate, but for those fishermen who live some distance from a dam the catching of shad is a serious problem as they have to drive back and forth to the dams and hire a boat in order to catch them. The collection of worms usually requires a trip to the hills some distance away.

As a rule carp sell reasonably well during the spring, but during the warmer months the entire catch cannot be disposed of as the fish buyers take only a small percentage of it. Some of the smaller carp are left on the lines as bait for yellow cat. Many fishermen try to avoid catching carp.

When it is possible to place the live boxes in springs the fish remain alive and in good shape. However, even though the boxes can be favorably located, there is still the problem of the carp. These fish have to be placed in a separate box as they will kill other fish of the same size confined in a box with them. In addition, many fishermen are not fortunate enough to live near springs and so have to place their boxes in the backwaters of the reservoirs where the water temperatures often vary between 90° and 95°F. Under such conditions the fishes become sluggish and often die in two days.

An examination of the commercial fishery on the TVA reservoirs indicates that certain improvements and changes would be desirable. Under the present system, fishing is done on a small scale by many individuals who are unable or unwilling to invest in proper equipment for caring for and handling their catch. Many who fish are floaters and drifters who have no permanent interest in the development of the fishery. The catch is handled under very unsanitary conditions, and thousands of pounds spoil each year. Many fishes are killed and thrown away, either because there is no market for them or because there are no proper facilities for keeping them alive until they can be marketed. One reason for the present conditions is that setline fishing is not adapted to operations on a large and profitable scale. Under correct supervision and inspection, coupled with an educational program, the opening of the reservoirs to netting for the food and coarse species would go a long way toward improving conditions. Netting would provide a large and consistent supply of carp which should insure a market and regular shipments to the larger eastern cities. Also, fishing on a larger scale would allow investments in equipment so that the fish could be properly cared for until they were marketed.

The fishermen were two to one in favor of permitting licensed netting in the reservoirs, but were opposed to a license for setline fishing.

SUMMARY

A census of commercial fishing was started on the lower three TVA reservoirs, Wheeler, Wilson, and Pickwick in the spring of 1940. A total of 774 monthly records of the commercial catch was obtained, which listed a catch of 386,000 pounds of food and coarse fishes. On the basis of these returns, it is estimated that more than 900,000 pounds of fish were taken from these reservoirs in 1940. The average monthly catch per fisherman was 500 pounds. Carp were predominant in the catch from Pickwick Reservoir and probably would have dominated the catch from the other reservoirs if the fishermen had not avoided this species. Catfishes were predominant in the catches from Wheeler and Wilson Reservoirs.

Approximately 43 per cent of those engaged in commercial fishing derive their entire income from this occupation. It is estimated that 1,340 persons were supported wholly or in part by commercial fishing in the lower reservoirs during 1940. The average fisherman spends \$65.65 for equipment, and it is estimated that those who devote their full time to fishing have a net income of about \$600 per year. Each fisherman's family consumes 507 pounds of fish annually. The fishermen experienced difficulty in marketing carp. The majority of them were in favor of permitting netting in the reservoirs under license.

DISCUSSION

CHAIRMAN JACKSON: Mr. Bryan, did you say that the family consumption was 500 pounds of fish per year?

MR. BRYAN: Just 507 pounds per family.

CHAIRMAN JACKSON: Do you know how many people represent a family?

MR. BRYAN: Taking the fishermen as a group, it averages four.

CHAIRMAN JACKSON: That is an amazing consumption of fish. It's the highest figure I think I have ever heard.

MR. BRYAN: It seems that the poorer the people were, the more fish they ate.

DR. THOMAS H. LANGLOIS (Ohio): Didn't he say the average catch was 500 pounds?

MR. BRYAN: The average catch per month was 500 pounds.

CHAIRMAN JACKSON: That is very illuminating. I think if we could get more people to eat that much fish, we would be in a class with some of the European countries.

The meeting adjourned sine die at four-fifteen o'clock.

TECHNICAL SESSION

TUESDAY AFTERNOON—FEBRUARY 18

Chairman: H. W. SHAWHAN
Director of Conservation, Charleston, W. Va.

Discussion Leaders:

DR. DURWARD L. ALLEN, *State Department of Conservation Lansing, Mich.*
DR. LOGAN J. BENNETT, *Leader, Cooperative Wildlife Research Unit, Pennsylvania State College, State College, Pa.*
WILLIAM J. TUCKER, *Executive Secretary, State Game, Fish, and Oyster Commission, Austin, Texas.*

DESIRABILITY FOR CONTROL OF PREDATORS IN WILDLIFE MANAGEMENT

DESIRABILITY FOR CONTROL OF PREDATORS IN WILDLIFE MANAGEMENT AS EXPERIENCED IN ARIZONA

K. C. KARTCHNER
State Game Warden, Game and Fish Commission, Phoenix, Ariz.

Originally there obtained a nature's balance that made the West a paradise for wildlife. What are now known as predatory animals had ample food in rabbits, prairie dogs, gophers, and other rodents, and there were deer, antelope, and elk for the mountain lion. Then came the encroachment of the white man with the necessity of making wild game a big part of his living. He also indulged in ruthless slaughter far in excess of his needs that resulted in wildlife depletion well known to all.

To further disturb nature's balance, a campaign was later waged upon rodents for farm and range protection, thus reducing the natural food supply for coyotes, wolves, bobcats, foxes, etc., resulting in change of diet for them, particularly the coyote. Despite a continuous campaign to reduce its numbers, this animal has increased and spread to the foothills and mountains where formerly it was hardly known. Its adaptability to changed conditions has been amazing. The coyote now kills cattle, deer, antelope, young elk, sheep, and any other animals available. It multiplies rapidly and continuous trapping, hunting, and poisoning are now necessary to control its depredations. If a game animal or cow is too big for one coyote to kill, others join in and it is not uncommon to find grown mule deer that have fallen victim to these predators. At this time the coyote is the greatest menace to upland wildlife in the State of Arizona. Next in importance are the mountain lion, bobcat, fox, skunk, and ringtailed cat. The mountain lion is of course the most destructive individually. It is believed that a grown lion will consume a deer per week throughout the year. However, the numbers of this species have been greatly reduced and at present big game losses from lion attacks are far less than from those of the coyote.

Lobo wolves, by the way, were entirely exterminated in the State some twenty years ago. However, some occasionally drift in from Mexico only to be taken soon by hunters and trappers of the Fish and Wildlife Service.

In a state like Arizona, with about 70 per cent of its total area under federal control, either as national forests, parks, monuments, or Indian and wildlife reservations, the problem of predator control is difficult. In addition to funds for supervision, the Fish and Wildlife Service has at its disposal approximately $19,000 per annum for predator control. The State Legislature now appropriates only $10.500 to be administered by the Fish and Wildlife Service, making approximately $30,000 all told, the greater part of which must be spent on livestock ranges, to aid stockmen who are perpetually menaced by losses from predators.

In view of the great disparity between federal and state controlled lands, the people of Arizona feel that the Federal Government should allocate more funds to be spent in the State for this much needed work. Based upon an annual appropriation of $10,500 by the State it is believed the Fish and Wildlife allocation for predator control should be increased to something like $24,500, based upon 70 per cent federal lands as against 30 per cent under state control.

The old bounty system has been tried throughout the country with varying degrees of success, mostly negative. Every few years an effort is made in our State, to restore that system. Under the bounty plan no efficient organization is set up. Predatory animals are taken from areas where they are most numerous without respect to whether they are a menace to wildlife or livestock. When the hides or scalps are paid for, the money is gone and the predator problem is about as it was to begin with. Without an elaborate system of checking on trappers, graft is inevitable so that in the end the system is more expensive than a well-regulated paid hunter and trapper setup.

Under the latter system you have direct control and sufficient elasticity so that areas, where damage is greatest, can be treated at once. Then too, the worst killers cannot be taken under a bounty system because the process is too expensive. After the bulk of predators are destroyed by bounty trappers, the wisest animals remain and it takes expert and persistent trapping to get them.

In Arizona if it were possible to increase the federal funds, as suggested, and still contribute such amounts as the Game Department can spare for augmenting the activities of the Fish and Wildlife Service, plus those for the trapping we are allowed to do under the Pittman-Robertson Act on special projects, we are convinced that Arizona's game population could be doubled in a few years. In illustration, consider the Kaibab National Forest where twelve years ago we had an estimated mule deer population of some 30,000 head—the product of no hunting and thorough predator control. As late as June, 1931 when the writer was a member of a national delegation which made a careful study of conditions on the ground, this was the most thoroughly devastated range that I have ever seen. Under optimum conditions the deer had become so abundant that they had eaten every vestige of vegetation from the ground up to as high as they could reach as fast as it appeared. The area was opened to hunting and predators were allowed to increase, so that at this time the deer herd has been reduced to something less than 10,000 head. This radical reduction had to be made in order to bring the range back to normal. That has been accomplished and at the present time there is an abundance of feed everywhere. The point here is that although hunters have taken anywhere from 5,000 deer in 1930 to 700 in 1940, it was predators that brought about the main reduction. Last summer the State Game Department, U. S. Forest Service, and Fish and Wildlife Service, after thorough joint examination, came to the conclusion that it was time to inaugurate a systematic predator control system. For the past twelve years coyotes and bobcats had been taken only in the cold months when their furs were most valuable. Mountain lions have been kept down fairly well by wealthy sportsmen employing competent local guides. Accordingly the Fish and Wildlife Service immediately assigned salaried hunters and trappers to the area. Although they did not get started until July, the records already show a 5 per cent increase in fawn survival over that of 1939. Under the new arrangement hunters and trappers will start in again early this spring, the idea being not to let up on predator control until we have built the herd back to its normal size of something like 15,000 deer—a number which it is believed the range can maintain without deterioration.

We feel that the National Park Service should change its policy with respect to predators. Big game animals are a prime attraction for tourists but as long as the Park Service maintains its policy of total protection for all wildlife, including predators, game populations in the parks are going to be at a low minimum. As already noted, the coyote in particular has left its old haunts in the open prairie country and is now to be found throughout the high mountain areas. In fact, there it may be considered an exotic but from that or any other point of view, we deem it highly important that the National Park Service change its policy with respect to predatory animals and join in a co-operative arrangement whereby predators will be brought to the lowest possible minimum as on adjoining game areas, where it is naturally much more difficult to keep predators down with the parks serving as a breeding ground for them.

We have to deal also with a sentimental group, who for the most part are not acquainted with Western conditions and who would protect all wildlife to preserve a balance of Nature which as we all know, has been so thoroughly disturbed by man that it can never be restored.

DISCUSSION

DR. BENNETT (Pennsylvania): Is the coyote population increasing in spite of the predator control that has been going on?

MR. KARTCHNER: Yes, we probably have more coyotes in the State of Arizona today than we have had at any time in the past twenty years. There are various reasons, one being that coyote skins have been of very low value, hence private trappers have gone into other lines. The Fish and Wildlife Service, as I stated, have some of the best trappers and hunters in the world, but they don't have enough of them. Their force should be at least doubled.

In our Pittman-Robertson projects we can clean up an area that we intend to plant with some species that probably was there originally and has been extirpated. We think by working in all possible ways (and I believe the Taylor grazing people are planning to devote a certain amount of money for predator control) we will solve the problem sooner or later, but so far, we have been unable to cope with the coyotes.

DR. BENNETT: About how many coyotes are now being taken in Arizona each year, and how many do you think would have to be taken to get them under control?

MR. KARTCHNER: I believe that last year some 3,800 coyotes were taken. In my opinion, from seven to eight thousand would have to be disposed of to make a real reduction in this species.

MR. JOHN M. ANDERSON (Illinois): Would it be possible, by allowing more wolves to live, to bring about a decrease in the coyote population?

MR. KARTCHNER: A wolf is about the most destructive animal you can imagine. The cattle interests in the State of Arizona wouldn't stand for any consideration that would benefit the wolf.

MR. ANDERSON: What is the economic effect of a small wolf population compared to an excessive number of coyotes?

MR. KARTCHNER: Wolves were much more easily exterminated; they were so unusually destructive that everybody got after them. A wolf can kill a grown cow or a horse any time and may go on and kill another the same day. The coyote has changed not only his habitat but his diet due to the encroachment of man; where once it was only found on the prairies and ate gophers and prairie dogs, it has moved up into the mountains now and takes any animal that is available.

MR. DOUGLAS E. WADE (Missouri): The speaker stated that if predators could be removed the game population would be doubled. I would like to have him expand that a little more.

MR. KARTCHNER: The Game Department is no more for range depletion than the Forest Service or any other landowner. We realize that a good, healthy vegetative growth is absolutely necessary to a good game supply. There are many areas in the state where the game population could very well be double what it is today, and should be, to be in keeping with the carrying capacity of the range, having in mind livestock and any other interests that may be involved, but we could double the game supply in Arizona, taking the state as a whole, and still have a good food supply. Naturally, we would have to be sure that our reduction machinery was in working order, that it would remove the surplus each year.

MR. V. W. LEHMANN (Texas): In one county in Texas we have been taking up to around ten thousand predators annually for about ten or fifteen years and we haven't made a dent in them yet. I just came from a ranch where we caught a thousand. I have been from one end of Texas to the other, through all the game country, and I have yet to find a single ranch on which an increase of game can be directly attributed to predatory animal control.

MR. KARTCHNER: I grew up in Arizona and I remember a time when it was unheard of that a coyote killed a calf or a deer; it had plenty to eat without making any inroads on such animals. Now, however, there is nothing else for them to eat. The rodent population is down to a point where it doesn't furnish them enough food, and they must eat deer and antelope, young elk, and cattle in order to survive.

MR. ELLIOTT S. BARKER (New Mexico): If Mr. Lehmann will come to New Mexico, we can show him plenty of examples where game has benefited through predator control on some areas, and suffered terribly from lack of it on others.

Permit me to cite the example of the Jornado Range Reserve, an area of about 200 square miles under Forest Service administration, a herd of 40 or 50 antelopes did not increase appreciably in a 25-year period, despite the fact that they had full protection and an excellent range—in fact, every advantage except that the coyotes and golden eagles on the area also were protected. The policy of predator protection was changed three or four years ago, great numbers of coyotes and some golden eagles have been taken, and the antelope herd has doubled in numbers.

On a similar area of approximately the same size, known as the Flying H Ranch, twenty years ago there were only about 30 antelopes. This range had never had refuge protection, but there was little poaching, and the ranch owners were always favorably inclined toward game of all kinds. The country was heavily grazed by sheep and cattle and the antelope had no special advantage except absolute predator control, as the ranch is enclosed with a coyote proof fence, and golden eagles have been kept to a minimum.

Here the increase from 30 head of twenty years ago has been such that we have removed some 500 bucks through permit seasons, trapped for transplanting more than 600 head, and still have 1,000 left on the ranch.

Now, as to the wolf as a factor in coyote control, I know of no evidence that wolves ever kept down the number of coyotes. I worked frm 1912 to 1919 in Rio Arriba County, New Mexico, where both wolves and coyotes were very numerous. Coyotes often fed on what was left of the carcasses of cattle, sheep, and horses, that had been killed by the wolves. One trapper, Pete Gimson, whom we hired in the fall of 1915, trapped 16 wolves and 69 coyotes in a 60-day period on the same area.

THE ADVISABILITY OF PAYING BOUNTIES FOR THE KILLING OF PREDATORS

RICHARD GERSTELL
Pennsylvania Game Commission, Harrisburg.

Present indications are that sound wildlife management possibly may require under certain conditions some degree of carefully executed control over one or more predatory species throughout a given area, or areas, during a specified period, or periods, of time.

The purpose of this paper is not to say when, where, and how control is to be applied, but rather to discuss the advantages and the disadvantages of paying bounties for the destruction of predators, once the need for that action has definitely been established.

The premise of the discussion is that the aim of predator control is the protection of game rather than personal property, while all generalizations are based on the writer's studies of the Pennsylvania bounty system. Statistical data supporting the statements are to be found in ***Research Bulletin No. 1*** of the Pennsylvania Game Commission, entitled "The Pennsylvania Bounty System." Printed at Harrisburg, Pa., in 1937, the publication is now out of print, but copies are available in many private and public libraries.

Broadly speaking, to be of any appreciable value as a sound means of predator control, a bounty system must embody three principal features. First, the entire responsibility for its operation must be vested in a qualified conservation agency, not an elective, law-making body. Second, the operating organization alone must possess the power to place any species of bird or mammal on the predator list, or to remove it therefrom, to set the rates of bounty payment, and to declare the areas for and periods of their effectiveness and the power, combined with a specific obligation, to pass upon the validity of each and every claim presented. Third, there must be adequate legal provision to allow for just and impartial prosecution of any and all attempts at fraud.

The advantages to be derived from the operation of a bounty system are of several types. Each of these is briefly treated below.

Educational—Among the greatest benefits derived from the payment of bounties, are those of an educational nature. The first of these is concerned with the usually pleasant contact formed between all the various bounty claimants and the conservation agency. This probably is of especial value to the more recently organized departments, which are as yet in urgent need of direct associations with rural residents.

It is through such ties that the organization frequently is able best to win approval for its general program.

Secondly, the practice, at least to some degree, has served to educate the public to the necessity for predator control. In this connection, however, there is a serious question as to whether or not the system tends to overemphasize the relative importance of this phase of wildlife management.

Thirdly, the establishment of bounties for the destruction of certain species frequently leads to the development on the part of the interested public of a wider knowledge of animal identification. For example, when rewards are first provided for the killing of particular species of hawks, or owls, many individuals of species for which no bounty is offered are presented in claim for payment. Through the rejection of these erroneous claims, the identification of certain species is gradually learned by a large number of people. True it is that this may be a somewhat wasteful method of education, but it nevertheless produces appreciable results.

Economic—The widespread distribution of large sums of money in the form of bounties is of no small economic import. Unfortunately. accurate appraisals of all the various factors involved are beyond our present reach.

It appears however, that at least some of the economic results of the system are advantageous. In the first place, the payments have frequently meant much to rural families upon whose lands a large percentage of our annual game supply is produced. Occasionally they may represent the difference between a landowner's taking, or not taking, an interest in the protection of game. Secondly, they definitely provide at least small remuneration for efforts made by landowners and others to improve hunting conditions through the control of predators.

Around points such as those just mentioned, however, bitter controversy rages. Many persons are strenuously opposed to the employment of professional trappers for control work. Others are equally antagonistic to the payment of landowners for shooting privileges, though the persons controlling the land can, as a general rule, regularly sell the hunting rights on their properties only if they take some action aimed at the protection and increase of game. Thus there arises the question as to whether or not a conservation department, supported primarily by funds paid in by hunters, should pay indirectly for some of the things for which so many gunners are unwilling to pay directly.

Similarly, it may be argued that the landowners, who provide the natural habitat for so much of our wildlife, are entitled to whatever financial gains they may derive from the payment of bounties, regardless of whether their actions were motivated by a desire to kill the predators for the protection of game. Here the question is, of course, whether the rural families should be granted financial assistance of this type, desirable as it may be, by the conservation agencies or by other state and federal organizations.

Another economic advantage of the system is that it stimulates an interest in trapping, which is the principal method of harvesting that highly valuable annual surplus represented by the yearly fur crop.

Investigative—Though frequently not utilized, another advantage of the bounty system lies in the fact that it can be made the source of supply of large numbers of individuals of the same or of different species that may be desired for investigative work. The collection of such specimens is essential to research in taxonomy, animal distribution, reproduction, food habits, and other subjects. The data procured through such studies are now sorely needed in connection with the development of sound management programs.

As with its advantages, the disadvantages of a bounty system fall into several generalized groups.

Limitations of Application—Principal among the disadvantages of predator control through the payment of bounties is the fact that the species to which it can successfully be applied are definitely limited in number.

Experience would seem clearly to indicate that the practice is applicable only to the larger mammalian forms with relatively low population totals. Even among such species, effective control can be expected only under relatively high rates of payment.

Numerous attempts at control of the medium-sized and small mammals, as well as the birds of prey, which are mostly migratory by nature, have met only with failure, regardless of the rates of payment.

Inefficiency—The payment of bounties for the destruction of predators in an effort to relieve undesirable pressure upon game species is highly inefficient. This is due primarily to the fact that it is impossible to differentiate between those specimens killed because of the bounty and those killed for other reasons, but which are nonetheless presented with claims for payment.

For example, there are many animals killed either for sport or in protection of personal property regardless of whether or not a bounty is offered for their destruction. Under a bounty system, many of these are, however, presented in claim. Obviously, each and every payment of this type represents money wasted—money paid for an act that would have been consummated anyway without remuneration. Claims of this type represent in most cases a large percentage of the total filed.

Encouragement of Fraud—Whenever rewards are offered for the killing of predators, there is at the same time set up encouragement for the attempted perpetration of frauds. This difficulty has without doubt been the primary cause for the repeal of the majority of our bounty laws.

Under a well-devised system, such as previously defined, there is, however, little or no reason to believe that such acts cannot be kept to a reasonable minimum by carefully checking all claims before payment and by diligently prosecuting every attempt at fraud.

SUMMARY

It would in summary appear that as a general rule it is for three principal reasons unwise to attempt the control of predators through the payment of bounties.

First of all, the successful operation of any bounty system depends upon precisely drawn legislation which even under present day conditions is most difficult to achieve.

Secondly, the advantages of the system are far more than balanced by its disadvantages. For example, the educational benefits derived from the practice can doubtless be better and more efficiently accomplished through the public information divisions of the conservation department, using modern techniques including the motion picture and radio, than by offering rewards for the killing of certain birds and mammals. Also, as already pointed out, the system's principal economic advantages are open to question, while most departments should be in position to obtain more desirable research material through the cooperation of its own personnel and other interested persons than through the collection of specimens killed at random by untrained workers. On the other hand, limited application, inefficiency, and the encouragement of fraud are undesirable factors which cannot be entirely divorced from the operation of the system.

Finally, though some few particular predator problems can admittedly be solved through the payment of bounties, opportunities for such use of the system are comparatively rare. At the same time, the very possession of the power to declare bounties almost constantly places upon the conservation agency strong, though usually unwarranted demands for application of the system to problems which they do not fit. Unfortunately, most departments are not as yet strong enough to withstand public pressure of this type. Thus, the system is likely to be used not only in cases which it does not fit, but also in others based on fiction rather than fact. Needless to say, that is both undesirable and indefensible.

DISCUSSION

DR. DURWARD L. ALLEN (Michigan): I noted, as I am sure many of you did, that Mr. Gerstell laid down some premises and reached some conclusions that anticipated queries that might have arisen. Nevertheless, any who desire should ask questions.

I have one: Do you feel that any predator control at all on a statewide basis is necessary to satisfactory production of game in Pennsylvania?

MR. GERSTELL: I can conceive of a time and of situations when it might be desirable over the Commonwealth as a whole to control some particular predatory species, and if it can be shown that it is necessary and desirable to do so I would say let's have statewide predatory control for those species.

CHAIRMAN SHAWHAN: I believe that you are now paying a bounty of $4.00 on both the red fox and the gray fox. Did your decision to do that originate with the Game Commission of Pennsylvania or was it in response to public demand?

MR. GERSTELL: The bounty on the gray fox in Pennsylvania has been continually in effect since the present system was inaugurated in April, 1915. From that time up until 1929 we paid on both the red and the gray fox. In 1929, because it was felt that the fur price was sufficient at that time to effect the necessary control over the red fox, the legislature, which then controlled bounty payments, removed the red fox from the list. Last July our Commission, after due field investigation and after plenty of public pressure, concluded that there was in certain parts of Pennsylvania a fox problem. In about two-thirds of the northwestern counties of the Commonwealth the Commission placed, for a limited period, a bounty on the red fox. Our observations since would seem to indicate that the bounty is bringing in a number of foxes which otherwise would not have been taken, and that is helping to alleviate a problem.

MR. ED. V. KOMAREK (Georgia): Have red foxes and gray foxes increased in West Virginia and Pennsylvania in the last three or four years?

CHAIRMAN SHAWHAN: Speaking for West Virginia, I would say that the gray fox has increased materially, due very probably to the continued low price of the fur during that period.

MR. GERSTELL: Speaking for Pennsylvania, I am quite certain that, taking the Commonwealth as a whole, in the last four years there has been an increase in both red and gray foxes, and I would like to go one step farther and point out that the increase in gray foxes has taken place under constant bounty payment.

MR. KOMAREK: If I am not mistaken, it appears that both the gray and the red foxes are increasing in numbers, and have been for the last five years. Whether this is a cyclic phenomenon I don't know, but it seems to me that it might be well for The Wildlife Society to set up some study of the matter. Throughout the Southeastern States foxes, particularly the gray fox, have increased tremendously.

DR. CARL O. MOHR (Illinois): Mr. Gerstell referred to the bounty system as having alleviated their problem somewhat in Pennsylvania. Do your records show a definite increase in one or more species of game in those areas in which the bounty system has been put into effect?

MR. GERSTELL: In some instances, yes, but I am unable to say that the increase was due entirely to the control of the predators, although it may have been; in other words, I can't prove that it was; also I can't prove that it wasn't.

DR. E. L. PALMER (New York): Isn't it possible that an increase of foxes might accompany an increase in game?

CHAIRMAN SHAWHAN: I cheerfully concede the possibility. From time immemorial an increase of game lasting over a period of years has resulted in an increase of predators.

SOME COYOTE-WILDLIFE RELATIONSHIPS

E. E. HORN
Fish and Wildlife Service, Berkeley, Calif.

In the Western States the coyote is a predator of major importance. Since early settlers shipped strychnine around Cape Horn in 1848 to fight predators, the stock raisers have reported losses from coyote depredations on their herds and flocks. Later, in the history of our western country, biologists, sportsmen, and game enthusiasts waged a verbal battle regarding the influence of predators upon deer, antelope, elk, and other game species. Ardent sportsmen demanded heavy control to favor game; ardent biologists took an equally firm stand in demanding no control, and stressing the necessity of "balance of nature," to bring about the optimum conditions for game desired by both factions; and the general public was left to wonder what it was all about. No serious question seemed to arise concerning the mountain lion. It has generally been accepted as a killer and the classical estimate that a lion kills 52 deer per year seems to stand unquestioned. Bears, excepting the grizzly, share a better reputation, only an occasional one becoming highly predatory. Controversy has been rife with respect to the coyote, however. He kills the stock, eats the deer, robs the hen house, sucks the eggs, holds the rodents in check, and is essential to a biologically-balanced farm, according to who is speaking. When there is such divergence of opinion, there must be either a dearth of factual data, or a limited viewpoint justified, perhaps, by experience under given conditions but not properly applicable throughout the range of the coyote.

In an endeavor to procure better answers to these questions, the Forest Fauna Research Project of the Fish and Wildlife Service has been conducting specific studies of predation in California for the past five years. One piece of work on coyote-deer relationship was carried on cooperatively with the Fish and Wildlife Service, the U. S. Forest Service on the Los Padres National Forest, Santa Barbara County, California, and with the California Division of Fish and Game. Other studies on coyotes and their prey have been, and are, in progress in Madera and Fresno Counties, and plans are now completed to begin a similar study in Modoc County on March 1, 1941. It is highly important that studies be made on areas presenting radically different ecological conditions if we are to obtain an accurate idea of coyote-prey relationships throughout the range of the animal.

The same method of study has been followed in conducting all of these investigations.

1. A systematic collection of scats has been made from definite

travel-ways, at regular intervals, for more than a year, during which period there was no disturbance of the predators or their prey. These scats were analyzed to get information concerning the food.

2. Systematic trapping of rodents, and other field work has been done to get an index of available foods.

3. Predators have been trapped and their stomachs examined as a check on the data from scats.

4. Finally coyotes have been kept off the area by continued trapping, and following changes noted. A comparable check area has been maintained, whenever possible, where coyotes were left undisturbed. These intensive studies have been carried on over a period of years to yield sound data.

After a limited amount of work on coyote predation in various sections of California, a systematic study was begun on the San Joaquin Experimental Range, in the Sierra Nevada foothills on the east side of the San Joaquin Valley. This area is under complete control, and is not subject to changes of usage, unless they are desired. Part of its 4,800 acres is grazed by cattle. Rodents are undisturbed. No hunting is permitted. At first coyotes were unmolested, but after six calves were killed by coyotes one spring, the animal husbandry man and the range superintendent insisted that these carnivores be removed. No deer occur on this range, and there are but few of these animals in the first few miles up into the mountains to the east. Analysis of scats showed that 82-83 per cent of the coyote food, by frequency of occurrence, was rodent. No remains of deer occurred in the scats. Now, according to theory, the removal of coyotes should result in an increase in the rodents and rabbits that constituted their main diet. Intensive rodent studies before, during, and after control of coyotes here showed that the ground squirrels have dropped to only one half of the number present when the study started, and when coyotes were present. This drop occurred after coyote control was inaugurated. The number of cottontail rabbits increased, while the coyotes were present, remained about level for two years after coyotes were trapped, and dropped to about fifty per cent during the past fall and winter. Kangaroo rats, present in numbers of not less than 30 per acre when coyotes were present, suffered a heavy decline and became scarce over a six-weeks period before coyotes were removed. It is far safer to assume that disease had more to do with these fluctuations than did the presence or absence of coyotes. Gray foxes, bobcats, hawks, and owls are present in considerable numbers, and study of their food indicated that they may be far more important as rodent predators than are the coyotes. In this instance, coyote control alone did not bring about an upward trend in rodents.

Some five years ago, sportsmen who hunted deer in the brushy mountainous country of Santa Barbara County requested that the U. S. Forest Service remove coyotes from certain portions of the Los Padres Forest—a source of water for domestic use of southern California cities. This watershed is closed to agriculture and livestock grazing. Hunting and fishing are allowed, only under special permit and no automobiles are admitted. The unit was ideal for controlled studies. In accordance with existing agreements, the Forest Service asked the Fish and Wildlife Service to conduct a study of coyote-deer relationships and it fell my lot to outline the program and direct the study.

For more than eighteen months systematic collection of scats yielded nearly 7,000 specimens. Analyses showed that, deer remains were found in some 60 per cent of these scats. All rodents and rabbits combined, occurred in only 23 per cent. Insects and fruit were of about equal frequency with the rodents. Deer was by far the predominating item. Hoofs of fawns were quite common in the scats. On the basis of this study one could assume that deer constituted the major part of the diet, and might deduce that coyotes play a big part in holding the deer population in check. Our aim was to test the results of scat analysis as an indicator of predation, and to determine accurately just what influence coyotes have upon the deer of this area.

After eighteen months of scat collecting, 371 coyotes were trapped on 160 square miles of this area, while an additional area was left untrapped as a check. Examination of stomachs of these trapped animals gave reasonable agreement with the scat analysis, and though occurrence of deer in the stomachs was somewhat lower, it was more than 50 per cent. Systematic trapping has continued ever since.

From the start of this study attention was given to the numbers of deer, their movements, food, condition, sex ratio, and age classes. Coyote populations were also followed. Numerous kills of deer by coyotes were studied. Snow occurs only on the highest part of this area, but still coyotes can and do pull down and kill healthy adult bucks. Forest Service studies of the Rocky Mountain mule deer in Modoc County showed that a lone coyote can kill a 200-pound buck, if a wire fence is present to deflect the deer, and that two or more coyotes can kill a healthy buck in open country.

After coyote removal, there was an increase in fawn survival each year. In brief, this study shows that coyotes on this area feed largely upon deer, and that the removal of the coyotes has resulted in increased survival of fawns with an increase in the younger age classes of deer.

Study of smaller mammals showed that a marked decrease in squirrels and rabbits, took place after control of coyotes. On all of the areas we have studied intensively in California, we have not obtained one bit of factual data which indicates that rodents or rabbits have increased following removal of the coyotes. Rather, rodents have decreased, and the circumstances strongly indicate that fluctuations in rodent and rabbit populations occur that are unaffected by the number of coyotes.

This study is now being continued by the California Division of Fish and Game as a Federal Aid Project. From all present indications, coyotes on this area do exert considerable influence in holding the numbers of deer in check. If that is true, and coyote control is made a part of management of deer on the area, it will be necessary in herd regulation to increase the hunter take of deer. Inviting more hunters would increase fire hazard and that can not be tolerated in this watershed area. A change in the open season to December might help. If increased hunting can not be allowed, the amount of coyote control should be limited to what will favor the proper size of the deer herd. Here the problem truly becomes one of proper land utilization, and not a simple one of coyote control.

CONCLUSIONS

Study of scats and stomachs from Santa Barbara County, California, showed that deer constituted a large part of the diet of coyotes. Removal of these predators from 160 square miles has been followed by increased survival of fawns, and by a decrease in rabbits and rodents.

Coyotes in the foothills of Madera and Fresno Counties feed principally on squirrels and other rodents. Deer are not present. Rodents and rabbits decreased after removal of coyotes, and some species are again increasing.

These studies indicate that coyotes play a measurable part in regulating the numbers of deer, but do not control the rodent-rabbit populations.

Increased research on specific ecological units is essential to develop management plans that include predator control.

DISCUSSION

DR. LOGAN J. BENNETT (Pennsylvania): I would like to ask Mr. Horn if he noticed any changes in the rodent populations that appeared to be correlated with the varying degrees of grazing by domestic cattle.

MR. HORN: We have made some intensive studies of rodents in relation to range in two different places in the State. Those areas are divided into carrying capacity pastures grazed at the rate of 10 acres, 15, and 20 acres per animal. There is no correlation between these intensities of grazing and rodent populations. When grazing is completely eliminated there may be a complete change in plant composition. Certain forms that are important to rodents as alfilaria, bird clover, and ground lupine tend to go out, and they are replaced with Bromus, rushes, and other comparatively worthless plants.

Under those conditions, in some places we have noted a reduction in the number of squirrels. We have, however, observed an increase in the number of pocket gophers, probably due to cessation of trampling by grazing animals.

MR. ED. V. KOOMAREK (Georgia): Perhaps I missed something, but in that first area where you were studying the effect of coyotes on rodent population, did you have a check or a controlled area where you did not trap coyotes?

MR. HORN: No.

MR. E. R. KALMACH (Colorado): If the coyotes had not been trapped would the increased number have kept the rodent population at a lower level?

MR. HORN: While we did not have a check area, we were fortunate in doing intensive study on that same area for a year and a half before the coyotes were removed. During the time the coyotes were present in full number and uncontrolled, we had approximately 12 squirrels to the acre. About a year after they were controlled, our squirrels perished from some cause and they now are down to a point of around 2.4 or 2.5 to the acre.

MR. PAUL E. OSBORN (Iowa): Mr. Horn stated that in the years following coyote control the fawns increased. I wonder if he would care to say how much.

MR. HORN: We have not yet analyzed the data for that census, but the first year, as I recall the figure, there was about a three-fourths survival, and the second year, a bit higher than that. It was a rather material increase.

MR. V. W. LEHMANN (Texas): Perhaps other conditions resulted in better deer and, therefore, more fawns; to what do you attribute the increase?

MR. HORN: As far as we could tell, there was no greater number of fawns; it was just a case of more of them surviving.

One other thing I did not mention is the effect of predation upon the vigor of the herd. A lot of the predation is on the fawns. You often hear that the coyote takes only the weak and the sick. In four years' study in the field a good many kills were followed through; we would hear the chase begin, tell when the coyotes pull the animals down, and go and see what they captured. They were not the weak, they were good, healthy deer. As far as fawns are concerned, the coyote can take the strongest as easily as the weakest.

MR. LEHMANN: How many buck deer did you see the coyote kill?

MR. HORN: I don't know that I can quote you the exact figures. You will find them in a publication now in press. As I remember, on this Santa Barbara unit there were some 15 or 18 bucks and does observed or found killed.

MR. LEHMANN: Did you ever find a place where there was coyote hair and old doe tracks?

MR. HORN: No; but certainly not every attack on a deer is successful. We found places where there were signs of a struggle but no deer kill.

MR. KOMAREK: Isn't it logical to assume that if we harvest a game crop it may also be necessary to harvest a predator crop?

MR. HORN: If we are going to use control of predators as a tool for game management we have got to consider it in two lights, as a means of increasing game and as a means of decreasing game. I think it would be unwise to go into an area and endeavor to kill off the predators, hold them down, and do nothing else about it. On our area, if we get the increase that is indicated by present data, we are going to have to do one of two things, we are going to have to increase the number of hunters to keep down the number of deer and keep them in balance with the available food for we are going to have to leave enough predators, if they are the limiting factor or some factor, to take the surplus that we can't remove by hunting.

PREDATOR CONTROL IN SOUTHEASTERN QUAIL MANAGEMENT

HERBERT L. STODDARD AND ED. V. KOMAREK
Thomasville, Ga.

During recent years, much has been said and written concerning the necessity of controlling predators in quail management. In the past ten years we have arrived at the following conclusions and practices, which are based on the studies of the Cooperative Quail Investigation from 1924 through 1928 and of the Cooperative Quail Study Association from 1931 until the present, and on our experience on approximately a hundred of the major quail preserves from South Carolina to Arkansas and southern Mississippi. As a guide in our practical work we have information acquired from the history of some twenty-five hundred quail nests in the Thomasville-Tallahassee region, and elsewhere; from a preliminary study of stomach contents of a considerable number of predatory mammals found most destructive in the nesting studies; and from field studies in the region totaling more than seventeen years in the case of the senior author and more than ten for the junior. A valuable supplement has been furnished by the history and game data of some sixty preserves with which we have been regularly connected in a consulting capacity, as well as of nearly as many more that we occasionally visit—comprising a total of approximately a million acres owned and managed primarily for quail shooting, well distributed over the Southeast, although chiefly in the coastal plain.

For several years the managers of some of these preserves have energetically controlled limited groups of mammals and reptiles upon our recommendations; others have done nothing, or have followed their own ideas. In the light of these different policies, and with the carrying capacity of the lands known to us, records of the number of quail killed annually has been fully as helpful in clarifying our ideas on the value of predator control as have the first-mentioned studies.

Consideration of man's past and present relation to game and predatory animals is necessary in appraising predation on quail, particularly where these birds are the primary crop of the land. There can be little doubt that the natural balance was upset by eradication of the puma and wolf by the early settlers of the region and by the bringing of a portion of the land under the plow. Night hunting of the raccoon, opossum, fox, skunk, wildcat, and other small furbearers with dogs was a major sport in the Southeast for at least a hundred years, and probably helped prevent the development of undue numbers of these predators. Later, rising fur prices stimulated night hunting and trapping for a short period, though this again declined around 1930, coincidental with the fall of fur prices.

The sport of night hunting with dogs is dying, largely due to the recent development and widespread enjoyment of the radio, motion picture, and automobile; all of which have brought about a rapid change in the habits of country people in the Southeast. At the same time, night hunters have been excluded from many areas by the development of deciduous undergrowth, fences, and prohibition of trespass.

During this period the Southeastern Pine Belt has been undergoing a profound ecological change brought about by forest management and fire exclusion. Formerly there was a certain degree of favorable uniformity in land-handling practices of the entire region. ''Roughs'' were burned out about as fast as they developed and night hunting and trapping were carried on, as was the shooting of quail by all those who cared to. But profound and unfavorable changes (from the quail shooting standpoint) are taking place, and these have to be taken into consideration by the game manager.

We believe the great increase of the gray fox (over the more forested parts of the Southeast, at least) may be due to a combination of the trends mentioned. Certainly, the deciduous undergrowth developing in unburned pinelands and the prohibition of trespass deter night hunters and trappers and offer scattered sanctuaries for mammals such as foxes. At the same time, rodents usually increase tremendously during the first stages of the vegetative cycle following fire exclusion, insuring foxes an abundant food supply. When our studies were started in the Thomasville-Tallahassee section in 1924 the gray fox was comparatively scarce; now it is too abundant. Such an increase is widespread over the Southeast, and over-abundance is believed responsible for the recent outbreaks of rabies among foxes in several counties of Georgia and South Carolina. Since dogs usually become infected as a result of these outbreaks, the condition is a serious one.

Preliminary examinations of some four hundred gray fox stomachs, taken during the quail breeding season on preserves where the approximate numbers of these birds are known, show serious destruction of quail eggs and young in some years, and but little in others; there is a strong indication that proportionate destruction is greatest where abnormal fox abundance occurs, and that availability of other food supplies exerts a profound influence.

The same tendency to reach over-abundance seems equally true of skunks—at least those of the genus *Mephitis*. These animals multiply whenever night hunting or fur trapping declines, especially on unburned hill lands, and may reach abnormal abundance within a very few years—after which diseases and other factors may be expected to reduce their numbers drastically at intervals. Where abundant, skunks of both genera, *Mephitis* and *Spilogale,* have proved especially destructive to quail in the Southeast due to their egg-eating habits.

The prolific opossum also is an egg-eater and may be expected to become too numerous for the good of quail wherever the specified conditions prevail.

As mentioned, we have had exceptional opportunities to correlate the decline in quail kill on preserves where these small predatory mammals (as well as house cats and cur dogs) have multiplied without restraint, either on the ground in question or in surrounding country, and to note the rise in the number of quail taken following reasonable control. This striking correlation is responsible for our effort to collect at least a thousand stomachs each of the gray fox, opossum, and the two kinds of skunks, during the breeding months of quail on lands where quail populations are approximately known. This has become a major project of the Cooperative Quail Study Association, with the cooperation of the United States Fish and Wildlife Service, and is to extend over a series of years. We hope these studies, when used in comparison with those first mentioned, will clarify the predation picture in many details. While a good deal of reliable data exist on the food habits of these mammals during fall, winter, and early spring, it is woefully deficient for the summer months.

Meanwhile, we believe we have sufficient practical evidence to justify recommending to quail preserve owners that they conduct routine control of foxes, opossums, skunks, house cats, and cur dogs—preferably by night hunting. The extermination, even locally, of wild furbearers is not the object; but merely keeping them in numbers approaching "normal."

In the Southeast the bobwhite is, for all practical purposes, single-brooded and, while these birds continue nesting attempts from late April to August or September if necessary, they cannot perpetuate and furnish a shootable annual surplus where combined pressure from natural enemies is too great during the breeding season—even though food and cover conditions approach the ideal. This pressure comes from many forms of wildlife as well as from the elements. Among contributors to nesting failures might be mentioned, in addition to the mammals previously discussed, raccoons, wildcats, several species of egg-eating snakes, wild and domestic turkeys, hawks, owls, crows, jays, and fire ants. Some of these cause little trouble or compensate for it to the extent that combatting them would be evidence of poor judgment; others are impracticable to control due to extreme difficulty or prohibitive cost. Enough pressure from summer predation, however, must be removed so that most of the pairs can bring off broods before mid-season if there is to be an abundance of well-developed birds in the coverts by late November, when the shooting season starts. The presence of many half-grown covies at that time indicates either that the elements have been adverse to breeding and rearing, or that too great an abundance of egg- and young-eating predators are present. Since small mammals ordinarily are responsible for the heavier nesting losses and are subject to economical control, more stress is given to keeping their numbers within safe bounds than to dealing with other predators that are more difficult and expensive to control. At times fur prices alone may stimulate trapping to the point of adequate reduction. Such control prevents population "flare-ups" and the appearance of nature's own corrective for over-populations—namely, disease; hence, reasonable control of numbers of fur animals in the region has much in its favor.

Seldom have we been forced to recommend control of hawks, owls, and other birds in the interest of quail, except the "blue darter" hawks (Cooper's and sharp-shinned). This is fortunate, since such a high proportion of raptorial birds are of a migratory or wandering nature and are beneficial in other parts of their range. While several species of hawks and owls prey to a minor degree on bobwhites of all ages, the provision of well-distributed "refuge coverts" will usually sufficiently control this damage. The killing of red-tailed, red-shouldered, broad-winged, and marsh hawks, even where minor damage to quail by them is noticeable, would be distinctly poor policy, for these are all eaters (at times) of various snakes that, as a group, may consume up to 20 per cent of the quail eggs in the wild. No practical control for these snakes has been found except paying bounties to negro tenants. The large soaring hawks kill and eat many snakes in late winter and early spring after the burning has been done when the snakes are comparatively inactive and spend much time sunning themselves on the "burns."

Curiously, destruction of quail eggs and very young birds by heavy populations of wild turkeys may make it difficult to maintain high turkey and quail populations on the same ground, and owners may be forced either to discontinue quail shooting on lands where wild turkeys are becoming abundant or maintain a better "balance" by bagging more of the turkeys. In some cases, particularly favorable areas have been given over to turkey management exclusively, and other areas developed for quail.

Enough has probably been said to indicate that predation is one of the most serious and complex problems confronting the manager of lands where quail are a major crop and large surpluses are desired for shooting, year after year. The experienced southeastern game manager realizes keenly how incomplete is the information available to guide him in his local situation. Appraisal of the importance of predation and decision as to predator control must rest largely on local evidence.

The manager realizes the advantages of reducing predatory pressure on quail where this can be done most readily and economically, and with least harm to other interests. For instance, he can keep the small mammal group under control by night hunting with dogs, which furnishes sport to negroes on the preserve and is a method in which they are adept. Seldom is there danger of too close control, for night hunting becomes dull sport after the mammals reach low numbers.

He will usually avoid attempting control of the larger soaring hawks, even though these may become locally abundant—as, for example, marsh hawks during the high of rodent cycles, or red-tailed or broad-winged hawks during migration. At such times these raptors may cause considerable annoyance by scattering covies in their attempts (usually futile) to capture quail. He realizes that this class of hawks at times does much compensating good by keeping egg-eating snakes and rodents under control. Furthermore, he is probably a good citizen and would deplore the killing of creatures, temporarily present, that may be of great value to farmers in other sections. In other words, a high grade manager has the public good keenly in mind and feels more justified in controlling the sedentary creatures spending most of their lives on lands under his control than those of migratory or wandering nature.

He usually tries to keep the Cooper's hawks as low as possible on his quail lands and around his dove plantings, but appreciates only too well that his helpers are largely unable to cope with these wary birds and that as one is killed another takes up the territory from the seemingly inexhaustible supply on adjoining ground; so he usually compromises by letting the hawk tribe more or less alone (though shooting "blue darters" as opportunity presents) and concentrates on developing "refuge coverts" well scattered over his territory. Hawks prefer hunting grounds where prey is easily available, abundance being of little attraction to them where escape coverts for their prey are numerous.

He probably does not conduct control of fire ants, because of the knowledge that efficient and economical methods have not yet been developed, even though these pests are known to be abundant and taking a heavy toll of hatching game birds.

While he would probably like to control more closely certain of the racers and so-called chicken snakes that give trouble by eating quail eggs or young chicks, as a rule all he finds it practical to do is to encourage negro tenants to kill these reptiles for small bounties and to keep his quail range well burned so that the sluggish reptiles are available in early spring to the very hawks that annoyed him slightly during the fall and winter by scattering coveys. To get desirable results from paying bounties on the most destructive species requires, of course, a knowledge of snakes and their habits.

Hence, it will be readily seen that our ideal quail preserve manager is no vermin-control specialist. To do a good job he must have a broad practical knowledge of such birds, mammals, insects, and reptiles as compete to any extent with quail; also he must know a good deal about their inter-relationships and the whole ecological complex. He must realize that he is living in a period of rapid change in land-handling practices and adjust his policies as changing conditions make it desirable. Above all, he must be a man of good, sound, common sense and wide knowledge and tolerance of humans as well as of other animals. Obviously, he needs all the scientific aid he can get from the various investigations of animal life and environment; but, at the same time, he must have sufficient knowledge and judgment to choose what is locally applicable. He is, of course, an expert agriculturist with a general knowledge of forestry, livestock, and machinery. He knows hunting dogs and their care. He is politician enough to hold his own in dealing with county boards and road commissions. Truly, quail management may be a difficult and complex profession, of which the control of enemies forms but a part. A wide gulf separates such a man from the vermin killing "gamekeeper" of former days!

DISCUSSION

DR. DURWARD L. ALLEN (Michigan): Some of the points brought out by Mr. Stoddard certainly need emphasis, and several of them have not been emphasized to the extent that they could have been before in this session. One particularly was the different status that a wildlife species, especially a carnivore, may have from one local area to another. He also made the point that hunting had taken the place of predator control in the past but does not do so now. That is something we are trying to emphasize in Michigan, to teach the people to utilize these predator populations and to crop them just as they do game.

Are there any questions?

MR. THOMAS L. KIMBALL (Arizona): Can you tell me the damage done to bobwhites by house cats as compared to other predators?

MR. STODDARD: We find that destruction by stray cats is sometimes very serious in the case of nesting birds. The house cat is one of the few creatures that has the ability to spring on the bird during the period of incubation and kill it. Some of the other predators on quail, as the skunk, occasionally make an attempt to catch the incubating bird but seldom succeed. We find that the hatching period is the critical one for damage by the house cat; that is, there is more cat predation during the twenty-four hours preceding and just following hatching than during all the remainder of the nesting cycle. Apparently the cheeping of the young chicks within the egg is sufficient to attract the attention of prowling cats. Though losses are serious, it must be remembered that they are also from areas where the cat is controlled and for that reason much less numerous than in the country as a whole.

PREDATOR CONTROL AND WILDLIFE MANAGEMENT

WILLIAM E. RITER
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Before entering into a discussion on the subject of predator control and wildlife management, it is desirable to define two terms, namely, "predator" and "control". For the purpose of this discussion, a predator may be defined as any wild animal that preys upon one or more species of other wild animals that are being fostered in wildlife-management plans. Control is the curbing or restraining of the activities of the predator species to the extent necessary to prevent undue injury to the species preyed upon. In most instances this may mean taking some of the predators, though in no case does our definition of control imply extermination of the species concerned, for it is recognized that predators have their place in the biological picture.

The question of whether predator control has a place in wildlife management has been the subject of much discussion. Some advocates of control maintain vigorously that no wildlife-management plan will succeed without the rigid control of predacious species, while the opponents argue just as energetically that predation is not a serious factor in the management of wildlife. Generally the adherents of each side of the controversy take extreme views and the weakness of their contentions lies in the fact that each attempts to apply his rule to every wildlife-management area whether conditions on the different areas are similar or dissimilar. The ecological relationships of wild animals are so complex and conditions on different areas so varied that it is impossible to formulate a general rule that will be applicable to all situations.

The practical wildlife manager recognizes that there are certain definite factors that he must consider in his management plan, any one of which may affect its success. These are food, water, cover, disease, weather, predation, and protection. The word "protection" here means protection from the "human predator." There are, of course, other factors that may influence favorably or unfavorably the management of wildlife, but the seven here enumerated may be considered the cardinal ones. In certain areas, one or more of these may be limiting factors in the success of the management plan, and for this reason the relative importance of each as an accelerator or an inhibitor depends on the circumstances of each individual case.

Predation is then one of the chief factors in wildlife management, and it may assume the leading role in limiting or prohibiting the attainment of the wildlife manager's goal. Two or three typical cases may illustrate its importance.

Sometime prior to 1919 certain antelope herds in south-central Oregon, northeastern California, and northwestern Nevada, though relatively small, were further reduced owing to various causes, the most important of which seemed to be disease. By 1920 there were not more than 500 antelopes left in the areas mentioned. In 1921 the Mount Dome herd numbered about 80 animals and the Nevada band about 200, and in 1923 the Oregon band contained approximately 200. Food conditions on the range were poor, the areas having been heavily overgrazed. Despite this, however, the range was capable of carrying many times the then existent antelope population.

Some restrictions on hunting antelopes were in force during the period and had been for some time prior to it, although the usual amount of poaching continued. Despite this protection from shooting, and although the range could have sustained greater numbers, no appreciable increase in the herds was evident. Predators, especially coyotes and bobcats, were abundant and heavy killings by these animals were noted. Some limited predator-control work had been conducted among the Nevada band since 1915, but aside from that no concerted effort toward control was made until 1921 to 1923, when predatory-animal hunters began operations in the several areas. Between 1921 and July 1, 1934, about 7,500 coyotes and bobcats were trapped. During that period a very satisfactory increase in the numbers of the antelope occurred, and in 1935 estimates varied from 10,000 to 25,000 animals, the more competent observers placing the number at 10,000. This increase occurred despite the fact that the food situation became increasingly acute and the status of protection from man was not materially altered. At the present time the predator problem, although not entirely solved, does not constitute a major threat to the existence of the herds.

E. A. Schilling, Range Examiner, Southern Region, United States Forest Service, recently reported an interesting observation made on an area comprising some 100,000 acres on the Chattahoochee National Forest in northern Georgia. Much cultural work had been done on the area to provide openings in the forest canopy and artificial food patches for game. The remnants of wild turkeys and grouse that were being fostered were not responding to the improvements and the protection afforded. Something was wrong. Investigations revealed that bobcats and foxes were numerous; wild turkey bones were frequently noted at bobcat dens; and evidence of turkey and grouse kills by foxes was found. Several bobcats and foxes were trapped and their stomach contents analyzed. The analyses disclosed that grouse and turkey constituted an important part of their diet, thus substantiating field observations. In 1937, after careful preliminary study, a general trapping program was initiated on the area. In order that trapping of the furs should not be wasteful, the season was limited to winter months. During 1937, 126 bobcats and 116 gray foxes were taken, and in 1938, 91 bobcats and 83 foxes. A great increase in the turkey population was noted in the fall of 1937. An additional increase was observed in 1938, but the gain was not so great as it had been in 1937. All factors considered—climate, food, cover, protection from shooting—it was evident that the sudden increase in the number of turkeys was in response to protection afforded against predators. Mr. Schilling also reported a similar result on a 125,000-acre area on the Black Warrior National Forest in Alabama.

On the Lower Souris Waterfowl Refuge in North Dakota in 1936, a study was begun to determine the relation of skunk predation to duck nests. During the season of 1936 skunks destroyed 30.6 per cent of the duck eggs. In the same year 54.9 per cent of the eggs were successfully hatched. Between November 1, 1936, and July 1, 1937, 423 skunks were removed from the area studied, and a reduction in the skunk predation on duck eggs from 30.6 per cent in 1936 to 6.7 per cent in 1937 resulted. The successful duck hatch was increased from 54.9 to 68.9 per cent. The activities of the skunks affected chiefly the blue-winged teal. The hatch of blue-winged teal eggs in 1936 was 35.1 per cent successful, and in 1937 on the area on which control was practiced it was 78.3 per cent successful.

In these instances it will be noted that the fostered species existed in subnormal numbers at the time predator control was undertaken, a situation in which protection of even individual animals is necessary if the species is to survive and increase. This is an important point to remember, for where a fostered species exists in numbers far below the normal carrying capacity of the area, further inroads by predators may be disastrous.

The Red Rock Lakes Refuge in Montana, for instance, supports a large part of the only nesting population of the trumpeter swan left in the United States. The number of these birds is so very small that it is still doubtful whether the species can be restored. Certainly predation may easily be disastrous and there should be no question as to the advisability of control if predation should occur to any degree whatsoever.

Predator control may also be justifiable, and even necessary on an area that is carrying a normal population of breeding stock of a fostered species if the increase of the fostered species is being appreciably utilized or harvested by man. Such a condition prevails on many private game plantations. No general rule of control that will apply to all such areas, however, is possible except perhaps the following one given by Herbert L. Stoddard in a letter of November 12, 1935, in which he relates his observations on the depredations of skunks on quail on game plantations in southern Georgia:

"I do not think that any generalizations as to the extent to which predator control contributes to the quantity of game that can be harvested by man are in order, as the matter is purely a local one that varies from region to region and from spot to spot within a region.

"'Flare ups' of local predators known to exert a lot of pressure on game birds must be controlled if there is to be a satisfactory percentage of game left for the gun and an ample breeding stock for continued production; I do not think there can be any question about this. But the control in my opinion should always be directed towards the proper species and only to the extent that the animal is reduced to a level from which it can make a reasonably quick recovery in case an ecological kick back is experienced, and need of a larger population becomes evident."

It may be well, however, to utter a word of warning relative to investigating predation on areas that are carrying normal breeding numbers consistent with food and cover, especially where the increase is not being cropped by man. The inexperienced observer may note many cases of predation and conclude that they constitute a serious drain on the population of the fostered species. The extent of this predation may in reality represent a normal condition to which the species is locally adjusted. Concerted predator-control operations may be conducted and yet at the end of the succeeding breeding season the average breeding stock may show no perceptible increase. It has been frequently demonstrated that when the saturation point of a species for the critical period of the year has been reached on any area, the excess numbers are reduced by starvation, freezing, or disease or other factors. Under such conditions no amount of protection against predation will save the surplus and the control of predators may be ill-advised and wasteful. The game manager may, in such cases, make the mistake of placing too much importance on the "individual numbers" of prey taken by the predators and overlook the fact that such predation may be insignificant when considered in the light of the effect it may have on the population as a whole of the fostered species on the area.

To summarize, the following should be taken into consideration when determining whether to resort to predator control in the management of wildlife:

1. Predator control as a factor in wildlife management should not be overlooked, although it is but one among many others. Its impor-

tance in the success of a wildlife-management plan depends entirely on local conditions—each area is a problem by itself and all cardinal factors should be studied together and each properly evaluated.

2. Predation may be a major factor on (a) areas on which the population of the fostered species is subnormal although other conditions are favorable for their development; and (b) on game areas where any considerable part of the increase that would normally be utilized by man is being taken by predators.

3. Where breeding populations of the fostered species remain normal for the area, predator control is of little or no consequence in attempting to increase the numbers of the breeding stock; under such conditions, food, cover, and water during the critical period are generally the limiting factors.

DISCUSSION

DR. LOGAN J. BENNETT (Pennsylvania): This paper certainly gives us a good general picture of the predator control problem. Are there any questions?

MR. ED. V. KOMAREK (Georgia): Not exactly a question, but I think one could summarize the papers presented today by saying that the carrying capacity of a piece of land may not be regulated simply by the food and cover on it, but by those facilities and in addition the other animals of the environment.

CHAIRMAN SHAWHAN: Dr. Allen, will you lead the discussion?

DR. DURWARD L. ALLEN (Michigan): This paper is open for discussion.

I might call attention to one point that has not been referred to very much this afternoon. It was brought out by Mr. Stoddard. That is that predation sometimes may be an indication of some deficiency in the habitat. I am thinking of one area in Michigan where there was very poor rabbit habitat, deficient in cover, and we found the spring rabbit population didn't even double in that area to the fall, and when female cottontails produced four litters of young of five each in the summer, it was quite evident that it was mortality among the young that was the limiting factor on population in that area. We found that it was predation that was accounting for a great number of those young, but we also found that around areas of coppice where there was good cover there were more rabbits, and we believe that a program now being worked out in that area of selective cutting which will leave large brush heaps and coppice growth will solve our problem there much more practically than any extensive and intensive and long-time program of predator control. In other words, a long-time program of predator control is not always going to be the answer in all of these areas. Perhaps some habitat management can do it much better.

MR. KOMAREK: I would like to bring out a point along that line. You mentioned the work being done near Thomasville with respect to the cotton rats. We no longer control them directly. We found out enough of their habits, and today if quail are being seriously bothered by cotton rats it is usually a sign that the environment is out of balance. However, there seem to be other predators, and as you manage a piece of land for quail you also manage it likewise for all its component other animals within that environment. Where we can find differentiations as we have in the cotton rat and the quail habitat, that indirect control has been very advisable. Whether we can do it with the gray fox we don't know. We have certain studies along that line, but they remain to be tested as yet. Certain other animals, notably the skunk, seem to have more or less the same habitat requirement as quail. In such a case, the more you increase quail, the better quail habitat you have, likewise the better skunk habitat you have.

Again, that stresses the point that a predator problem is local, and it is also on each separate species and has to be treated separately all the way through.

MR. ROY WOOD (Virginia): I would like to ask Mr. Shawhan of West Virginia a question in regard to the payment of bounties on gray foxes in West Virginia. Do you ever have any opposition from the fox hunters, and if so, how do you get around it?

CHAIRMAN SHAWHAN: A very apt question, one which bespeaks some degree of experience, perhaps.

No, we encounter very little opposition from the fox hunters where the gray fox is concerned. You will observe that I did not say that we offered a bounty upon the red fox. The red fox, over most of West Virginia, does not occur in sufficient numbers to be dangerously detrimental. They are assuming those proportions in a few limited localities. Only in one or two sections of the State, limited in area and extent, do we encounter any opposition to the payment of bounties for the gray fox. In fact, to the contrary, we face an almost irresistible demand for such bounties, and the payment is limited only by the finances available to us.

With regard to the desirability to control predators and wildlife management, from the excellent papers and from the ensuing discussion the Chair reaches the none too original and certainly none too definite conclusions that predator control should be well and carefully considered before undertaking it; that the attitude toward and approach to the problem should be judgmatic rather than dogmatic; that it is distinctly a local problem.

TECHNICAL SESSION

WEDNESDAY AFTERNOON—FEBRUARY 19

Chairman: Shaler E. Aldous

U. S. Fish and Wildlife Service, St. Paul, Minnesota

Discussion Leaders:
Gordon Fredine, *Department of Conservation, St. Paul, Minn.*
Fannye A. Cook, *State Game and Fish Commission, Jackson, Miss.*
Lyle F. Selko, *State Game and Fish Department, Oklahoma City, Okla.*

RELATIONSHIP OF FUR ANIMALS TO GAME AND FISH MANAGEMENT

PROBLEMS OF BEAVER MANAGEMENT IN A FISH AND GAME PROGRAM

Gardiner Bump
State Conservation Department, Albany, N. Y.

Few mammals have captured the imagination and lined the pocketbook as has the beaver. No species has been more persistently sought after, more ruthlessly exploited over most of its range, than has the trappers' "black gold." Once eliminated from an area, its chances of reintroduction were slight, for until recently, new seed stock was not to be had for the asking. In a few states, however, beavers have become sufficiently numerous over the past forty years to point out the existence of, and stimulate solution for, certain problems that have followed increasing abundance. Because of the widespread recent interest in the reintroduction and management of beavers, it is informative to consider how the situation has developed and been handled in one of these states—New York.

That beavers in the last forty years have become so abundant in thickly settled New York State as to present a nuisance problem may seem hard to believe. Radford (1907a) estimated New York's population of beavers at "the commencement of the white man's settlement" as being "not improbably several million." He quotes from an old Dutch writer to prove that the Province of New Netherlands, about 1671, furnished "fully 80,000 beavers a year." Fort Orange (now Albany, N. Y.) was built for, and out of, "black gold" profits.

From this original abundance indiscriminate trapping so reduced the beavers that by 1800 scarcely 5,000 were reportedly to be found in all of the Adirondack wilderness. Another hundred years and the number had shrunk to a pitiful 15 survivors (Radford, 1907b). (See Map, "Original Stock—1900"). This remnant was then given strict legal protection. To replace what the trap had destroyed, about 20 beavers, wild-trapped in Canada, were liberated in the Adirondacks between 1901 and 1906. In 1907, 17 "yellow beavers" were obtained from Yellowstone Park. All but three survived the trip and were released in the same region. (Map, "Introductions—1900-1910").

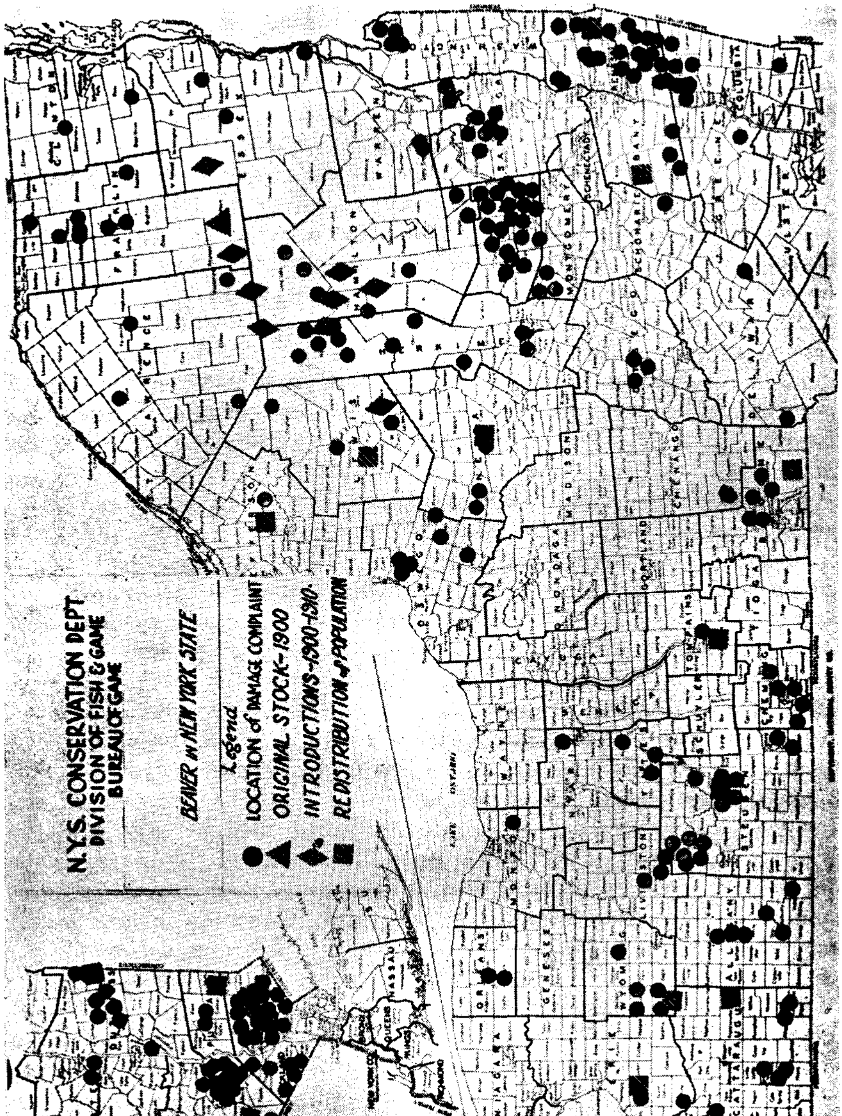
The results were immediate and gratifying. By 1905 guides and trappers reported seeing 40 beavers, in 1906, 75, and in 1907, 100, resident in the Adirondacks. By 1912, so numerous had they become in certain localities that complaints of damage were common. Three years later the number of beavers resident in the Adirondacks was estimated at 15,000.

Trappers, sensing the forthcoming harvest, were delighted, and conservationists pointed with pride to the results. But here and there lumbermen and campers, seeing the damage resulting from the beavers' sharp teeth and engineering skill, frowned and shook their heads.

By 1920 the Conservation Department was literally flooded with damage complaints (Map, "Location of Damage Complaints"), whose rising tide, not to be denied, culminated in 1924 and 1925 in the winning of open seasons. Thus in the short space of 24 years, and given little help except a start and protection from man, the beavers staged such a remarkable comeback as to justify two conservative open seasons in which more than 6,000 were trapped. Then protection was resumed and everyone but the beavers settled back, satisfied that the problem had been solved. They, with magnificent indifference, in the face of the threat that open seasons might mean extermination, proceeded to increase so rapidly that three years later another open season had to be declared. This time no fewer than 5,000 were harvested in a single year.

The five years that followed represented the high tide of beaver popularity in New York State. The presence of beaver dams in a neighborhood somehow made men envision the better parts of the primeval wilderness again at their back door.

But beavers still were born with sharp teeth and they knew how to use them. So to do something to satisfy damage complainants, a "Beaver Bus" was purchased in 1932 and two men hired to spend their entire time trapping nuisance animals. Without so much as a thought as to the damaging results of past beaver introductions, 110 nuisance beavers were trapped and liberated in other areas of the


N.Y.S. CONSERVATION DEPT
DIVISION OF FISH & GAME
BUREAU OF GAME
BEAVER in NEW YORK STATE
Legend
LOCATION of DAMAGE COMPLAINT
ORIGINAL STOCK—1900
INTRODUCTIONS—1900-1910
REDISTRIBUTION of POPULATION

State the first year. Only the poorer "yellow beavers" were destroyed. During the six years in which this practice was continued, more than 600 beavers were thus re-established, not only in the wilder parts of the State but throughout the semi-agricultural counties as well. As a result, there are not to exceed ten counties in the entire State where beavers are not now resident. (Map, "Redistribution of Population").

This method, while thoroughly satisfactory to the complainants and to the general public, was, of course, only a palliative and not a preventive. Beaver complaints continued to mount until, despite open seasons in 1934 and 1935, in which 6,432 beavers were harvested, the State was spending about $4,000 a year in nuisance beaver control. (Map, "Location of Damage Complaint"). That trapping was at least a less costly method of control was illustrated when, during the open seasons of 1937 and 1938, the reduced number of 4,653 beavers were taken. Following the open seasons, damage complaints would be infrequent from the counties where trapping was permitted, only to increase again with time. But in most of the counties where beavers were of recent introduction, public opinion still remained favorable to their continued protection. Nuisance trapping was abolished except as demanded by public policy. Game protectors in each county were charged with looking into local complaints, determining whether substantial damage was being done, and attempting to adjust the situation. Where the damage was considerable, permits were given to dynamite dams, and, in the most severe cases, to shoot the offending animals. To prevent possible exploitation of this privilege, a strip of skin, including the ears and running down the back a distance of at least 6 inches, was required to be presented to the Department from every beaver killed under permit by a private individual.

This method of controlling nuisance beavers has proved to be the most economical, and in the long run the most satisfactory, yet devised. As long as the State maintained a beaver control crew, complainants were insistent that all the animals causing damage be removed. To catch the last beaver from a pond or a stream was, to say the least, time-consuming. Then, too, beavers from surrounding areas often re-occupied the trapped-out areas within a year. Complaints thus became chronic and tempers increasingly shorter. Under the new method the State provides the implements of control in terms of helpful advice, assistance in destroying dams, and in permits to shoot the offending beavers. The initiative for control, however, rests with the individual who claims to be damaged. Experience indicates that in most cases the actual damage is usually so much over-rated that the community at large is seldom concerned. Thus respect for his neighbors' interests and opinions, added to the possibility of catching a few beavers for himself, if and when an open season might be declared, have further strengthened the human tendency not to move in a matter of this kind unless driven to it. Complainants usually "take it out on the dam" thus initiating a game of "put and take," with the beaver putting back at night about as much as man can tear out in the daytime.

In the end, the beavers usually win, so that, unless really important facilities are damaged, such as highways or pastures, or good standing timber is flooded, few permits for shooting the offenders are issued.

It should be emphasized that such a delightful *laissez faire* attitude on the part of a state probably can prevail only where, as in New York, a decision has been handed down by a high court that, though wildlife belongs to the state, damage therefrom is an "act of God" and damage claims, therefore, are not collectible.

As to beaver management in a conservation program, we may take the item of public interest in beavers as a certainty. Stories heard in childhood about the intelligence and engineering skill of this animal have developed a strong sentimental interest in its re-introduction and maintenance. There is no counterbalancing sentiment strong enough in New York, however, to be of practical help in controlling beavers when they become a nuisance.

In New York beavers apparently have few destructive enemies save man. They are fecund, averaging three to four kits a year, a large proportion of which apparently survive. For the most part beavers are gregarious, living sociably together. Their choice of food and their manner of obtaining it ofttimes leads them into conflict with man's interests, as does also their habit of damming up streams.

Most of the areas occupied by beavers in New York are relatively low-value swamp-lands or pastures. Their occupation by beavers presents a potential source of revenue, far greater than otherwise might be expected from these lands, though sometimes harm is done by flooding deer wintering grounds or impairing trout streams.

A difficulty in management is that when an open season is provided in which to harvest the crop, some smart trapper may beat the landowner to the catch. In the State as a whole, during the seven open seasons which New York has decreed in the new era of beaver abundance, at least 22,000 pelts have been marketed at an average price of $17 each, representing a gross income of $374,000.

As to esthetics, little may be said, for no community can measure the value to an individual of the opportunity to watch beavers cut a silver streak across a moonlit pond, or of the peeled sticks which old and young alike find drifting along the edge of the dam and carry home as prizes. Conversely, the trees cut or flooded about a lake or campsite, or an unsightly array of dead timber marking the confines of a beaver swamp, all represent values on the other side of the ledger that must be taken into consideration.

It is not within the scope of this paper to comment upon all of the problems that follow beaver reintroductions. Special studies of importance covering many of them have been made (Salyer, 1935; Cook, 1940; Rasmussen, 1940; Johnson, 1927; Bailey, 1922; Lowrie, 1921). However, those to which we in New York have had to give serious thought are here listed:

1. Destruction of individually valuable trees about camps, lakes, and stream borders;
2. The killing of trees more or less valuable as timber through flooding;
3. The elimination of coniferous swamps that are wintering grounds for deer;
4. The flooding of railroad rights-of-way, highways, buildings, trails, tillable lands, pastures ,and wild or cultivated swamps from which a crop, such as cranberries or sphagnum, may be harvested;
5. Disruption of water supply or conditions through interference with normal water levels;
6. Reduction in the productivity of slow-moving trout waters through the elimination of spawning grounds, the smothering of trout eggs by silt, decreasing the available oxygen in the ponds by raising water temperatures, and through the barrier effects of beaver dams;
7. The problem of controlling beaver poaching and of ensuring a fair opportunity to harvest a crop;
8. The control of nuisance beavers; and
9. The amount of education required to make the general public understand something of the ramifications of the beaver problem.

But, if you like beavers, there is also a brighter side. Providing you can find satisfactory ways of controlling, dodging, or ignoring the above-mentioned problems, the benefits that may flow from an increased, but not too great a stock of beavers include:

1. A marked increase in public interest in wildlife, particularly beavers;
2. An opportunity to explain conservation as wise use rather than merely protection, using the beaver as a perfect object lesson;
3. Some regulation of stream flow;
4. The improvement of conditions for trout in streams with rapid runoff through the establishment of refuge pools during periods of low water and maintenance of a more even flow;

5. The utilization of low-grade land to produce a high-grade crop;
6. The opportunity to harvest profitably a wildlife crop; and
7. The production of additional nesting and resting places for waterfowl.

To sum up, the successful introduction of beavers into a favorable environment inevitably engenders a host of problems. These arise from, or are affected by, the value of the resultant fur crop, the deep public interest in beavers, the probability that some of the beavers will become a nuisance, the impracticability of handling this problem through continued removal of beavers by state trappers, the necessity of developing more satisfactory methods of control, and the pulling and hauling of divergent interests that are affected variously by an increase in beaver abundance and activities. These matters should be carefully analyzed and their effects weighed before the species is introduced.

Someone has defined a weed as merely a plant out of place. Even beavers can be in this category unless they are properly managed.

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DISCUSSION

CHAIRMAN ALDOUS: The discussion on this paper will be led by Mr. Fredine.

MR. GORDON FREDINE (Minnesota): What I would like to know, regarding beaver and beaver trapping, is just how valuable the solution of beaver problems can be to general game management. It seems to me that if in accordance with Mr. Bump's suggestion it is a species that is possibly easy to manage, and one with which we can show some rather spectacular results, proper handling of beavers will boost the stock of game managers throughout the country. We may not be able to show a profit in many of our undertakings, but in this one I think we can. For that reason alone, I think the beaver problem should receive the most careful attention.

I would like to know how we can better regulate trapping so as to coordinate beaver control and beaver harvest with other game management features. The beaver trapping problem has been taken up in great detail by many workers, and I would like to know if there are any indications of improvement in those states where trapping has been permitted for several years, as far as trout waters are concerned, and whether the present method of opening territories and trapping is solving the beaver-trout problem.

MR. BUMP: There is much theory but little fact available on that point, so we are continuing study.

MR. FREDINE: Do you think you can satisfactorily regulate the crop by opening an entire block, as you have pictured, or do you think that some day it will be best to open a certain watershed and try to control the take on an individual stream, rather than in an entire region?

MR. BUMP: Beaver pelts are so valuable and there is so much competition for them that we dare not handle less than several counties in a unit. Otherwise the problem of protecting the crop until the time when the state indicates that it may be legally taken is too difficult.

MR. H. D. RUHL (Michigan): As to the beaver-trout problem, the chief difficulty is in knowing just what you want to produce. At least in our state, the streams vary greatly. Some are continuous, some are chains of pools, and some are at the point where even slight warming of the water would be rather detrimental to the trout. Some have great fluctuations in population between spring and summer, according to the volume of water. We have brook trout, brown and rainbow trouts, besides other game fishes to consider.

We haven't solved the beaver problem, but we have demonstrated a few things, among them, that you can have a continuous open season for at least ten years. Last year we took more than 7,000 beavers.

We have attempted to roughly regulate the population by closing certain areas and we have been able to keep a rather low population fairly well distributed, but we do not believe that we have been able to keep close to the optimum beaver population in all the areas. In general it has been below optimum in some, and perhaps approaching optimum in others.

Personally, I am satisfied that the manipulation of population within rough limits is going to be easier than finding out what levels should be maintained, everything considered.

MR. FREDINE: Mr. Ruhl, do you think you are going to be able to control damage through licensed trapping or are you always going to find it necessary for the state to trap?

MR. RUHL: If there are any beavers at all, there will be some out of place. The actual physical job of controlling the beavers—where they are doing damage to culverts, roads, and cottages, disregarding the trout situation—has not been difficult with the population at the level that we have in Michigan. With us control is relatively easy and pays its way. We limit the number of pelts taken by an individual; he must bring in each pelt to be sealed, for which he pays a dollar. These fees are sufficient to pay for the state control program.

MR. FREDINE: Did you find that the legal trapping season substantially reduced poaching?

MR. RUHL: Yes, there isn't any question about that. We delayed opening the season for fear of eliminating the beaver as before, but since it has been opened, our poaching problem has decreased until it is not abnormal.

MR. FREDINE: I believe that our state people are coming to the point where they are willing to have a beaver trapping season in areas where there is no damage, just as a harvest, and I think that is a very healthy attitude. It shows that the people are thinking along the lines of management rather than of protection alone.

MR. ERNEST SWIFT (Wisconsin): We closed the season on beaver in 1921, due to the fact that the population was very low. In 1926 the price began to rise, and from 1926 to 1930 there was what we termed a "beaver war" in Wisconsin. It was mixed up with the alcohol racket and gangsters were making pay loads of alcohol and beaver skins, and running them with machine guns. That was also true in Michigan and in Minnesota.

A mistake was made in keeping the season closed too long. When we opened the season, we reduced the population, and we have less trouble today, although we budget only $10,000 a year for beaver control. The price of beaver is coming up to the point where the trapper this year may get $25 a pelt.

MR. VERNON BAILEY (Washington, D. C.): I sympathize entirely with Mr. Bump's problems in New York. I have been all over those beaver ponds with him, and know the conditions pretty well. I have been acquainted with those conditions for a generation or two back, and I know he has a very difficult situation.

There are a few things, however, that I don't like about it. I don't like shooting those beavers and throwing them away, and I don't like trapping them with steel traps, which break their legs and torture them. I would like to come up there again and demonstrate better traps and better methods of trapping beavers. If there are a lot of those beavers which they believe should be shot, I am wondering if Mr. Bump will arrange with his department to pay me a dollar apiece for catching them for him. I will take them out and find a good home for them where they can be comfortable and not do anybody any damage.

MR. DOUGLAS WADE (Missouri): There are men here from four states that have a beaver problem—can they inform me as to how much has been spent on sustained research on the beaver? I do not mean money spent on administrative research, but biological research in the field.

MR. RUHL: What you call "administration," I might call "surveys," "investigations" and so on.

We have spent a lot of time on this work in one way or another, probably a fair proportion in relationship to other species. Probably our research has not been too great on any of the fur animals.

MR. FREDINE: In Minnesota, very little money has been spent on the beaver. We are starting a program now, and expect in the next four years to spend at least $3,000 a year on the beaver problem alone.

MR. BUMP: In New York we are spending very little directly, but quite a bit indirectly, because the beaver is already a substantial crop which we are managing in one way or another. We have a limited amount to spend on fur research, and we prefer to spend it on muskrats and raccoons, as being crops that we are not managing as well and about which we need to know more.

MR. SWIFT: We have a laboratory and a pathologist who has studied the beaver from his own standpoint and we have sample areas that we have used for biological observations.

MUSKRATS IN THE DUCK MARSH

DR. MILES D. PIRNIE
W. K. Kellogg Bird Sanctuary, Battle Creek, Mich.

Many unmanaged marshes produce fur crops and duck shooting, but I am confident that improved management will increase greatly the value of any marsh for waterfowl or muskrats. I do not wish to seem over-optimistic as to management possibilities, however, for there are many obstacles. Probably, even ten years from now it will be much easier to raise radishes or guinea pigs than to keep a marsh in productive balance.

Observations made last summer on large duck marshes in Ohio, southern Ontario, and Michigan have prompted me to offer this paper —as a sort of follow-up for William T. Krummes' excellent contribution in our meeting just a year ago (Krummes, 1940). In his scholarly discussion of muskrats as a factor in waterfowl habitat management Mr. Krummes said: "Good waterfowl habitat is generally good muskrat habitat. The ecological effect of the muskrat on the waterfowl marsh is very important, and if the animal is allowed to increase uncontrolled, too much vegetation may at length be destroyed and competition between the muskrats and waterfowl may become serious." He also pointed out that normal activities of muskrats tend to keep ponds and channels open and also create loafing grounds attractive to the ducks and geese. I am confident that all of you agree with his conclusions, but I am not so sure that any of us are over anxious to tackle the job that confronts the refuge managers and those in charge of duck clubs. They are expected to keep the muskrats under control and in the status of an asset rather than a liability, regardless of difficulties, one of which is the lack of tested techniques.

Proper handling of a muskrat marsh should be aimed at maximum pelt production without serious injury to waterfowl habitats and foods. A few marshes remain naturally in almost perfect balance, but most will require more or less of the management methods listed below (in order of their importance):

Control of water levels;
Planned removal of surplus and nuisance muskrats;
Supplementing the natural food supply.

The control of water levels implies facilities to raise, lower, or hold at certain depths; it does not mean maintaining a fixed level. The reasons why this control is desirable are: (a) To prevent damage by floods or excessive droughts, (b) to keep the marshes flooded sufficiently to furnish a maximum of muskrat habitat, (c) to create mud flats and shallows which are so essential to the natural reseeding of duck potato (*Sagittaria*), millet (*Echinochloa*), and other useful vegetation, (d) to maintain bars and beaches for waterfowl loafing grounds and shallows for feeding, and (e) to permit navigation for hunting and trapping, and in servicing the area. Without suitable water levels, any marsh soon becomes relatively useless to muskrats and waterfowl.

The obstacles to water management sometimes outweigh the advantages. The expense of pumping, diking, and ditching may be prohibitive. Water control in some places may be impracticable because of floods or droughts. Not infrequently the conflicting interests of adjacent properties become serious obstacles to management. Examples of the successful control of water levels may be found at the Souris Refuges in North Dakota, and at some of the Lake Erie duck marshes.

Next in importance comes planned trapping, for without it, serious over-utilization may result. Also, most attempts to restore stands of the larger aquatics are doomed to failure unless muskrats are kept in bounds. When other foods are scarce, the muskrats will dig and eat duck potato tubers as fast as an army of CCC boys can plant them.

Unorganized or competitive trapping is likely to take either too many or too few animals. If a trapper's pay is based on his total catch he is not willingly kept at "control" work while others are trapping where the animals are abundant. One duck club pays its men a fixed rate so as to be in position to accomplish managed trapping without unfairness to any of the men.

Do not get the notion that the average manager or wildlife technician can always forecast accurately what the catch will be; nor are any of us too qualified to read the past or to predict the future in the marshes. We recognize the many gaps in life history data; and, in marsh ecology researches we are handicapped by the dearth of dependable records of muskrat populations, changes in water levels, etc. Here is a fine opportunity for trained investigators to work with the men who spend the entire year in the marshes. I am positive that opportunities of this sort exist at duck clubs, smaller shooting properties, and at the muskrat marshes where pelt values come first and ducks second.

Unfortunately, the existing laws protecting the muskrat do not always make it legally possible to put into practice the control trapping that is called for in good management. Therefore it seems of great importance to grant more leeway in the regulations. Adaptable, prolific, and widespread, muskrats seem to rise and fall not directly with the intensity of trapping but more in proportion to the food supply and the habitat available to them. It is quite evident that legislatures and the public tend to disregard differences between species and continue to rely on traditional generally protective legislation.

Frequently it is desirable and also feasible to supplement the natural food supplies of muskrats by new plantings or by certain cultivation practices. Success will depend on many things, not the least of which are the two we have just considered, namely, control of water levels and planned trapping.

Probably too much effort and money have gone into attempts to introduce new species of cover and food plants. Quite probably more attention should be given to finding out how to manage the common, local plants of importance by learning under what conditions they grow readily from seeds, at what depths the seedlings thrive, and to what extent each species is likely to be of local use to waterfowl or muskrats.

It is common knowledge that breaking the sod usually starts ragweed and fox-tail; similarly, "harrowing" the marshes seems to favor new species. The ruts made by wagon wheels on flooded beaches often have the densest growths of water weeds. Boat channels and dredge-cuts almost invariably have luxuriant growths and wide assortments of useful plants, probably because they trap the drifting seeds, stems and tubers, and also because breaking the bottom crust favors many aquatics just as hoeing helps corn or cabbages.

After many years of experience, the manager of a fine duck marsh on the north shore of Lake Erie is convinced that in many instances better results are obtained at less cost by creating flowages through channels and ditches than by artificial plantings. Last summer at this same marsh I saw plenty of evidence that his conclusions were justified, and I urge trials of all sorts of bottom cultivation to improve plant growths. I am sure that more channels and cuts through dense marsh stands will help spread water plants and distribute the muskrats themselves.

It is universally known that muskrats like carrots, corn, and numerous other vegetables; yet very seldom are these planted to help these valuable furbearers. But why not? In using cultivated grains, it is important to avoid violation of the anti-baiting regulations if shooting of wildfowl is part of the program, but the regulations permit the sowing of millet and wild rice and the planting of duck potatoes, sago, etc., even on shooting areas.

CONCLUSION

Although excellent progress has been made in life-history studies and in a few management techniques, many chances for new management are being overlooked. The control of water levels and managed trapping are the basis for good muskrat-waterfowl management. Special effort should be directed toward the natural restocking of marshes by bottom cultivation, special planting, and muskrat control. Legal protection of muskrats should be no more liberal than the animals require. Excessively short trapping seasons are wasteful and tend to discourage management.

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DISCUSSION

CHAIRMAN ALDOUS: I am sure there will be a good many questions you will want to ask Dr. Pirnie. Mr. Selko, will you take charge of the discussion?

MR. LYLE F. SELKO (Oklahoma): Since muskrats are so often found near duck nests, I would like to ask Dr. Pirnie what information he has as to the effect of muskrats on the eggs in the nests, on the nests, or even on the ducks.

(*Above*) Duck pond made by muskrats near Saginaw, Michigan.

DR. PIRNIE: At the bird sanctuary we had a total of between 500 and 1,000 duck nests under observation, and muskrats were present much of the time. Neither goose nor duck eggs seemed to be taken by the muskrats, certainly not with any regularity.

MR. SELKO: I understand that in northern Iowa, where studies are being conducted on diving ducks, it has been observed that they use openings that muskrats make in emergent vegetation. Have you noticed that in your sanctuary?

DR. PIRNIE: In Minnesota, I found some of the best gatherings of redheads and coots in lakes with clumps of cat-tails but with plenty of openings in the center. I think the summer gatherings of drakes are more likely to occur on the lakes in Manitoba, rather than in the marshes. But certainly the openings in the marshes are used by the flapper birds. We don't know how important they may be in attracting certain species.

MR. DOUGLAS WADE (Missouri): Dr. Pirnie made a statement concerning private practices, and I believe that every day we are losing information on private practices concerning muskrats and duck marshes that ought to be gathered. There is one man here who might contribute to that topic—Harold Terrill, of Missouri, who has some information on one marsh that is rather a fine example.

MR. SELKO: Mr. Terrill, would you like to give us that information?

MR. HAROLD V. TERRILL (Missouri): There is one marsh along the Mississippi with which I have worked quite a bit, where stabilization of the water level has resulted in a large increase in muskrats. We watched the population grow from that indicated by one muskrat house in the marsh on January 1, 1939, until the harvest in January of 1941 amounted to about 3,970 muskrats. It is a very good illustration of the fact that if habitat is suitable, wildlife will move in and thrive.

It so happened that in this particular area, the muskrats migrated in from the river. By March 1, 1939, there were close to 100 houses. The owners of the duck marsh were willing to pay as high as $25 a pair for muskrats on account of their value in opening up the marshes. But they raised the water level from 3 to 6 inches, and the rats came of their own accord. The natural increase from January, 1939, to January, 1941, permitted the harvest of enough rats to pay for the pumping of the water. Pumping water is expensive, but when you can get a $5,000 return from a 900-acre area just by raising the water level, I think it is a good illustration of a simple technique that can be used to make barren areas productive.

MR. SELKO: Dr. Pirnie, as to managed trapping, I would like to ask you if you have attempted to live-trap muskrats and transplant them at the sanctuary. In Oklahoma we do not have a large general population, but we do have heavily concentrated, localized populations that are becoming a nuisance. Do you know of any very effective manner of live-trapping these muskrats?

DR. PIRNIE: I am not qualified to answer that question but I will refer you to Mr. Ruhl.

H. D. RUHL (Michigan): Well, they can be trapped, and costs will depend upon circumstances. I know that about 600 pairs were live-trapped in an over-populated marsh one spring, the catch being about one muskrat per two trap miles. It is no more difficult to live-trap them than to use steel traps. My notion is that if you do the proper job of taking the surplus when the fur is at its best, you will eliminate, for the most part, the necessity of any large-scale removal operations. I would say the biggest objection is that it takes time and costs money.

FUR, FISH, AND GAME—SOME SUGGESTED RELATIONSHIPS[1]

DOUGLAS WADE
University of Missouri, Columbia, Mo.

A famous geographer has stated that we are still the optimistic children of the frontier, and that "we have not yet learned the difference between yield and loot." In other words, "we do not like to be economic realists." Four years ago, during this conference, a wildlife leader said that "facts, like pine trees, take not only rain, but time." Another leader recently wrote, "At present fur-animal restoration is only beginning to emerge from the field of wishful thinking to become a definite effort to accomplish practical results."

The "loot" idea, few facts, wishful thinking, and a lack of financial support seem to characterize the field of native fur-animal management today.

Since this session has been directed toward a discussion of the relationship of fur animals to fish and game management, I wish to emphasize that the bases for management of game, fish, and furbearers are the same. It is therefore logical to assume that fur animals have derived some benefit from most programs of fish and game restoration. Perhaps, if this were realized by more wildlife technicians, administrators, writers, and educators, and if they were to make special efforts at every opportunity to mention native fur resources along with fish and game resources, the effect would be a helpful stimulus to fur investigations.

According to the American Fur Tax Committee of 1935, Pennsylvania had 148,900 farmer-trappers. When we apply the findings of studies made in Snyder County and Crawford County to this number, it appears that each trapper makes from four to ten dollars a year from his fur-take activities. Furthermore, the trappers in Pennsylvania have approximately $1,400,000 invested in trapping paraphernalia; and each year they expend about $300,000 for additional equipment and replacements. Between 1926 and 1938, the fur-takers (mainly trappers) in Pennsylvania caught 12,820,000 fur animals which had a cash value of $14,408,000.

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[1]Contribution from the Missouri Cooperative Wildlife Research Unit, Columbia, Missouri. Missouri Conservation Commission, American Wildlife Institute, U. S. Fish and Wildlife Service, and the University of Missouri cooperating. Most of the material presented in this paper was gathered while the writer was employed by the Pennsylvania Game Commission under the terms of the Pittman-Robertson Act. Data from Crawford County, Pennsylvania, was gathered through the assistance of William C. Grimm, Leader of the Pennsylvania Pittman-Robertson Project R-8.

TABLE 1. ESTIMATED NATIVE FUR-ANIMAL TAKE AND THE RAW-FUR VALUE IN PENNSYLVANIA[1] FOR THE PERIOD 1926-1939 (INCLUSIVE)

Year	No. of fur animals caught	Unprepared pelt value[2]
1926-1927	1,230,965	$ 2,230,906.00
1927-1928	1,092,411	2,099,714.00
1928-1929	956,894	1,594,020.00
1929-1930	962,424	1,207,857.00
1930-1931	1,008,614	783,846.00
1931-1932	967,016	630,678.00
1932-1933	1,121,967	525,867.00
1933-1934	1,083,328	943,154.00
1934-1935	1,217,570	909,480.00
1935-1936	946,437	938,537.00
1936-1937	1,361,050	1,873,617.00
1937-1938	870,419	670,121.00
Total	12,819,095	$14,407,797.00
12-Year Average	1,068,257	$ 1,200,649.75

[1]These figures are based on the reports of Pennsylvania fur-dealers, on the Pennsylvania Game Commission bounty records, and on estimates for the furs sold out of the State. Reliable estimates placed the percentage of furs shipped out of the State at 33 per cent for 1926 to 1933, 25 per cent for 1934-35, 20 per cent for 1935-36 and 1936-37, and 18 per cent for 1937-38. From all indications, the percentage will be still lower for the season of 1938-1939.
[2]Does not include receipts from bounty claims.

In cash value the native raw fur crop of 1938 exceeded or equalled any one of the following agricultural commodities produced in Pennsylvania: barley, rye, grapes, cherries, pears, wool, honey, oats, buckwheat, small fruits, maple products, cloverseed, or timothy seed. A comparison of the value of farm products and the fur crop in Snyder County is given in Table 2. There the value of the raw fur crop constituted about 0.35 per cent of the total value of all farm crops and produce.

TABLE 2. PRODUCE AND CROP STATISTICS IN SNYDER COUNTY (FROM THE U. S. CENSUS OF 1935)

Produce or crop	Amount	Value (gross)	Per cent Total value
Corn (1937)	837,320 bu.	$ 561,000.00	....
Tame hay	20,490 tons	279,690.00	....
Potatoes	160,590 bu.	99,570.00	....
Winter wheat	311,800 bu.	305,560.00	....
Oats	312,730 bu.	137,600.00	....
Tobacco	11,500 lbs.	1,250.00[1]	....
Buckwheat	10,330 bu.	6,400.00[1]	....
Barley	4,280 bu.	2,950.00[1]	....
Rye	18,100 bu.	13,030.00	....
Apples	131,710 bu.	92,200.00	....
Peaches	42,070 bu.	40,810.00	....
Pears	4,340 bu.	3,120.00[1]	....
Eggs	1,237,690 doz.	272,290.00	....
Swine	....	89,580.00	....
Sheep	290	1,740.00[1]	....
Beehives	890	2,760.00[1]	....
Fur crop (1937-38)	10,287 mammals	6,540.00*[2]	....
Fur crop (1938-39)	7.981 mammals	5,586.00*[2]	0.35
		Total $1.921.666.00	

[1]Fur crop exceeded or equaled these agricultural produce or crops.
[2]Does not include receipts from bounty claims.
*Average gross value per square mile (based on 311 square miles): 1937-38, $21,00; 1938-39, $17.90.

To equal the annual cash value of Pennsylvania's native raw fur crop, would take the *yearly total production* of a farm area equal to McKean County, Pennsylvania, which has 1,500 farms totalling 130,000 acres in size, a rural population of 30,000 and a capital agricultural investment of $7,674,380. McKean County is one of the poorer agricultural counties in the State.

Each year trappers remove large numbers of foxes, skunks, opossums, minks, and weasels when the pelts are in prime condition and economically valuable. These animals have, nevertheless, too often been taken during so-called "vermin" drives—at seasons when the pelts are worthless. Trappers also catch animals other than furbearers. In fact, they have often been accused of taking many rabbits and game birds in their traps. In order to determine whether or not this accusation was just, I questioned 983 trappers in Snyder County, Pennsylvania, as to the number of *all* animals other than furbearers taken in their traps during the seasons 1937-38 and 1938-39. I was able to obtain what I thought were truthful statements from only 74 trappers—mostly youths. The older trappers were reluctant to reveal the exact numbers of game animals caught. A summary of the replies from the 74 trappers concerning the animals other than furbearers caught is given in Table 3.

TABLE 3. ANIMALS OTHER THAN FURBEARERS CAUGHT (BASED ON THE REPORTS OF 74 SELECTED TRAPPERS IN SNYDER COUNTY—COMBINING THE SEASONS OF 1937-38 AND 1938-39)

Species	Number caught	Number of trappers reporting	Most frequent age of trappers reporting	Total number of traps used	Remarks
Rabbit	98	39	15	639	3 box-traps, others steel
Cat	70	25	17	673	Majority caught in bait sets
Norway rat	34	7	10	83	Trap sets made along streams in or near towns
Crow	32	20	16	467	Bait sets
Dog	31	10	18	257	All released except two
Mice	22	2	17	32	....
Cave rat	21	4	21	225	Caught on Shade Mountain
Red squirrel	7	6	15	135	Bait sets
Star-nosed mole	5	2	31	81	Muskrat sets
Chipmunk	4	1	16	43	....
Bob-white	3	2	16	68	Bait sets in hollow logs
Flying squirrel	3	2	17	46	....
Horned owl	2	2	18	63	Bait sets
Owls (unidentified)	2	2	10	27	Bait sets
Small birds	2	2	13	27	Bluebird and Cardinal
Moles (unidentified)	2	2	13	22	....
Black duck	1	1	16	24	Corn set for muskrats
Pheasant	1	1	16	15	Bait set
Chicken	1	1	16	15	....
Woodcock	1	1	10	9	Caught Dec. 27. 1938

During the trapping season of 1939-1940, 71 trappers located in Crawford County (northwestern Pennsylvania) and Snyder County (central Pennsylvania) kept detailed records of their trapping activities. Included was a list of the numbers and kinds of animals other than furbearers caught, the numbers and kinds released, condition when released, and number killed. Of all the animals caught (3,556), 76 were game animals (64 rabbits, 10 ruffed grouse, one ring-necked pheasant, and one fox squirrel). Only 36 game animals died, whereas 40 were released and were expected to survive. Certain data on the animals caught are given in Table 4.

TABLE 4. ANIMALS, OTHER THAN FURBEARERS, CAUGHT BY 71 TRAPPERS* SEASON OF 1939-1940

Animal	November		December			January			Total	Per cent of grand total	Animals released alive	Game animals killed
	10-19	20-30	1-9	10-19	20-31	1-9	10-19	20-31				
Wild mice	44	36	48	17	5	2	0	0	97	2.7	....	....
Norway rat	1	3	8	6	1	1	1	0	76	2.1	....	.....
Rabbit	24	8	14	4	8	1	5	0	64	1.8	35	29
Red squirrel	10	12	5	2	9	1	1	0	40	1.1	3	....
House cat	5	13	8	5	3	2	0	0	36	1.0	11	....
Flying squirrel	10	12	5	2	0	1	0	0	30	0.8	8	....
Woodpeckers	....	....	....	....	....	....	....	20	20	0.5	....	....
Crow	5	1	0	0	2	2	0	0	10	0.28	....	....
Ruffed grouse	2	5	1	0	1	1	0	0	10	0.28	3	7
Owls	0	5	1	0	0	1	0	0	7	0.19	....	....
Dog	2	3	1	0	1	0	0	0	7	0.19	7	....
Moles	1	2	1	0	1	0	0	0	5	0.14	....	....
Others**	1	1	4	1	2	0	0	3	12	0.33	3	....
Totals	105	101	96	37	33	12	7	23	414	11.6	70	36

Fur Animals 3,142
All Animals 3,556

*Average age of the trappers—33 years.
**Includes one pheasant and one fox squirrel which were released.

If we apply the proportions given in Table 4 to a statewide catch of about 1,000,000 fur animals, it seems probable that 117,000 animals other than furbearers are caught. Of these 18,000 are rabbits—9,000 of which are killed. The annual rabbit-take in Pennsylvania by hunters in recent years has averaged about 2,000,000 animals. Is the loss of 9,000 rabbits (0.45 per cent of 2,000,000) killed by trapping activities during the open season on furbearers a serious matter to the species? On the other hand, we find that 21,000 Norway rats, 27,000 wild mice, 3,000 stray house cats, 2,800 crows, and about 1,000 owls of various species are taken and killed by the trappers. Personally, I lament the loss of certain of these species, but surely none of us can quarrel with the removal of the Norway rats.

The Pennsylvania Game Commission has for several years carried on an educational program designed to teach trappers how to make sets in a way less likely to catch game animals. Also, within the past several years, laws prohibiting the setting of traps in holes have been enforced. However, more work along these lines is needed—particularly in the development of efficient traps that will not kill or maim the animals caught and sets that will not attract game animals.

In today's fur-animal session, you have learned of the relationship of beavers to game and fish management and of the importance of considering the muskrat in waterfowl-habitat management. I should like to point out two relationships between fishes and muskrats that may have escaped your attention. In 1938-1940, during a preliminary survey of about 100 miles of representative streams in central Pennsylvania, I examined many muskrat den entrances. In almost every case a school of small fishes was found. This may indicate a significant relationship between muskrat dens and fishes. Perhaps the fishes were attracted to the den entrances because food and protective cover were present. Some fishermen believe that channel catfish utilize muskrat den entrance-ways as spawning sites. From the standpoint of fish management in certain streams, it therefore might be worthwhile to consider muskrats.

In northwestern Pennsylvania and in many other places where excellent muskrat and mink marshes and streams exist, trappers have leased them from the owners or are operating them on a share basis. Some day these trappers are likely to become interested in management procedures. They will want to know what techniques to apply to the streams and marshes in order to produce more fur animals. Will the state or federal conservation agencies lead in providing the information? What part will the fur industry play? In this connection I should like to mention the work of Harry Van Cleave, retired employee of the Pennsylvania Game Commission, who is now working for a trap manufacturing concern. Mr. Van Cleave has been calling the attention of the farmers in the rich farmlands of southeastern Pennsylvania to the management of streams and stream banks for the purpose of increasing the muskrat population. Perhaps two or three carefully chosen demonstration areas would enable this work to progress more rapidly.

To stimulate increased participation of the raw fur industry in fur-animal restoration program, it is urged that each state and federal agency actively engaged in wildlife work show more interest in the problems of this industry. Many of its personnel are to some extent unaware of the actual field problems in fur-animal conservation but they have shown in many cases a desire to learn that should be satisfied and encouraged. Here is a relatively unexplored public-relations field.

In conclusion, I believe that a well-planned native fur-animal management program would prove highly beneficial to many fish and game species and would increase a wildlife crop that has a cash value. Wildlife administrators, educators, and other workers can give native fur resources a better "place in the sun" by merely mentioning, at every opportunity, fur along with fish and game. Game killed by trappers during the fur seasons probably constitutes a negligible part of the total killed by hunters and trappers together. The fur industry (particularly the raw fur industry) should take a more active part in furnishing funds for fur-animal research and in the development of management-testing areas. Finally, I should like to present Table 5 in which ranking of fur discussion during the six North American Wildlife Conferences has been tabulated. Is the 5 per cent representation sufficient?

TABLE 5. FUR PAPERS APPEARING IN TRANSACTIONS OF NORTH AMERICAN WILDLIFE CONFERENCES 1936-1941

Year	Fur sessions	General Papers All	General Papers Fur	Special Papers All	Special Papers Fur	Total fur papers
1936	x	43	4	79	....	4
1937	x	38	1	55	6	7
1938	....	53	....	94	9	9
1939	....	33	....	66	2	2
1940	....	23	....	55	2	2
1941	x	20(?)	1	30(?)	5(?)	6
Totals		210	6	379	24	30
Per cents		100	2.8	100	6.3	....

Grand Total, All papers 589 .... 100 per cent
Fur papers 30 .... 5.09 per cent

DISCUSSION

CHAIRMAN ALDOUS: Will Miss Cook take charge of the discussion?

MISS FANNYE A. COOK (Mississippi): I am sure that all of us appreciate having our attention called during this session—and particularly through this paper—to the large number of papers that have been presented during the life of this Conference, and to the literature generally referring to furs.

I have undertaken to direct some fur projects in Mississippi during the last few years, and I have found it very difficult to get sufficient research literature.

Mr. Wade asked if we thought that it was quite fair or sufficient to leave the subject of fur animals in the background, and I am sure none of us feel that way about it. The fur industry is one of the most important industries of our commonwealth, and it is deserving of first-rank discussion and consideration.

I agree very much with the speaker in his attitude toward the trappers. When we started our Game Commission activities, we contacted the trappers first of all, addressing them personal letters under the signature of the Director of Conservation and the Game Commission, and it was surprising to note the great number of replies we received from negroes and whites alike. Many of them wrote very poorly, but appreciatively of our interest in their welfare. They were very cooperative, and we feel that by maintaining contact with them and encouraging them, we will have less trouble with law enforcement. We believe they are observing our trapping seasons and caring for the furs better by virtue of our instructing them in better methods of getting furs. I think if we did give our trappers more consideration, and showed more sympathy for them and interest in their work, we would get better cooperation all the way around.

MR. GORDON FREDINE (Minnesota): I think it is very important that we work with the raw fur dealers, as Mr. Wade suggested. We thought we were making some headway with them in Minnesota. We had a meeting with a group of them and they applauded our desire to expand management research on the fur problems, and we thought we had them all back of us, until, in the closing minutes of the meeting, they passed a resolution opposing a bill coming up in the legislature giving the Department of Conservation broader authority so far as setting seasons was concerned. They explained that while they wanted us to do better work on furs, they wanted to be very sure that there would be a trapping season. They wanted that season set in the law and didn't want it left to the discretion of the Commissioner of Conservation. However, they did admit that the quality of fur is improving steadily in our State, and they gave us the credit for that, since they believe it is due to better law enforcement and to the setting of seasons at proper times of the year.

MANAGEMENT STUDIES OF TRANSPLANTED BEAVERS IN THE PACIFIC NORTHWEST

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There are three important phases in management of the beaver in the Pacific Northwest: (1) Protecting the animal as a producer of fur, (2) removing it from highly cultivated lands, and (3) putting it to work as an agent in soil and water conservation in mountain meadows. In the present stage of land use in the Pacific Northwest, and for some years to come, to manage the beaver as a producer of fur is less important than to use it as a soil and water engineer.

The origin of beaver management in the Northwest was a series of experiments carried on by the Biological Survey and the State of Washington Department of Game in 1920. The State of Washington has continued the program of beaver management, both by dead trapping and live trapping, to the present time.

The State of Oregon at first attempted to handle the problem of damage by beavers in a different way. From 1923 to 1931 a large part of the State was thrown open to trapping. Records for the first four years indicate the rapidity with which the beaver population was reduced.

TABLE 1. BEAVERS REPORTED TRAPPED IN OREGON

Season	Number of licenses issued	Number of beavers trapped[1]	Value of pelts
1923-24	1,884	12,019	$160,000[2]
1924-25	1,020	3,669	47,513
1925-26	461	2,019	28,316
1926-27	323	1,336	18,704

[1]10 to 40 per cent of the licensees failed to report their catch.
[2]Estimate based on average values of period 1924-27.

During the last five years (1926-1931) the take of beavers was quite uniformly about 1,400 a year.

The results of the open season were unfortunate. In spite of the fact that trapping was forbidden on national forests, these areas were subjected to heavy pressure by poachers. Also, the harvest of beaver skins did not return its fullest possible revenue to the trappers, due to wasteful methods of trapping and skinning employed by inexperienced persons. Dead-trapping of beavers, in our opinion, is a very necessary means of immediate control in places where the animals are doing active damage but it should be handled by game officers who possess the necessary training and not by the public at large. In 1932 state and federal agencies in Oregon combined to inaugurate a program of live-trapping. Since the first colony was released on the Ochoco Forest, about 1,500 beavers have been trapped and released.

Since 1936, a study has been followed at intervals for the purpose of learning the causes that contribute to the success or failure of plantings and to study the behavior of beavers in their new homes, particularly from the standpoint of their timber and water requirements.

The geographic region under discussion lies in eastern Oregon and includes the semi-arid pine forests of the Blue Mountains, the east slope of the Cascade Range, and a portion of the Great Basin rim.

The opposing tendencies of beavers to remain where transplanted or to move to sites of their own choosing are expressed in Table 2.

TABLE 2. STATUS OF TRANSPLANTED BEAVERS IN EASTERN OREGON ONE YEAR AFTER LIBERATION

Explanation of symbols:
A Were living on planting site.
B Had moved short distance.
C Had moved, but a colony presumably the same appeared within a few miles.
D Had disappeared and new location was undetermined.

National forest	Period covered by report	Total colonies reported	Status of colonies A	B	C	D
Deschutes	1935 '37 '38	10	3	3	1	3
Fremont	1934-1937 incl.	22	5	4	1	12
Malheur	1934 '36 '37 '38	20	5	6	1	8
Ochoco	1932-1936 incl.	53	12	14	6	21
Umatilla	1935-1937 incl.	25	5	3	4	13
Wallowa	1936-1937 incl.	8	3	3	2	0
Whitman	1936-1938 incl.	49	7	12	14	16
Total in each status		187	40	45	29	73
Per cent in each status		100	22	24	15	39

We have given considerable thought to the reasons why three-fourths of the liberated colonies disappeared from the planting site within a few days or weeks. The principal reasons for the failure of colonies to settle upon liberation were apparently:

1. Lack of shelter; open meadow without concealing shrubbery.

2. Stream banks too low or slope too steep; no place afforded for deep ponds that would not freeze solid in winter.

3. Elevation too great in regions of heavy snowfall. The maximum elevation in eastern Oregon for satisfactory planting beavers is thought to be about 6,000 feet.

4. Stream too swift or subject to excessive flooding.

5. Lack of palatable foods, aspen or poplar. The presence of aspen is apparently a strong inducement for beavers to settle but, as will be pointed out, is a poor insurance that they will remain and form a permanent colony.

6. Capture by predatory animals.

7. Removal by poachers.

8. Improper handling of beavers preliminary to planting.

The duration of permanency of plantings—When beavers have adopted a new home they start a series of activities that may end in a few years in the exhaustion of the available food supply or that may continue indefinitely in pace with the annual increment of plant foods. With relation to present food supply, it seems possible to classify any colony in one of the following four groups:

Group 1. Colony in nearly pure stand of aspen, leading to speedy exhaustion of trees and emigration of beavers. The trees are felled with more zeal than discretion, for most of the bark of the trunk hardens and dries before it can be utilized. A high percentage (80-90) of the branches are cut from a trunk, and most of them are peeled for food. During the first year, however, only about 10 per cent of the coarser trunk bark is removed, increasing to 50 per cent as the trees become scarcer.

Group 2. Colony in willow not producing foliage as fast as required, leading gradually to depletion of food and emigration of beavers. The permanency of the willow supply depends on the annual loss of foliage to beavers, livestock, elk, and deer versus the annual increase of foliage.

Group 3. Colony in satisfactory balance with willow, producing foliage as fast as it is being cut. Many examples point to the conclusion that if an ample supply of willow is available the year round beavers will maintain ponds and their offspring will populate adjacent drainage systems. Willow bushes will persist in spite of repeated pruning by beavers, although certain ones will eventually be killed by flooding if their roots are entirely submerged in the beaver pond. The willow and the beaver exist in a virtual state of symbiosis, the willows supplying the food and the beavers raising the water table to permit the flourishing of the willows. If the willows are destroyed, as they occasionally are by livestock, the beavers emigrate; if the beavers are trapped out, stream erosion proceeds to lower the water table and the willows die for lack of water.

Group 4. Colony living at a subsistence level on mediocre food. The future of a colony living on lodgepole pine, alder, or birch is generally precarious. There is some evidence that colonies may subsist indefinitely on lodgepole pine by moving along the stream as the local food supply is depleted, i.e., employing the principle of harvest rotation. On the Whitman and the Ochoco forests we found native beavers peeling lodgepole pine where willow was also close at hand, indicating that pine is a palatable food and not a starvation diet.

Rate of activity of beavers as a measure of their timber and water requirements—Qualitative studies are generally easier than quantitative. It is far easier to determine the character or nature of beaver work than to measure it. In the present discussion, we are able to give a rather fragmentary record of the average amount of work accomplished by a colony of from four to six beavers over periods of from one to five years.

Cutting of trees and shrubs—The food trees cut by beavers east of the Cascade Mountains are principally the following:

Group 1—*Taken by preference*—
- Aspen (*Populus tremuloides*)
- Black poplar (*Populus trichocarpa* var. *hastata*)
- Willow (*Salix* species)

Group 2—*Commonly taken*—
- Lodgepole pine (*Pinus contorta*)*
- Birch (*Betula* species)
- Mountain alder (*Alnus tenuifolia*)
- Red osier (*Cornus stolonifera*)

Group 3—*Sparingly taken*—
- Snowberry (*Symphoricarpos albus*)
- Wild rose (*Rosa* species)
- Wild blackberry (*Rubus* species)
- White fir (*Abies grandis*)
- Douglas fir (*Pseudotsuga taxifolia*)
- Yellow pine (*Pinus ponderosa*)
- Juniper (*Juniperus occidentalis*)
- Larch (*Larix occidentalis*)
- Spruce (*Picea engelmanni*)

We have been able to estimate the rate of tree cutting on two sites only. On these, the stand of timber was almost pure aspen. Beavers were released in late summer, in one case four animals and in the

*There is some evidence that lodgepole should be included in Group 1.

other, six, and to the best of our knowledge all remained on the spot. The rate of cutting of aspen was found to be approximately:

At the end of 3 months (first winter)	20 eight-inch aspens
At the end of 3 years	75 eight-inch aspens
At the end of 4 years	100 eight-inch aspens

Construction of lodges and dams—The materials that are used by beavers in the construction of lodges and dams are well known to game managers. Whatever materials happen to be handy are used: driftwood, stones, mud, bark, pine cones, or green poles cut especially for the purpose. There seems to be a tendency for beavers to use large sticks on the lodge whenever possible, even though the animals may be feeding entirely on small willow wands. Where living among willows, they will travel some distance to cut yellow pine, juniper, or other trees for use as heavy timbers in the lodge or dam.

The histories of five plantings with respect to construction of lodges have been followed. In summary, lodges were constructed by colonies of four to six beavers at about the following rate:

At the end of 3 months (first winter)	lodge 2x6 feet*—1 small
At the end of 1 year	lodge 2x10 feet—1 medium
At the end of 2 years	lodge 2½x10 feet—1 large
At the end of 3 years	lodge 4x10 feet—1 large lodge started, 1 new started
At the end of 4 years	lodge 4x15 feet lodge 4x10 feet lodge started
At the end of 5 years	lodge 3x10 feet lodge 2x 8 feet lodge 2x 6 feet lodge started

*Smallest dimension is height; largest is diameter.

The rate of dam construction varies enormously with the conditions of the environment. The following six cases, however, will indicate in a measure the range of dam-building activities.

	Number of dams	Height*	Length*
At the end of 2½ months	10	1	13
At the end of 1 year	5	1½	14
At the end of 2 years	9	1½	22
At the end of 3 years	15	1½	24
At the end of 4 years	1	1	75
At the end of 5½ years	12	1½	12

*Dimensions given are the height of the top of the dam above the waterlevel of the tailrace and the length from bank to bank, in feet.

Size of reservoirs—Records of the amounts of water held in the ponds of eight transplanted colonies exhibit a wide range of values. At the end of three years one colony had stored only 3,400 cubic feet of water, while another had stored 45,000 cubic feet. The average amount of water stored by a colony at the end of the third year was about 15,000 cubic feet, including water backed up in marshes as well as that held in the beaver ponds.

In conclusion, we should like to state the following opinions applying to the semi-arid regions of eastern Oregon and Washington:

1. The number of beavers dead-trapped where they are doing damage should be increased.
2. The causes that contribute to the failure of plantings are sufficiently well known that, by careful attention to the selection of sites, the game manager can establish 60 per cent of the colonies released.
3. Considering the wide variety of habitats under which beavers are known to thrive, it is not practicable to determine beforehand, by the use of numerical standards only, the carrying capacity of a prospective planting site.

DISCUSSION

MISS FANNYE A. COOK (Mississippi): In Mississippi we are engaged in restoring beavers, undertaking it very seriously under a new farm and forest management program, and we are running into a great many problems.

I noticed that Dr. Scheffer advances the same information that others do regarding the food preferences of the beaver. I think it was Vernon Bailey who said that the beaver range and that of poplar are parallel. Everybody seems to state that the poplar or some species of the poplar is the beaver's favorite food. We have yet to find beaver either gnawing or cutting poplar, even where it is very prevalent. Our beavers show a preference for sweetgum and willow, and other native trees and shrubs, but not for the poplar. I should like to ask Dr. Scheffer if, in his observations and studies, he noticed any fluctuation in the extent to which beavers cut trees, especially in the different seasons. Do you find them feeding, cutting, and gnawing any sort of trees during the spring and summer and winter alike?

DR. SCHEFFER: No, we found exactly the reverse. Our beavers are much more active in the spring and summer on the banks and we have noticed that during this fall and winter they remained almost entirely within the bed of the stream, feeding on succulent parts of smilax and other things they dig from the banks. They have made slides and short trails from the water this winter to get acorns. They seem to be very fond of the acorns and I think must compete considerably with our wild hogs for this mast.

MR. LEO K. COUCH (Washington, D. C.): It is true that in the North and in the West the poplar is a leading beaver food, along with the willow and the aspen. In Virginia the sweetgum seems to be the beaver's favorite food, with swamp maple and willow next. It has only been in the last few years that we have known much definitely about the foods of the beaver in the South.

One question comes to my mind. These studies that Dr. Scheffer mentioned were largely conducted in Oregon, starting in 1936. What relationship did the livestock have to the success of the beaver plantings?

DR. SCHEFFER: Generally speaking, along the sides of streams, where willows are scraggly and limited, they may be badly damaged by livestock, as well as by elk and deer. I have observed situations in a number of the forests which confirmed that, particularly in one instance where, for two years, attempts were made to plant willows along a denuded mountain meadow at an elevation of about 6,000 feet. In both years, considerable money was spent in trying to restore willows to that streamside, but the livestock and elk practically killed them out. Exclusion of stock, particularly, would be a necessity in attempting to bring back the willow beaver food along a streamside.

DR. D. I. RASMUSSEN (Utah): I am particularly interested in the taking of censuses of beavers. I was wondering what information you got on the formation of new colonies after transplanting. Was it two or three years before another colony was produced, or, even after five years, were they pretty well confined to that original colony? Also, what constituted a "plant" that you call a colony?

DR. SCHEFFER: I have no clear-cut evidence on the dispersal of the offspring of the original planted colony. The longest time we followed any plantings was five and one-half years. As to lodge construction, we found three lodges formed and a fourth one started—I believe those were the figures—indicating that in at least several cases followed for that length of time, the offspring stayed right where the parents were planted.

A "plant" consists ideally of a minimum of four beavers, two of each sex, not counting the kits.

MR. G. H. SOULEN (Texas): I take the opportunity to corroborate Miss Cook's statement about the adaptability of southern beavers as far as food is concerned. In some places where the willows were taken out by floods, the beavers changed over to walnut, pecan, oak, liveoak, post oak, and even to cedar. Not only will they take those foods, but will reproduce on them and become fat.

I would like to ask Dr. Scheffer what method was used in marking, and if he found any food predilections as to the size of the trunk diameter.

DR. SCHEFFER: At the time this study was made, no successful means of identifying released beavers had been worked out.

I made no quantitative analysis of the predilection of beavers for various diameters of aspen.

MISS COOK: May I ask one more question of Dr. Scheffer? What advantage may there be in dead-trapping beavers over live-trapping? Is it any more effective or expedient to dead-trap them? We are anxious to save all of ours, because we are trying to restock, and yet we get complaints and we must control them.

DR. SCHEFFER: With present techniques dead-trapping is more effective in getting the beavers.

THE POSITION OF FUR RESOURCES IN THE SCHEME OF WILDLIFE MANAGEMENT

FRANK G. ASHBROOK
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All those who are interested in the conservation of wildlife in its broadest aspects will agree that it is highly desirable to include fur animals in any general plan for wildlife management. If conservation is ever forced to pay its own way, failure to take fur resources into account might result in ultimate failure for there is not sufficient revenue in sight from other sources to pay for adequate administration of wildlife refuges in the United States. Federal and state legislators may not grant sufficient funds to properly administer all these areas, and less consideration will be given to financing research unless there is a worthwhile return from refuge operation.

The wildlife conservation movement during the past twenty years, has been handled as a national luxury, a spending of money for intangibles, as esthetic, sporting, and recreational values. These are necessary and essential for a more abundant life, but they are not the only important factors to be considered in setting up a program for conservation of wildlife.

It seems to me that the most serious weakness in the conservation movement is its subordination of tangible to intangible values, of commercial to noncommercial or, if you please, of trapping to hunting. This subordination of fur resources is an incongrious viewpoint in a very materialistic world.

The Pribilof Island seal herd is the outstanding exception in the field of wildlife conservation. Under management it has yielded a profit, but the opportunity was, perhaps, unique. I am firmly convinced that sooner or later all conservation of wildlife must meet the economic test—does it pay in dollars and cents? The attitude of Congressmen with respect to the sale of natural resources produced on federal lands is one of considerable interest as evidenced not only by their inquiries but by the bills they have introduced.

Practically all federal refuges have been established primarily for the protection of migratory waterfowl and big-game animals and no areas have been set aside specifically for fur animals. Even though this was the situation in the beginning, there seem to be good reasons for modifying the policies sufficiently to give the fur animals a break.

However, many of our federal refuges are in fact great natural reservoirs of fur animal life. The restoration and building up of the fur resources on these reservations is an essential part of the conservation and management work of the state and federal Governments and in the not too distant future fur animals may be paying the way for the migratory waterfowl.

A definite policy has already been established for conserving fur animals, including harvesting and disposing of the fur crop on lands administered by the Fish and Wildlife Service. Within a few years, if properly managed, more than a quarter of a million dollars can be derived as the annual net income from fur taken on federal refuges and this sum will increase as time goes on.

The acquisition prices for federal refuge lands have been predicated upon the estimated returns from fur where these animals are an important natural resource. In such places, and as far as practicable in others, the refuges should be made to yield the highest possible revenue from the sale of natural products without detriment to their conservation values.

Properly handled, the fur resources of all present and prospective areas reserved for wildlife conservation, should pay a fair return on the investment in lands and in some instances, within a reasonable number of years, should return to the public treasury the total cost of the lands including interest. If they do not, it will be due primarily to unwise management of their fur resources.

In this connection, there is much need for more complete knowledge regarding production and the relationship of fur animals to other species, and for a more tolerant attitude toward fur animals in all programs for wildlife conservation. Almost every state has fur resources that are a source of income to some of its citizens. The methods of handling these resources are almost entirely haphazard, and in fact, few state game and conservation commissions have given sufficient, if any, serious thought to the matter. In most states there is no provision for keeping a record of the furs taken each year. In the case of some of the most valuable fur animals—martens, fishers, wolverines, and others—the situation has become so serious that the Fish and Wildlife Service has appealed to all state game and conservation commissions in states where these animals are still found, to protect them with a closed period extending over a number of years.

A brief retrospective glance will show what has happened to the beavers to make their conservation so essential. In 1916, the Canada beaver, represented in the United States by the typical form and several local races, was to be found only in widely separated localities east of the Rocky Mountains. Maine, New York, Michigan, Wisconsin, and Minnesota had a few colonies of the animals, and a scattered remnant still persisted in the wilder parts of the Appalachian Range and in large southern swamps. West of the Mississippi the headwaters of some of its tributaries still contained a few beavers. In the Rocky Mountain region and westward, beavers were more common, and their works were still occasionally seen in the little mountain valleys.

The former Biological Survey, now the Fish and Wildlife Service, was quick to realize the situation. Restoring and establishing the beaver permanently as a natural resource was a problem for study. It seemed a wiser policy to treat the beaver as a valuable resource worthy of cultivation rather than as a nuisance to be suppressed or eliminated. We learned that rather than kill them and take the fur, the logical procedure was to transfer the animals to more suitable habitat. Places were found on tributary streams in national and state forests and parks, on wildlife refuges and private estates remote enough to avoid damage to roads, trails, and cultivated fields.

Live beaver traps, holding pens, and methods of transportation and restocking beavers were developed. The beaver transplanting campaign was approved as an aid in flood control and in the conservation of water. Appreciation of the economic possibilities of the beaver increased among farmers, stockmen and foresters, as well as among officials in charge of public lands and in due time the new viewpoint found wide acceptance.

The farmers and landowners in the United States have learned that the beaver constitutes a natural resource of very real importance. The income from the beaver catch to those who trap in any state represents a new source of income. Stating it another way, the people of the United States who trapped beavers last year were collectively better off by at least $1,250,000 than they would have been without the beaver.

During the past season (1939-40) there were 100,000 beavers trapped and the pelts sold in the raw fur markets. This is a considerable increase over previous years and is the result of cooperative efforts on the part of the state and Federal Governments to bring back the beaver and to reestablish this fur animal as a permanent wildlife resource. In practically every state where the beaver has been given an opportunity to reproduce unmolested the crop of fur taken during the past five years has increased.

In addition to the domestic production, 95,615 skins were imported into the United States during the period December 1, 1939, to August 31, 1940. Even though the domestic crop of beaver pelts was larger than before and the importations greater than usual, sales kept pace with production so that at the present time stocks appears to be exhausted. This indicates that the American market can still absorb at favorable prices a greatly increased domestic supply.

The experts have developed techniques in fur dressing that makes beaver fur fashionable today. This fur was formerly considered clumsy and bulky but now, due to improved processing it becomes light, soft, and pliable. Formerly its bulk prevented the stylist from draping the fur and dampness caused it to mat into an unkempt appearance. Now, the fur is sheared, which lessens its bulk, eliminates matting, and exposes the lovely blue-brown color that was formerly hidden beneath the long fur. Not completely satisfied with this achievement, the fur dressers worked on the opposite side of the pelt to thin the leather. They found a way to accomplish this by shaving and buffing and now all dressed beaver pelts are as flexible as cloth. So much for the contribution of the furrier to increase the market for beavers.

As to the position fur animals should hold in any wildlife conservation plan, I should like to present the following summarization:

The principal object of conservation, whether of fur animals or other forms of wildlife is "Conservation with wise use." Applying this principle involves a comparison of sporting and commercial values that up to the present time has been largely avoided.

However, any conflict of activities between sportsmen, trappers, and fur traders uselessly wastes both time and energy. These groups should work out their problems together and present a united front in urging legislation concerning conservation. The drainage of swamps and lakes not only is inimical to waterfowl, but also does away with the muskrat which could ultimately pay for the lands; forest fires destroy fur animals as well as game; and polluted waters destroy the food of these animals. Where there is laxity in the enforcement of game laws the situation is usually worse with respect to fur animals.

At present, when public attention is turning more and more towards conservation and restoration it would seem to be the wise policy to treat fur animals as a valuable resource worthy of cultivation.

All of us who are vitally interested in the conservation should insist that fur animals be given favorable consideration in evolving plans or policies for the maintenance and use of our wildlife resources.

DISCUSSION

CHAIRMAN ALDOUS: Mr. Fredine, will you conduct the discussion?

MR. GORDON FREDINE (Minnesota): Personally, I have no comment or questions, but let us hear from any who do.

MR. DOUGLAS WADE (Missouri): About ten years ago, some 45 million dollars was collected in excise taxes on furs. That was a 10 per cent excise tax, reduced later to 3 per cent. Is it still on?

MR. LEO K. COUCH (Washington, D. C.): I think it is.

MR. WADE: I would like to go on record as suggesting that a portion of the excise tax on fur be devoted to fur research.

MISS FANNYE A. COOK (Mississippi): Some of us are rather averse to recommending the propagation in captivity of species that can be produced in ample quantities in the wild. However, in some places the beaver may not be susceptible of extensive propagation under normal wild conditions.

Considering whether we are going to have sufficient cover and food to grow enough beavers to satisfy our home market, to say nothing of other markets, I have wondered whether we should not consider the possibility of breeding them in captivity. They seem to be very nice animals to manage. They are friendly, and there seems to be no trouble in getting food for them. Has such propagation been sufficiently tried?

MR. COUCH: In Minnesota, One fur farmer raised beavers in pens for a series of years. He cut aspen into 16-inch lengths and threw it into the pens. After the beavers took off the bark, he corded it up in the backyard and sold it for firewood.

Incidentally, the beavers were kept in the dark, and the interesting result was that parasites were almost entirely eliminated.

The slow rate of increase in the beaver may be an obstacle to success from an economical point of view.

CHAIRMAN ALDOUS: I might make one remark regarding what Mr. Couch says about the parasites. One other factor seemed more important to me, possibly, than the factor of light in reducing the parasites, and that was that this farmer took his water supply from a spring, and left no chance of contamination in that direction.

The beavers did get light during the daytime, but never any direct sunlight. There was an opening at the top of their house that admitted enough light so you could see your way around.

DR. J. E. SHILLINGER (Washington, D. C.): I would like to ask a question, following up the statement made that these beavers were raised successfully. Does that mean from a financial standpoint?

CHAIRMAN ALDOUS: I believe, from the experiences of this particular individual, that beavers can be raised profitably under favorable circumstances. He had some 80 beavers in his pens at one time, and he told me that with very little extra help he could handle at least 500. I think that a profit could be made with that many beavers. His losses from all causes were very low.

DR. VICTOR B. SCHEFFER (Washington): Did this man utilize the carcasses of the beavers after he had removed the skins?

CHAIRMAN ALDOUS: Not to any extent. He did feed them to dogs, and some of the neighbors obtained them for dog food. Other than that, no utilization was made.

MR. GORDON FREDINE (Minnesota): Dr. Swanson, could you give us any idea as to the extent that federal aid to the states is stimulating fur research?

DR. GUSTAV SWANSON (Minnesota): I have read a number of reports from states in my region, and find that several are doing, or claiming to do, a good deal of work on fur or on furbearing animals. Illinois, Michigan, and Minnesota have very progressive programs of fur research. More such work is needed, but I think a good start is being made, and the federal aid funds are doing a lot to stimulate the program.

MR. FREDINE: I think it is very encouraging that the federal aid covers work on fur animals. The states are allotted money on the basis of the number of licenses issued, that is, hunting licenses, but I think that trapping licenses, too, might well be included. That would help states that have particularly bad trapping and fur problems to get a little added revenue.

DR. SCHEFFER: Beaver management in Oregon at the present time is financed by Pittman-Robertson funds.

MR. G. H. SOULEN (Texas): Texas A. and M. College is now carrying on some experiments with beaver, and we will certainly welcome any suggestions that you have to offer. As to parasites, we have to think about the screw-worm, but have taken care of it by making pens insect-proof, keeping the entrances to lodges under water, and screening air vents.

TECHNICAL SESSION

WEDNESDAY AFTERNOON—FEBRUARY 19

Chairman: A. W. SHORT
Division of Conservation and Natural Resources,
Columbus, Ohio.

Discussion Leaders:

FRED A. SCHWOB, *Iowa Conservation Commission, Des Moines, Iowa.*
DR. WALTER P. TAYLOR, *Cooperative Wildlife Research Unit, College Station, Texas.*

REMOVING SURPLUSES OF WILDLIFE

REMOVING SURPLUS DEER BY HUNTING, ALLEGHENY NATIONAL FOREST, PENNSYLVANIA

RANDAL MCCAIN
U. S. Forest Service, Warren, Pa.

The stabilization and maintenance of a shootable herd of big game animals depend largely upon the proper harvesting of the annual surplus. Basically there is little difference between the management of wild and domestic herds. The small expanding herd on a bountiful range is regulated by taking only the non-breeding members. Large herds on a limited range often require more drastic reduction in order that a balance between numbers and forage supply may be quickly attained. Since many areas are now over-populated, game managers are interested in what is being done to meet the situation. With this in mind, there is given here a brief history of deer on the Allegheny National Forest and a record of the steps that have been taken in handling them.

The history of this deer herd is generally true for these animals in the State of Pennsylvania. By the time this forest was established (September 24, 1923), Pennsylvania's timberland, consisting of 13,000,000 acres, was well on the way to becoming a deer hunter's paradise. There is a wealth of published material on the history of deer in Pennsylvania and those interested in that most important phase of the subject should read ***Game Returns to the Land of William Penn*** (Biddle, 1937), but let it suffice here to state that from the stage of almost complete extermination, the way was prepared for a comeback by the establishment of refuges in 1905 and by enactment of the buck law in 1907. Prior to these dates, hunting with hounds and for the markets also had been curbed. To hasten their reestablishment, deer were purchased mostly from northern Michigan and liberated in the game refuges.

The Allegheny National Forest covers a gross area of some 739,000 acres in northwestern Pennsylvania along the Allegheny River. Four of the state's primary refuges lay within or directly adjacent to this territory, but by the time the forest was established, there were many small herds on it outside of the state game lands.

The factors which brought about great increase of deer on the forest are several. In brief they may be stated as follows:

1. Excellent range conditions created by forty years of lumbering.
2. Lack of natural enemies and freedom from disease.
3. Full protection by refuge areas and by adequate laws including the buck law.
4. Law enforcement of the highest order.

By 1930, deer in the southern half of the forest were so numerous that their needs far exceeded the long term forage supply. Female deer had been given full protection on the forest from 1907 to 1931, a period of twenty-four years. (The 1928 season on does did not apply to the forest and adjoining areas. Penna. Game Com. 1931). Overpopulations had occurred in the southern and central counties of the State for a number of years, and remedial steps had already been undertaken there.

The Game Commission's fight for the utilization of surplus deer first bore fruit in 1931 on a state-wide basis, but it soon became evident that the 1931 open season only briefly halted expansion of the deer herd.

Seth Gordon's article in the *Country Gentleman* for May, 1937, entitled *Conservation Madness,* tells of the battle against misguided public sentiment that balked sensible management. He tells how Dr. Kalbfus, the pioneer executive officer of the Pennsylvania Game Commission, tried unsuccessfully to convince a legislative committee of the need for an open season on female deer as early as 1917, but public opinion was blind to facts that any breeder of domestic stock would have recognized and corrected.

Even though farmers were killing some 2,000 deer annually to protect their crops, the sportsmen, as well as the public, over-rode all efforts to legalize the taking of female deer. Finally in 1928 they were partially won over. Gordon (1937) stated, "The hunters, who had always opposed killing the surplus deer, complained about the farmers killing the animals; also about the small size of the deer bagged, their thin, unattractive antlers, the many late helpless fawns observed during the December hunting season, and the hundreds of decaying carcasses found along the trout streams in the springtime.''

The Commission's efforts to exercise sound game management by taking surplus deer has proved its worth. The harvesting of deer on the Allegheny National Forest alone has given the sportsmen over a million man-days of hunting and the estimated 84,000 deer taken there during the past 10 years is evidence of the effectiveness of the harvesting procedure. The authority delegated to the Commission by the State Legislature to regulate seasons and bag limits is working untold good.

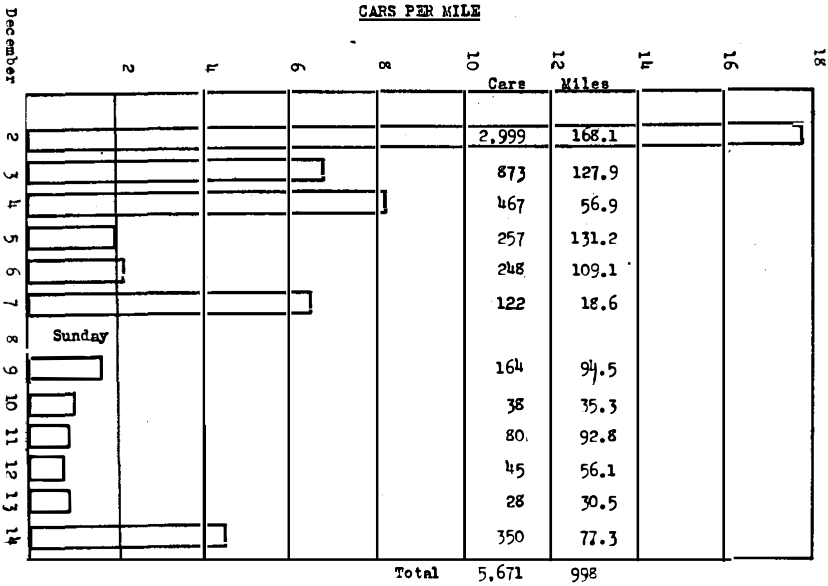
In general, the public had refused to believe that there were anywhere near as many deer as game men stated. They were also skeptical of reports that the food supply would become exhausted. The deer herd was expanding northward as well as in numbers and new groups of hunters had to be educated. It was plainly a case where facts were needed that could not be denied—facts with which the sportsmen could be induced to see the wisdom of sound game management practices. Public education would turn the tide and here was an opportunity for the Forest Service to cooperate actively in furthering the cause of conservation. As management of the deer could not be divorced from that of other products of the land, the Forest Service was invited to participate in helping to bring it in line with good conservation practice.

For three seasons only bucks were taken (Table 1). With the Kaibab National Forest overpopulation so recently before them as an object lesson, the Forest Service wanted to act decisively to prevent a repeti-

TABLE 1. HUNTER AND KILL ESTIMATES

Year	Days of hunting	Estimated number of hunters	Estimated number of adult bucks legally taken	Estimated number of antlerless deer legally taken
1931	6[1]	30,000	3,000	8,000
1932	12	10,000	1,000	....
1933	12	10,000	1,500	....
1934	12	15,000	2,900	....
1935	9-3[2]	90,000	5,000	11,000
1936	12	40,000	3,000	....
1937	12	42,000	5,700	....
1938	6	67,000	....	24,000
1939	9-3[3]	70,000	3,500	6,000
1940	12[4]	70,000	3,000	7,000
10-year Total	96-24[6]	444,000	28,600	56,000[5]

[1]Open on all deer except spikes and those under 40 lbs.
[2]Season split; first 9 days for adult bucks only.
[3]Season split in Forest and Warren Counties only. No antlerless deer taken in Elk and McKean Counties in 1939.
[4]Combined season except for spike bucks; no other restrictions.
[5]It is estimated that ¼ of these were male deer (Gordon, 1940).
[6]No hunting is permitted on Sunday in Penna. Total of 96 days' buck hunting and 24 days' antlerless hunting during the 10-year period.



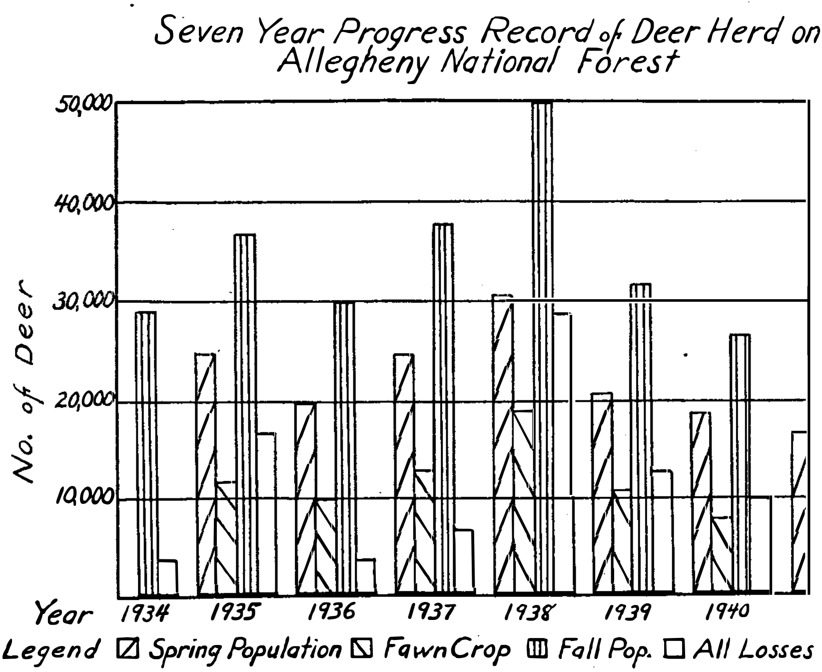


Figure 1 (*Upper*); Figure 2 (*Lower*)

tion of that unfortunate situation. Yet misinformed public sentiment stood in the way of needed management, and unlike in Arizona, there were hordes of hunters in Pennsylvania.

Early in 1935, facts were assembled as rapidly as possible and a definite campaign launched to add to the educational work of the State Game Commission. Research of the forest included the study of winter ranges and their carrying capacities. Counting deer by airplane, game drives, spot lighting, pellet group counts, and tracking have all been employed with more or less success. (Bennett, English, McCain, 1940.) Deer kill estimates and hunters' reports also were utilized as a means of making population deductions (Figure 2).

As a result of continued efforts to uphold game management and break down public resistance to taking does, the Commission was able to declare a 3-day season on antlerless deer in fourteen (14) counties following a 9-day buck season in 1935, which applied to animals in the national forest. The results, though gratifying, did not prevent a staggering starvation loss during the severe winter which followed (Figure 2). The forest loss of from two to three thousand was proportionally very much less than that for most of the State where 40,000 deer were estimated to have died as a result of malnutrition.

The national forest continued with the game drives (McCain, 1939) and collected much data on weight and measurements (Park, 1938) during the ensuing five years. "Show-me trips" as late as 1938 and 1939 were required to convince the die-hards that taking female deer was beneficial.

In 1936, the herd was allowed to recover from the heavy mortality of the previous season and severe winter. 1937 saw it on the increase again. The Commission's attempt to again introduce the permit system of harvesting the surplus was stopped by a court injunction and only bucks were taken (Table 1). By July, 1938, the combined weight of all cooperating agencies in educating the sportsmen began to be felt. Facts gathered by the forest personnel and the Commission could not be easily refuted. There were more surplus deer than ever and very much less for them to subsist upon (Gerstell, 1938). The legal take of 24,000 antlerless deer on the national forest in the 6-day season of 1938 was even larger than the total that most sportsmen had been willing to admit existed in the area, yet nearly two animals remained for each one killed.

An idea as to what such a season means is difficult to convey. The forest road system is made up of 403 miles of highways including U. S. and state routes and 311 miles of forest development roads usually with a dirt surface. This adds up to almost a mile of road for each 1,000 acres of land which probably makes the Allegheny

National Forest the most accessible big game hunting territory in the country. A count of hunters' parked cars on the first day of the 1939 antlerless season revealed that there were close to 20,000 hunters in an area of less than 100,000 acres in Forest County, or one hunter per each 5 acres. In this same sector, 2,000 cars were counted on six different stretches of road that totaled only 30 miles—this averages a car every 79 feet.

The hunting pressure and location of hunting in 1940 was determined by car counts totaling 5,671 on 998 miles of road (Figure 1). This is considered to be a good sample on which to base our estimate of 47,900 cars of hunters during the 12-day hunting period. The desire to be on hand when the season opened and to take advantage of Saturday holidays is easily seen. The table shows in a most striking manner one of the major faults of the present hunting method, that of concentration. Not only was the hunting intense on certain days, but by locality as well. This resulted in danger to the hunters, spoiling the sport for the still hunters and "old timers," and in utilization that was in no way correlated with range conditions.

Hunters have a tendency to flock to areas of heavy previous kills, but centers of deer populations move from one drainage to another over a period of years and there is a noticeable lag in the hunter follow-up.

In Figure 2, an attempt has been made to include all available data on the progress of the deer herd. Of special interest are the losses and their effects upon the herd. It is self-evident that when the loss is mostly of adult males, occuring after the rutting season, it will have little or no effect upon the increase the following year. Included in the loss figures are all types of losses, including legal and illegal kill, and those due to wounding, disease, starvation, killing by dogs, control for crop protection, exodus, and to highway kills, and other accidental deaths. Where living conditions are not ideal, old age is scarcely a factor to be considered in deer deaths. Hunting is the chief control measure, however, and proper hunting is the prime objective of management.

SUMMARY

Approximately one million man-days of hunting have been provided by the harvesting of surplus deer on the Allegheny National Forest. While utilization has not kept pace with the need for herd regulation, a very creditable showing has been made in the taking of more than 84,000 animals.

The success of the buck law in building up the herd created a prejudice against killing female deer that had to be broken down by public education. The public is still loath to place the problem wholly in the hands of their public servants.

It is the policy of the U. S. Forest Service "to cooperate with State . . . agencies to obtain utilization on a sustained-yield basis, and, to the fullest extent possible, cooperate with State, Federal and other agencies in all matters pertaining to wildlife on national forests and related adjacent areas." (Shantz, 1940.)

Special seasons create concentration of hunting, resulting in accident hazards, excessive illegal kill, and considerable public dissatisfaction.

The deer range is now badly depleted; the animals are concentrated in a few drainages and despite losses aside from the legal kill of more than 80,000 head in the past seven years, a surplus still exists. We have every reason to believe, however, that cooperative effort will soon see this herd put on a sustained yield basis, wherein a balance is maintained between numbers and the forage supply.

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WHAT HAPPENS DURING A GAME HARVEST?

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To date most of our efforts have been directed toward the production of game crops and relatively little has been done in the way of finding out how to make better use of the crops. What happens during a harvest period is just as important as what happens during the production stages. There are both economic and practical, as well as biological limits, to the size of game crops. As the "ceiling" of game production is approached, existing and probable future hunting pressures can be taken care of only by planned control of the hunting pressure pattern and by "setting of the stage" so as to assure the maximum man-hours of recreational return for each piece of game harvested.

A knowledge of critical events of the harvest contributes not only to the general management program, but also to the solution of a long list of problems in administration, enforcement, legislation, recreation, social relations, economics, cooperation, and personnel management. Many questions need to be answered for each species and geographic unit involved. What part of the season's hunting is done each day? What part of the season's bag is taken each day? Few realize that there are definite rhythms or patterns of hunting pressure which are, within limits, subject to control. What happens when any one of the several classes of hunters fails to harvest its proportionate share of the game crop? What portion of the game crop should be harvested by the farmer-landowner in order to insure cordial relationships with sportsmen?

Since few workers have studied game harvest events, especially where farm game species are involved, it has been necessary in Ohio to invent and develop new techniques for measuring conditions and practical methods for tabulating quantitative data, as well as to devise criteria of evaluation. To date ten investigators have prepared 38 reports on various Ohio game harvest events: Hicks, 11; Hicks and Leedy, 6; Leedy, 3; Chapman, 6; Baumgartner, 3; Benjamin, 3; Olds, 2; Wickliff, 2; Preble, 1; and D. Katz, 1. All of these reports have contributed to the conclusions of this paper.

How important is hunting season mortality in the life economy of a game animal? This question has been answered for but few species. Populations, especially those of species of high reproductive potential and efficiency, tend to turn over or change rapidly, even when little or no hunting is done. Sedentary and non-flocking species tend to have a smaller proportion of the annual mortality due to hunting removal, than is the case with mobile and gregarious species. Ohio studies have shown that cottontail population turnover is practically as rapid on refuges and other areas closed to hunting, as on lands subjected to average hunting pressures. In many species the mortality rate of the young is from 2 to 10 times that of adult animals. Hence, hunting losses may account for only a small part of the total annual mortality, although the game crop harvest removal typically accounts for one-fourth to three-fourths of all adult mortality on areas subjected to high hunting pressures.

In pheasants, for example, about 64 per cent of the total annual mortality of adult birds comes during the one-half month of the hunting season, 18 per cent during the four months of the reproduction (and mowing) season, 12 per cent during the four winter months, and only 6 per cent during the remaining 3½ months of the year. In a species where both sexes are not legally hunted, the mortality patterns of the males and of the females are quite dissimilar.

Population turnover is so rapid that a flock of wild cock pheasants, dating from October 1, will shrink to a 1 per cent remnant in only 27 months. In the case of hen birds, with much lower hunting season mortality, one bird in every 100 will still be alive at the end of 57 months. When the hunters go afield, only two-thirds of one per cent of the cock pheasants and only 4.4 per cent of the hens they may find are 3 or more years of age. Of the cocks, 83 per cent are juveniles, 13.6 per cent are yearlings, 2.7 per cent are 2-year olds, and less than 1 in every 100 are aged birds. About 91 per cent of the annual mortality of adult cock birds is due to the hunting season removal—35 per cent in the case of the hens. While it is true that part of the game harvest consists of vulnerable surpluses that otherwise would succumb to other types of mortality, it should be kept in mind that hunting season losses go beyond those surpluses. In fact, hunting alone, in the case of farm game species subjected to heavy hunting pressures, accounts for more than half of all adult mortality, and creates a critical management problem, namely, preservation of an adequate and strategically distributed broodstock.

Game crops are usually harvested without direct or accurate measurement of the net effect. The pheasant is the only Ohio game species for which we have as yet obtained an adequate record of harvest events in relation to population levels. For several years the average picture has been as follows: (1) Of every 100 cock pheasants shot, 83 are juveniles, 17 are adults; (2) the hunting season removes 74 per cent of the cock birds, 22 per cent of the hens, and 46.6 per cent of the total pheasants; (3) for every 100 cock birds bagged, 18 are reported as crippled and lost (obviously the actual crippling losses are somewhat higher than the 15 per cent loss reported); (4) for every 100 cock birds killed, nearly 40 hens are lost (Figure 1).

Since Ohio does not have an open season on hen pheasants, this loss of females represents both honest mistakes and intentional illegal kill. This is the normal rate of hen loss in sections having what would be considered good enforcement. The hen loss is even higher where enforcement is less adequate. The relative kill of hen birds increases as the open season progresses. Hence, a lengthened open season tends to add to the loss of hens. Since the pheasant crop yield per unit of hen broodstock is now well known, it can be definitely stated that the elimination of only half of the hunting season loss to hens results a year later in average crop increases of at least 15 to 20 per cent. Tests

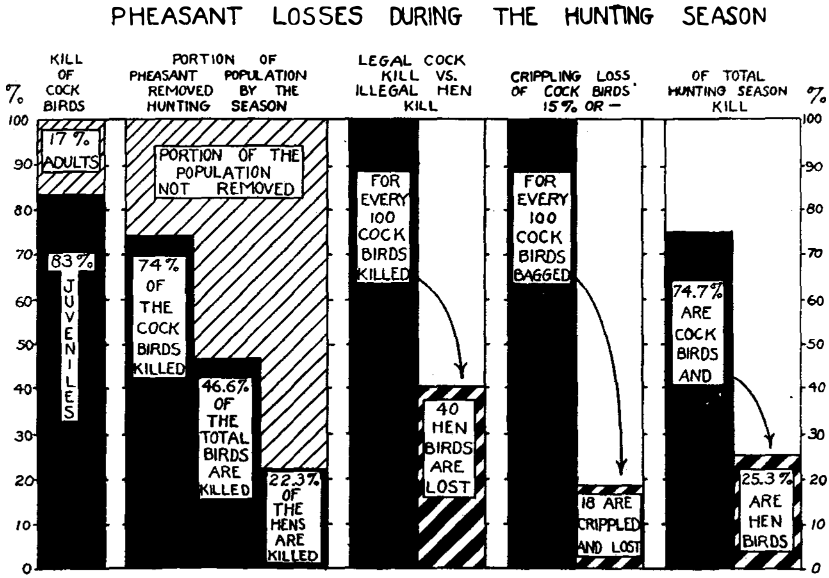


Figure 1

have shown that only by education can the hen killing be reduced. Other management measures seem not worth taking until this unnecessary leak is plugged. When hunters come to realize that the potting of one hen bird is more detrimental to their interests than the illegal take of a half-dozen extra cock birds, enforcement will become automatic and enough will be preserved to insure desired crops. This realization that the hen pheasant is the goose that lays the golden egg. is more important than any other single concept in pheasant management.

Ohio in 1939 had 667,000 hunters divided into three classes: (1) Farmer hunters, (2) hunters from cities, and (3) local hunters, i.e., those living outside of metropolitan areas but not on farms. Contrary to general impression, farmer-landowners constitute the largest of the three classes of hunters, totalling 306,000 or 46 per cent of the total. Though those residing on farms are not required to purchase licenses to hunt on their own lands, approximately two-thirds of them do so. Interviews with an 8 per cent sample of the farm operators of 31 counties indicated that nearly two-thirds (63 per cent) participate in the annual game harvest.

Events during game harvest periods are critical in determining farmer-sportsmen relationships. While control of trespass and other abuses is important, how a game crop is divided or shared between the several classes of hunters, is even more so. Each farmer-landowner developing an interest in hunting becomes an asset in game production by: (1) His willingness to modify agricultural operations in the direction of game management practices, and (2) by his effective position as a go-between or compromise agent between the somewhat opposing interests and viewpoints of farmers that do not hunt and of hunters that do not own land.

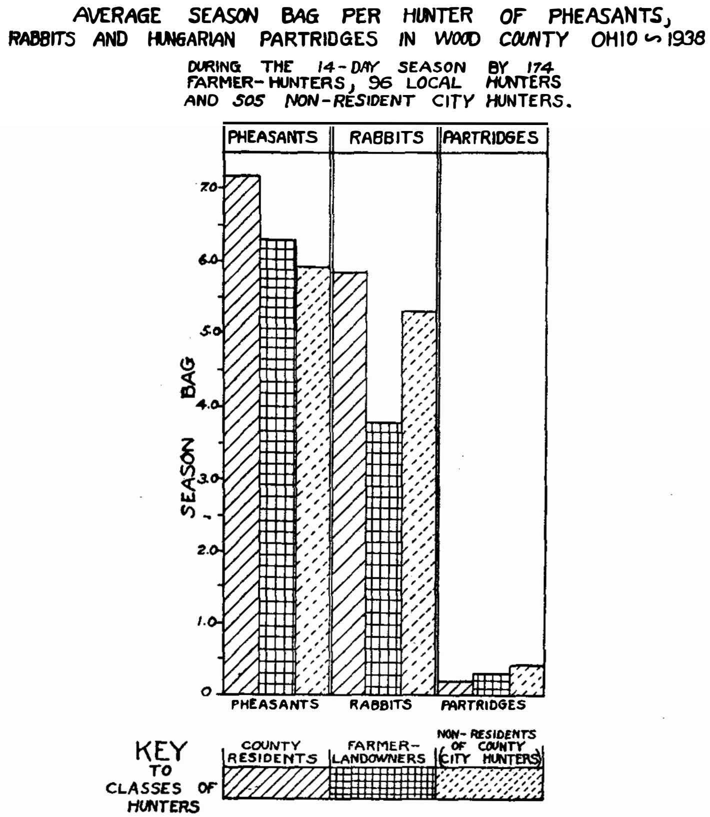
When there is an adequate number of farmer hunters to bridge the gap of these opposing viewpoints, farmer-sportsmen relationship problems tend to solve themselves. Innumerable local variables determine for each locality the critical threshold of the degree of landowner participation in game harvests necessary to insure cordial relationships.

Much has been learned in Ohio by superimposing six state maps indicating for each township: (1) The average game yields per unit of area; (2) the degree of landowner cooperation in producing game crops; (3) the average desire of landowners for more game; (4) an index of the acuteness or favorableness of farmer-sportsmen relationships; (5) the coverage of organizations or associations conditioning opinion or participation in management; and (6) the degree of participation of farmer-landowners in game crop harvests.

All experience to date indicates that a healthy set-up requires that no less than 55 per cent to 70 per cent of the farms of an area should have residents that hunt. Of the total game crop harvest, farmer hunters should get as their proper share, no less than 60 per cent where game yields are low, and no less than 35 to 45 per cent where game yields are high. In Ohio, at least, undesirable relations tend to develop, where farmer game harvest participation falls below these minima, although other local conditions may be equally decisive.

It is also desirable to set the stage so that the average season bag per hunter is proportionately balanced between each of the three classes of hunters. In Ohio the average season bag of pheasants per farmer hunter is usually more than that of the city hunter, but less than that of the local hunter. Note that farmers in the pheasant belt tend to pass up rabbits more than do local or city hunters (Figure 2).

Techniques have been developed for accurate field management of hunting pressure per unit of area. Hunting pressure curves for Plain and Liberty Townships of Wood County prepared each year have been most useful in interpreting harvest events (Figure 3). Note the typical rhythm of hunting pressures throughout the open season—the big drop during the first three days and later peaks on Thanksgiving Day and, under some conditions, on Fridays or Saturdays. Human behavior and other factors that influence hunting pressures, are such that most of the surveyed areas, especially adjacent townships or



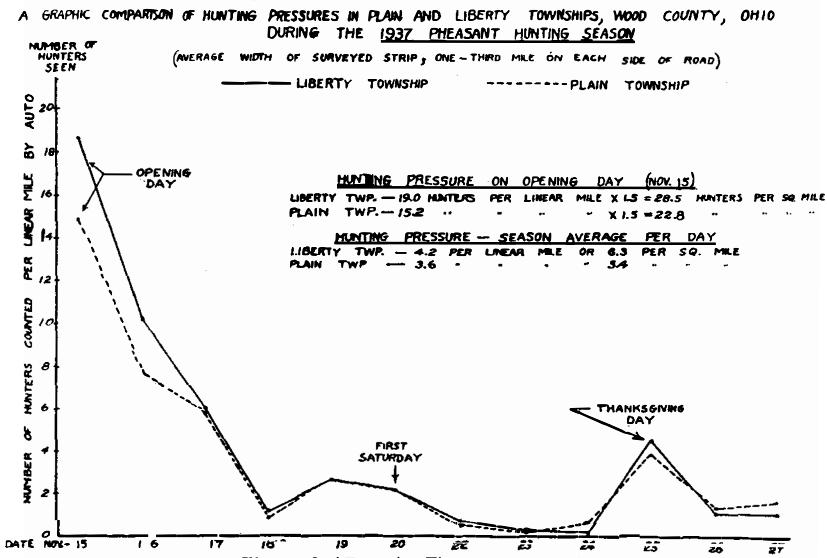


Figure 2 (*Upper*); Figure 3 (*Lower*)

counties, give nearly identical hunting pressure graphs throughout the open season (Figure 4).

Much work should be done on the origin of hunting pressures. Where controlled hunting checking stations are used, maps can be prepared for each day of the open season and for each year, to reveal the source of hunters and to study shifts in hunting pressure dispersal and the effect of publicity in obtaining desired hunting pressure distribution. Where a road blockade enables the investigator to interview all hunters passing a given point, it is possible to map the residence of each hunter, the township in which each hunted, the average success in each area, and the dispersal routes of a given hunting pressure source.

What part of the season's hunting is done each day of the open season? An average of eight Ohio surveys indicates that 22 per cent of the season's game bird hunting is done on the opening day, 46 per cent during the first three days, and only about 6 per cent during the last two days of the 14-day open season. Thus a couple of days either added to or subtracted from the present open season would make a difference of less than 5 per cent in the total amount of hunting done. Note that the hunting patterns of the three classes of hunters are essentially similar, except that farmer hunters tend to favor early season hunting (Figure 5).

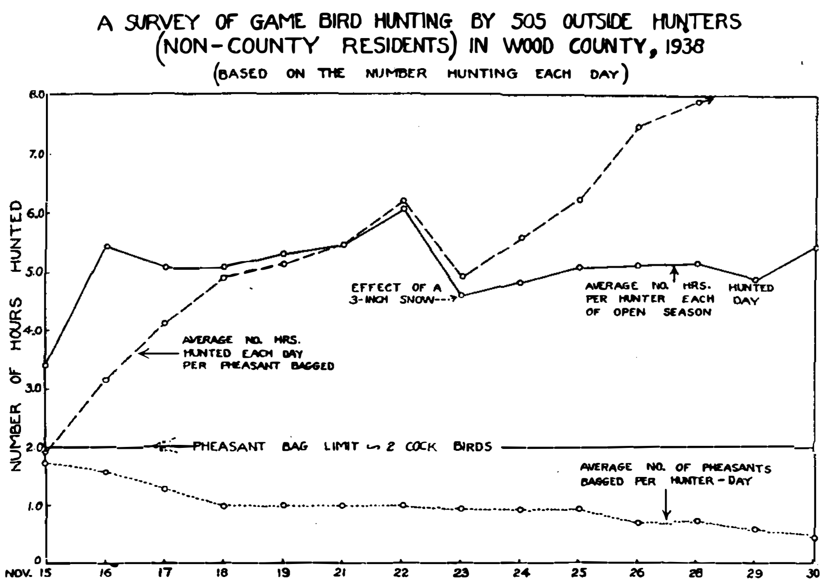


Figure 4

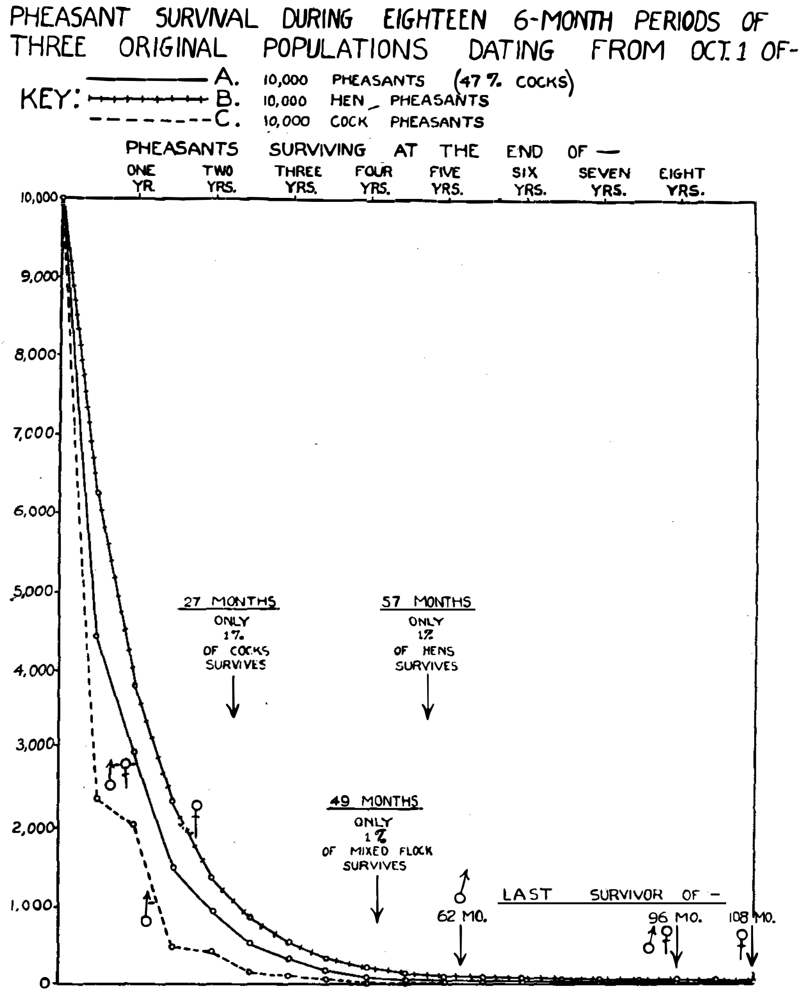


Figure 5

What part of the season's bag is taken each day of the open season? About 55 per cent of the season's pheasant bag is taken during the first three days (one-fifth to one-fourth on the opening day) and only 6 to 8 per cent during the last three days of the open season (Figure 6). Thus shortening or extending the season by three days influences the total kill by only about 5 per cent. Adequate refuges and safety zones, properly distributed, tend to reduce the early season kill (especially the slaughter of the opening day) and correspondingly increase the late season kill. This makes possible greater recreational return from a given number of birds available for harvest. Sedentary or non-flocking species, as the cottontail, can stand a longer open season and also show a more uniform bag throughout the open season.

Additional measurements should be made of what happens during continuous vs. staggered hunting seasons. Note the graph of hunting

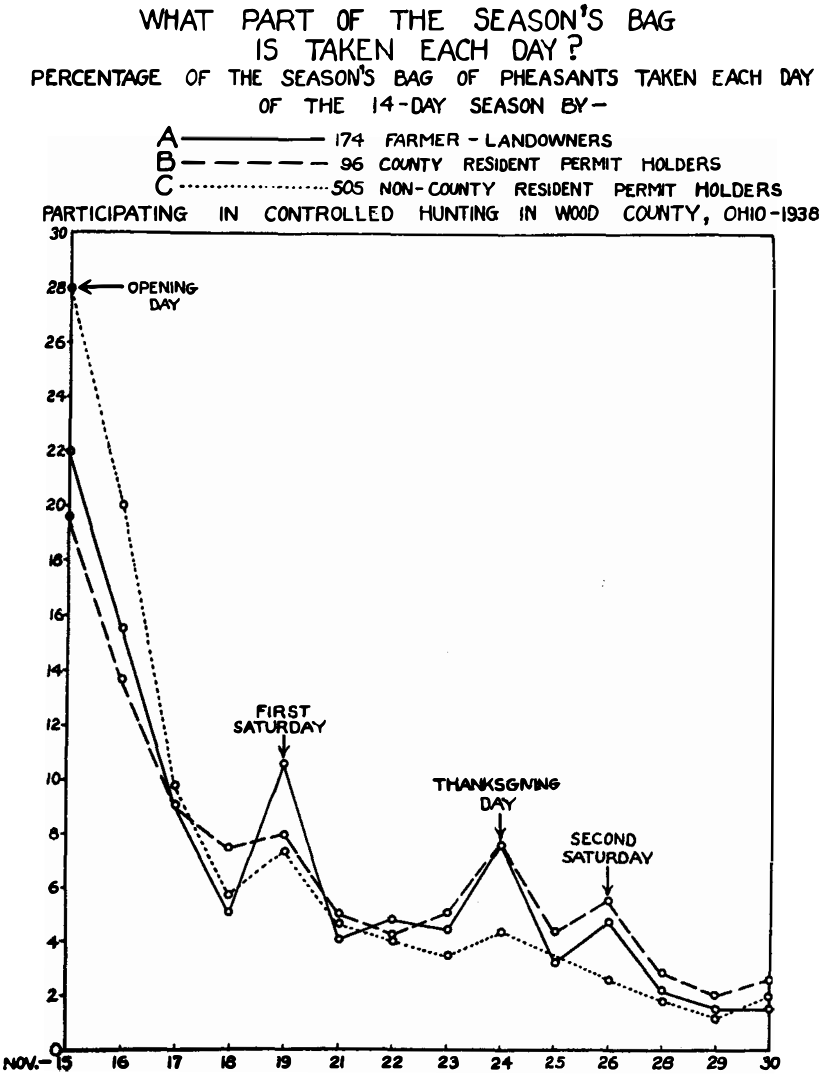


Figure 6

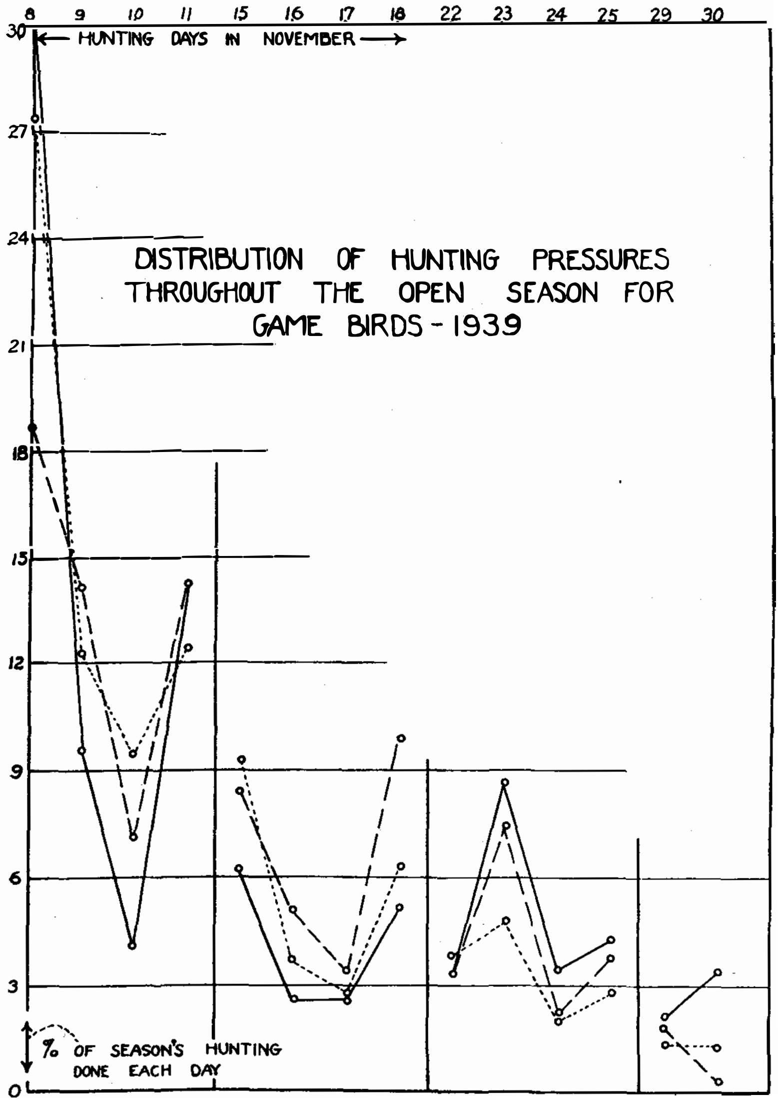


Figure 7

pressures based on three independent studies of Ohio's first staggered hunting season in 1939 (Figure 7). The staggered dates influenced the hunters more than the game. Though the staggered plan was found to have many desirable features, it resulted in a somewhat larger kill and failed to spread hunting pressures more evenly throughout the open season.

REMOVING SURPLUSES FROM NATIONAL WILDLIFE REFUGES

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The ideal wildlife refuge might be likened to a tank of water, open at the top so that when filled to the brim the water spills out over the edge, dampening the surrounding ground. There are, however, several factors that may prevent the normal diffusion of surplus wildlife from the refuge to adjacent territory. Hunting pressure outside the refuge may concentrate the wildlife within the protected area; lack of suitable habitat beyond the boundaries may make the area more desirable; and, in the case of bison, elk, and other species confined to a restricted area, the fence may be the factor that prevents movement in and out of the refuge.

With management satisfactory as to provision of food and protection, a surplus of resident or confined species may soon be produced. They may either remain, bringing complaints of damage done on adjacent private lands, or resulting in losses through disease and increased predation, or use may be made of them in one of several ways prescribed in the regulations for the administration of national wildlife refuges (50 CFR 12). Section 12.4 of these regulations states that "specimens of plant and animal life or other natural objects, including the nests and eggs of birds, may be taken on any refuge for scientific, exhibition, restocking, or propagating purposes under special permit issued by the Secretary and countersigned by the Director, but no permit shall be deemed to authorize the taking, possession, transportation, or sale of any wildlife, or of the nests or eggs of birds, contrary to State law."

On refuge areas the removal of wildlife surpluses has fallen into the following general categories, arranged in order of normal priority: (a) Live-trapping by the game authorities of the state in which the refuge is located, for use in restocking; (b) public harvesting either by means of a supervised trapping program on a cooperative or supervised fee-basis; (c) government harvesting to protect against damage to structures and habitat (and also the taking of predatory species when damage by them is such as to warrant their removal); and (d) disposal by the government of surplus big-game species from fenced preserves when such disposal is essential to the maintenance of a successful management program.

The live-trapping of surplus animals by state game authorities for stocking purposes, has been practiced in connection with several different species. Permits have been issued to state game departments to live-trap ring-necked pheasants from the 58,400-acre Lower Souris National Wildlife Refuge in North Dakota, the 10,700-acre Sacramento National Wildlife Refuge in California, the 6,000-acre Montezuma National Wildlife Refuge in New York, and the 20,000-acre Sand Lake National Wildlife Refuge in South Dakota. On the latter area the pheasant population has been built up from a low of 1,485 birds in the spring of 1937, about one bird per 13.5 acres, to a density at the present time ranging from 2.34 to 4.67 birds per acre.

This amazing increase in pheasant population, amounting to as much as 6,300 per cent in four years, is the result of extensive game-management development and practices directed toward the benefit of upland game as well as migratory waterfowl. The judicious use of shelter plantings, food patches, and nesting habitat has at the same time resulted in a marked increase of the European partridge and a slight increase in prairie chickens and sharp-tailed grouse; hundreds of the prairie chickens remain in the grain fields throughout the winter.

At the request of the South Dakota Game and Fish Commission, a permit was issued in November, 1939, authorizing the live-trapping and removal of not to exceed 10,000 ring-necked pheasants for restocking purposes. During the period from January 12 to March 19, 1940, a total of 1,830 birds was trapped and distributed. The "shining" method was first tried but dense vegetation made this impractical. Funnel traps capable of holding 100 birds were found to be most effective. These traps have been used very successfully this season in connection with a second permit issued for the same number of birds. Snow, about 12 to 15 inches deep, provided an ideal condition for trapping and from January 14 to February 12, 1941, a total of 3,208 birds was taken. A Pittman-Robertson project was approved to facilitate the hiring of trappers, purchase or rental of equipment, and transportation and distribution of the birds to suitable environment.

The live-trapping of deer and their utilization for transplanting by state game authorities has been approved for several refuges. On the 54,000-acre Aransas National Wildlife Refuge on the Gulf Coast of Texas, the deer population was estimated to be about 3,800 animals, with a sex ratio of 1 buck to 1½ does. A permit was issued during August, 1940, to the Texas Game, Fish, and Oyster Commission to capture not to exceed 500 deer. A Pittman-Robertson project in this case also sanctioned the construction and operation of traps, and the transportation and distribution of these animals to demonstration areas where they will be protected for at least five years. The success of this project may be judged by the fact that between October 29, 1940, and January 27, 1941, a total of 486 deer was removed. This number included 242 adult and yearling bucks, 35 male fawns, 153 adult and yearling does, and 56 female fawns. Only three deer were killed in the traps, amounting to only 0.6 per cent of the total catch. As more bucks were caught than were desired, towards the end of the trapping some bucks caught were released. Since completion of this paper, removal of the full 500 has been accomplished.

Studies have shown that surplus deer already exist on a number of other refuges including the 4,600-acre Blackbeard Island National Wildlife Refuge in Georgia, the 60,000-acre Cape Romain National Wildlife Refuge in South Carolina, the 85,000-acre Seney National Wildlife Refuge on the upper peninsula of Michigan, the 31,600-acre Tamarac Lake National Wildlife Refuge in Minnesota, and the 56,600-acre Little Pend Oreille National Wildlife Refuge in eastern Washington.

Wild turkeys, while present on a number of areas, have increased sufficiently on only two or three refuges to allow surplus removal. Fifty birds are being taken from the Aransas National Wildlife Refuge for restocking in Texas.

Permits have been issued to the New Mexico Game and Fish Commission to live-trap from 150 to 250 Gambel's quail each of the past three years, the number depending upon the surplus available on the 73,000-acre Rio Grande National Wildlife Refuge. This is an area administered cooperatively with the Bureau of Reclamation.

There are numerous other instances of state utilization of surpluses from refuge areas. The policy has generally been followed that wherever we have a surplus and these animals have been requested by the state, we will cooperate in making them available. Recently, in connection with Pittman-Robertson restocking projects, a number of requests for animals from refuges in adjoining states have been received. Paragraph 1437 of the policy manual for Federal Aid in Wildlife Restoration projects has been followed in such cases. This states that "when a State plans to obtain wild-reared game birds or mammals from any source within another State, it is incumbent upon the State desiring such wildlife to procure clearance from the State fish and game department in the State from which they are to be obtained." This has, upon occasions, resulted in delay in disposing of animals, to a point where damage was done to refuge habitat. For example, on the Lower Souris National Wildlife Refuge in North Dakota the beavers have increased from 50 to 459 animals in five years. Besides supporting the beavers, the comparatively limited timber must supply food also for deer, three species of rabbits, porcupines, and to some extent, mice. Until a survey of needs within the State has been completed, however, the North Dakota Game and Fish Department is hesitant to approve of disposal of animals outside the State.

Provision has been made for public harvesting of surplus animals from refuges by means of a supervised trapping program. Cooperative permits have been found to be thoroughly equitable in allowing local participation in the harvest of surplus animals. The division of return is established to avoid unfair competition with private trapping. While these agreements vary in accordance with local conditions, they are administered by the refuge manager who grants priority to adjacent residents and former landowners within the project. Our Division of Research has for some time been conducting studies in connection with fur resources, harvesting, improvement in the methods of handling, and marketing to increase the returns to the trappers and the information obtained through these cooperative operations on our refuges has contributed greatly to these studies.

Trapping of surplus animals on a fee-basis has been done on only one refuge within the system. The 145,543 acres of the Upper Mississippi River Wildlife and Fish Refuge, extending for 300 miles along the Mississippi River, are located in four states. Because the government lands are so interspersed with private holdings, control is exercised by means of a tag on each trap that is used within the refuge. Distinct tags are used in each state. No trapper is permitted to operate more than 50 traps. This system also has worked very satisfactorily.

A third type of wildlife surplus removal, by the Government, has been necessary in a number of instances to protect water impoundment structures against the burrowing of badgers, and muskrats, and other rodents. On the 9,300-acre Lacreek National Wildlife Refuge, South Dakota, muskrats were found to have burrowed at least 25 feet into earthen dikes. Trapping of animals in the vicinity of all dikes by the Government has been necessary. About 1,000 muskrats were live-trapped by the State Game and Fish Department for stocking lakes and marshes recently recovered from the drouth.

An extensive aquatic and marginal vegetation planting program has been conducted on many new refuges in an effort to establish plants high in food value before these waters might be taken over by less important species. On these areas control of muskrats frequently is necessary to allow the plants to become established. Later, muskrats may be extremely valuable in opening up dense vegetative stands and in providing through their lodges suitable sites for waterfowl nests.

The removal of predator surpluses from refuges has been done only by Government personnel. This permits operations in definite areas or the taking of offending individuals, while if opened for general public participation the possibility of directed control would be lost. Nesting studies on the Lower Souris National Wildlife Refuge, and others of the prairie refuges, have demonstrated the need for removal of skunks from waterfowl nesting grounds.

Another type of surplus disposal is the experimental muskrat trapping and marketing being conducted this year on the 8,200-acre Blackwater National Wildlife Refuge on the Eastern Shore of Maryland. Our Division of Research is supervising the handling of the pelts and carcasses in conjunction with studies being carried on at the Blackwater Fur-Animal Station.

Four of the 12 big-game preserves and ranges are enclosed by fences. The numbers of animals on these areas are shown in Table 1.

TABLE 1. ANIMALS ON FENCED BIG-GAME PRESERVES MAINTAINED BY THE FISH AND WILDLIFE SERVICE (ESTIMATED AS OF JUNE 30, 1940)

Preserve	Buffalo	Elk	Antelope	Bighorn sheep	Deer		Texas longhorn	Total
					White-tailed	Mule		
National Bison Range, Mont.	437	48	....	7*	36	100	....	628
Fort Niobrara National Wildlife Refuge, Nebr.	148	37	....	..	8	5	24	222
Sullys Hill National Game Preserve, N. Dak.	13	14	....	..	16	....	....	43
Wichita Mountains Wildlife Refuge, Okla.	497	202	32	..	799	....	171	1,701
Totals	1,095	301	32	7	859	105	195	2,594
Young born in calendar year 1939								
National Bison Range, Mont.	95	18	....	8	12	26	....	159
Fort Niobrara National Wildlife Refuge, Nebr.	30	11	....	..	2	....	4	47
Sullys Hill National Game Preserve, N. Dak.	7	8	....	..	2	....	....	17
Wichita Mountains Wildlife Refuge, Okla.	112	30	7	..	50	....	27	226
Totals	244	67	7	8	66	26	31	449

*All but this number were transferred to the Hart Mountain Antelope Refuge, Oreg.

The responsibility for the disposal of surplus animals to safeguard the ranges within these areas, and to insure the maintenance of healthy herds, is placed upon the Director of our Service. The number of surplus big-game animals is annually determined in the respective herds and, upon the Secretary's approval of the terms and conditions of the disposition of such animals, we announce them for sale for propagation, restocking, exhibition, or food. In the sale of such animals, preference is given to applicants to purchase them alive for propagation, restocking, or exhibition. There is authority under the law to donate animals to state, county, and municipal authorities for propagation, or exhibition and each year several animals are turned over for zoos and state game preserves.

Unsalable surplus animals are transferred to an Indian agency or other Federal Service on application for restocking, propagation, or food, the donee being required to pay all expenses incident to the capturing or butchering of the animals and their removal and transportation from the refuge.

The reproduction of bisons on the 61,000-acre Wichita Mountains Wildlife Refuge indicates clearly the need for surplus animal disposal. The population at the close of each fiscal year for the past four years was 344, 345, 420, and 497 animals, respectively. Births during each of the past four calendar years were 87, 53, 74, and 112 calves or a total of 336 additions to the herd. Surplus bison removals for the past four fiscal years, but not including the present one, amounted to only 129 animals. Of these 63 were disposed of alive, 29 being sold for exhibition and breeding purposes. Of the 63 that were butchered, all but 9 were sold. The latter were donated to the Office of Indian Affairs for food for needy Indians.

Similar practices and conditions prevail at the National Bison Range in Montana and the Fort Niobrara National Game Preserve in Nebraska. The small herd at the Sullys Hill Preserve in North Dakota is primarily an exhibition herd of definitely limited numbers.

SUMMARY

Surpluses of resident and confined populations of wildlife are resulting on certain of the national wildlife refuges. The normal diffusion of these animals to surrounding territory frequently is retarded through hunting pressure outside the refuge, through lack of a suitable adjacent habitat, and by fencing.

The removal of surpluses has generally been by one of four methods:

1. Live-trapping by state authorities for restocking purposes.
2. Public harvesting by trapping on a cooperative or fee-basis.
3. Government removal of animals damaging structures or habitat; the reduction of predators; and trapping in connection with experimental projects.
4. Disposition of animals from fenced game preserves by gift, exchange, or sale.

DISCUSSION

CHAIRMAN SHORT: Dr. Taylor, will you take charge of the discussion, please?

DR. WALTER P. TAYLOR (Texas): What comment is there with reference to Mr. DuMont's paper?

MR. W. B. HENDERSHOT (Ohio): I believe you stated that there was a pheasant concentration on Sand Lake Refuge in South Dakota of 2.34 to 4.67 birds per acre, and I would like to know at what time of year the census was taken and what was the method.

MR. DUMONT: The census was taken during the latter part of January. It should be mentioned that on the area that had a density of 4.67 birds per acre, the

State had just finished removing 1,200 birds by trapping. The population before that must have set some sort of a record.

The censusing is done by units, in this case using forty-five NYA boys that are in a camp on the refuge. They go across the units not more than 50 feet apart and flush the birds which are counted by observers at the end of the field.

I worked on the Sand Lake Refuge three and a half years and I know what a job it is to census the pheasants. I think it should be stated that there is an influx of birds from an area of from about 5 to 7 miles around the refuge which coincides surprisingly close with the opening of the shooting season. We had an opportunity to keep very close check on that pick-up in numbers.

DR. P. F. ENGLISH (Pennsylvania): I understood you to say, Mr. DuMont, that there were 30,000 deer in the Aransas Refuge.

MR. DUMONT: Three thousand eight hundred.

DR. ENGLISH: And you are removing a surplus of 500? Is that going to be enough to remove?

MR. DUMONT: I believe it is the opinion of the refuge manager that 500 is not enough.

MR. SETH GORDON (Pennsylvania): May I ask whether any records were kept of the cost of trapping and transferring those 500 animals?

MR. DUMONT: Records were kept but are not yet available.

MR. CLAYTON C. SWEARS (Michigan): I should like to ask Mr. DuMont if he has any figures available as to the distances to which the deer were removed, and whether there has been any tendency for the deer not to stay there?

MR. DUMONT: Is anyone from the Texas project here, who can answer this question?

MR. A. F. HALLORAN (Texas): I am not in position to give the exact figures of the distance these deer were transported, but the slight information I have is as follows: The deer were taken to local ranges in south Texas. One distance that I have in mind is 75 miles, and there have been some reports of tendency on the part of some of the deer to return, but there is no definite information that any of the deer have returned at this time.

MR. GORDON: May I go back to the pheasant question, Mr. DuMont, and ask you this question? If you had not trapped those surplus pheasants that you mentioned, in your opinion would the birds that gathered there largely because of gun pressure in the surrounding territory, again have dispersed in the surrounding country the following spring without doing any damage whatever to the refuge area?

MR. DUMONT: Yes, that is exactly the way they have been behaving. The birds come in depending on the pressure outside, whether through lack of food or stimulus of the hunting season. We did carry on intensive management to attract pheasants. We provided shelter for them by building straw fences. We made extensive shelter plantings, and there is ample water. Nevertheless, each year the birds do move outside to considerable extent. Frankly, we are concerned about pheasant density on the refuge and the state is extremely interested in working with us to reduce it, using the birds for stocking west of the Missouri River in areas which suffered rather severely from drought a few years back but which are now becoming a suitable habitat in which these birds can justifiably be released.

Each year there has been a migration into the area in the fall, and a diffusion from it as spring comes on and nesting territory is in demand.

DR. TAYLOR: The question was asked a few minutes ago by Dr. English, I believe, as to whether 500 was a sufficient number of deer to remove from the Aransas. I am going to ask Mr. Halloran what is his opinion of that, he being connected with the latest census that was taken there. Do you think 500 deer off the Aransas at the present time is enough?

MR. HALLORAN: No, sir, I do not. I believe that to protect that area from the possibility of an outbreak of disease, at least 300 more should be removed; in other words, the herd at no time should exceed 3,000. Breeding conditions on that range are satisfactory, and I believe that a goodly number of deer can be taken off every year.

MR. SETH GORDON, JR. (North Carolina): Judging from experience with deer in North Carolina, it would seem to me that trapping 500 animals would be possible only where there were good food conditions. I would like to know what type of trap and what type of baiting were used.

MR. HALLORAN: The trap is the Pisgah type with certain variations. The food conditions on the refuge are very good, the dominant food during most of the season being oak brush. The bait was cottonseed cake.

MR. H. W. OLDS (Ohio): Two more questions on the pheasant situation. How far do the pheasants disperse from the refuge in order to find nesting sites; and second, is there any local objection to the removal of surplus pheasants from the refuge?

MR. DUMONT: There is no need for the birds to disperse a great distance to find nesting sites; there is an abundance of unused land. According to our observations, the movements of the birds did not exceed 7 miles. During the winter, when conditions are rather severe, the only places that birds could be found outside the refuge were willow clumps that had not been blown full of snow and around feedstacks, or in the farmers' feed lots.

MR. OLDS: Is there a local objection to removal of the birds?

MR. DUMONT: Not now. There was in 1937 when it was estimated that there was a 90 per cent loss of pheasants in northeastern South Dakota through the severe winter weather of that year. Now the pheasants are so numerous in that part of South Dakota that there is no objection at all. The annual take of pheasants in South Dakota is getting back rather close to the previous high of a million and a quarter birds.

WILDLIFE SURPLUSES IN THE NATIONAL PARKS

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With establishment of the Yellowstone National Park in 1872, a precedent was set for reservation of superlative natural areas for the benefit and enjoyment of the people. The park system slowly grew through the years of wildlife depletion and came to be regarded as a highly important chain of refuges. With the first decade of the twentieth century there was a general awakening of public consciousness that destruction of natural resources such as forests and wildlife must not be allowed to continue. Concurrently the feeling grew that the national parks and their various resources should be sacredly reserved from commercial or other interference. Strictly protective legislation, some of which I will describe later, was enacted. Out of this public sentiment and legislation grew a body of management policies and regulations designed to protect the parks and to maintain them as nearly as possible in their natural condition.

The broad purpose of wildlife management in the national parks is to restore and conserve a normal fauna in an entirely unimpaired environment, from which the public may derive inspiration, enjoyment, and educational benefits. Under ordinary circumstances, "normal" conditions can be maintained only by allowing free action of natural forces. Except in unusual crises, any interference for the benefit of a particular species of animal or plant would almost inevitably react to the detriment of something else, and would mar the perfection of the picture of original conditions that we strive to present. The same result would follow any attempt to stabilize animal populations at a rigidly established level. The effects of natural forces are a desired part of the picture.

Unfortunately numerous circumstances, some of which will be described later, interfere with the operation of normal laws. Circumscribed areas, altered environments outside certain parks, disrupted faunas, as well as the presence of man and facilities for his accommodation, have conspired to interrupt the play of natural forces. It is only sensible, therefore, that in certain emergencies, management measures shall be approved to prevent extermination or, on the other hand, overabundance of species.

On non-park lands, a wildlife surplus might be defined as that portion of the game that could be removed by hunting without reducing the breeding stock or the annual increment. In the national parks, hunting is forbidden and wildlife ordinarily lives out its ''normal'' course, whether to be pulled down at an early age by a carnivore or to succumb to the infirmities of old age. It is evident that an entirely different definition must be reached to express ''surplus'' in the national park sense.

Nature is never static. Animal populations have always fluctuated. At rare intervals there may have been tremendous increases that brought about depletion of food, followed by wholesale starvation, local extirpation or perhaps even extermination of the species. Although such an overpopulation may be a natural occurrence, it is one that we wish to avert. Let us then, for the park areas, define wildlife surplus as the excessive number of animals of any given species whose effect on food or other factors of the environment would cause such destruction as to endanger the continued existence of itself, its food, or other interdependent species of animals or plants.

Because of the ability of birds to move from place to place as food becomes scarce or abundant, there is no surplus of any species of the avian fauna in any area of the national park system. In several instances, however, mammals have exceeded the carrying capacity of the range. Since we should concern ourselves as much with prevention as with cure, I would like to discuss first the primary causes of wildlife surpluses in the parks.

We are all accustomed to consider our national parks as vast wildernesses, in which conditions are ideal for animals. Unfortunately that is not always true because the boundaries of a number of our best-known parks were determined solely on the basis of scenery. They are mountain-top or high plateau areas, which although they may have plenty of mid-summer range for herbivores, contain little or no winter habitat. Such are Mount Rainier, Yellowstone, Grand Teton, Rocky Mountain, and other National Parks. The plight of the northern Yellowstone elk herd is one of the best known results of this lack of foresight in drafting the park boundaries.

Surely not even the most valiant supporter of park integrity can object to human occupation and use of lands outside the parks. Yet in several instances, valid grazing and agricultural uses have caused the most violent disturbances to the fauna of the parks. Originally, when snow commenced accumulating in Yellowstone, the elk drifted down the creeks and draws to the valley of the Yellowstone River and thence to lower elevations where lesser snow depths permitted them access to food throughout the winter. Elk were distributed from the present Yellowstone winter range (between Mammoth Hot Springs and the town of Gardiner, Montana) on down the valley to the present site of Livingston or even farther,—a distance of about 70 miles. Within 25 years after the battle of the Little Big Horn, this age-old migration was stopped practically at the northern boundary of the Park, because downstream the willows, sage, and rabbit brush, and aspens that had furnished browse had been uprooted and cleared away. Fences criss-crossed the old range. Ranch buildings and villages lay across the former migration route. Hay was cut and stacked for domestic stock. When thousands of starving elk tried to get at this forage that had formerly been theirs, they were slaughtered by the ranchers. Herds of elk were trapped on Deckard's Flat by hunters and shot down to the last animal. In this way the remaining elk were driven back and concentrated in the small upper fringe of their original winter range within the protected park. Greatly overgrazed, it is almost miraculous that this range still retains capacity to feed as many animals as it does.

Of course the high mountain meadows and open slopes of Yellowstone provide magnificent summer pasturage for considerably more than the 10,000 elk or wapiti of the northern herd. After several generations of over-grazing, however, the winter range within the park boundaries is calculated to be capable of supporting only seven or eight thousand elk in addition to the antelope, mule deer, and bison that also use it. Although a census has not been possible for two years, the elk herd is believed to contain at least twelve thousand animals. Thus there is a surplus of about fifty per cent.

A final abnormality that may be a contributing cause of over-population of elk at Yellowstone should receive mention. During recent years the northern herd has wintered almost entirely within the park.

Milder winters, as well as persecution outside the park, may explain this phenomenon. On the other hand, sufficiently severe weather has occurred during this period to make existence within the park appear difficult enough to drive out some animals. An interesting conjecture is that those elk with a strong migratory urge have been killed outside the park, while the present day survivors are the descendants of animals that have always made a precarious living by remaining at the highest elevations. Can it be possible that the migratory urge is being bred out of this herd?

Another example of loss of ancestral migration route and winter range is on the eastern side of Rocky Mountain National Park. Here, in Moraine Park and nearby areas, elk and mule deer are crowded together, hedged in by roads, fences, and community developments.

Abnormal conditions resulting in wildlife surpluses, however, do not all come from sources outside the parks. On the contrary, many troubles result from former practices within these reservations. Oversolicitude for the ungulates—deer, elk, and bighorns—was the reaction from a period of wholesale slaughter throughout the country. Unfortunately, anxiety to maintain as much game as possible blinded early park administrators to the now obvious realities of range-capacity limitations. Artificial feeding was practiced for a long time before its evils and short-comings were recognized. One result was an artificially sustained surplus, and for that reason some of the ranges are depleted.

Another policy connected with game protection was excessive control of predators. Cougars, lynx, bobcats, wolves, and wolverines were greatly reduced or even exterminated in most of the parks. Although this may have been compensated in some cases by an increase of coyotes, the effect was to remove operation of a natural check or brake when the ungulates were again becoming abundant. Wide-ranging predators as the wolf and cougar were destroyed outside a number of parks, by legal trapping or hunting and this had a detrimental effect on maintenance of a healthy park fauna and biotic balance. A result of the widespread destruction of predators has been an abnormal increase of grazing mammals within the parks and accelerated range destruction.

Many local wildlife surpluses in the parks have been due directly to presence of the public. Sometimes this has resulted from greater tolerance, even attraction, of a species toward man and man-made conditions while its enemies were constrained to remain at a distance. Deer have thus increased on the floor of popular Yosemite Valley, where their ancestral enemy, the cougar, dares not follow. A similar situation exists in Zion Canyon of Zion National Park. Heavy destruction of browse plants is the result.

The avid interest of the public in black bears results in abnormal numbers of these animals frequenting certain roads and the vicinity of developed areas in several parks. Food from the tourists' tables and garbage pails lures the animals away from their natural range. While the effect of such unusual numbers of bears on the environment is not as noticeable as in the case of deer and elk, the relationships with humans and property is certainly undesirable. Official bear feeding is now practiced at only one point in the national park system,—Otter Creek in Yellowstone National Park, but it results in a great concentration of grizzlies at this point. Its effect on the fauna and flora is unknown.

Correction of these wildlife surpluses may be accomplished by various methods. In some instances, winter range should be obtained by purchase of lands and elimination of uses that would conflict with wildlife. Some of these areas would become a part of the parks, while others would be federal or state lands to which national park protective policies would not necessarily apply. Rights-of-way for migrating animals between the parks and their winter ranges would have to be provided where necessary. In long-settled areas, however, the accomplishment of such a program is, of course, extremely difficult.

Public hunting outside the parks can solve at least two and probably three of the problems of surplus wildlife. In the cases of a surplus of elk at Glacier Park and at least partially of those of the Rocky Mountain National Park elk and deer, enough animals annually migrate to exterior lands to make adequate reduction possible by sport hunting. At Acadia National Park, Maine, a growing over-population of deer can be eliminated by action on private lands that surround the irregular park boundary. Wildlife control by this means requires close coordination between national and state officials. It also requires a flexibility of authority (that is only now coming into possession of a few state game officers) to regulate the hunting season, as well as the sex, age, and total of kills.

Very limited relief is found in the Act of 1916 establishing a National Park Service (39 Stat. 535), providing "for the destruction of such animals and of such plant life as may be detrimental to the use of any of said parks, monuments, or reservations." Vicious or potentially dangerous bears may be removed from congested areas under this authority. Undue destruction of vegetation in areas where it is important for human use may also be relieved by reduction or removal of grazing or browsing species. Unfortunately this solves only a few problems in developed areas. Specific authority exists for the disposal of surplus bison, elk, and bear from Yellowstone National Park (42 Stat. 1214 and 45 Stat. 1644), and of surplus bison and elk from Wind Cave National Park (52 Stat. 708).

Broader legislative authority is needed, however. This should cover any form of wildlife which, through an increase of numbers, might become so abundant as to threaten serious destruction of environment. It should provide for any methods of disposal compatible with general park principles. Local state needs for surplus animals should have priority over those of more distant areas. Donation of surplus wildlife, or acceptance of moneys for expenses of capture and shipment should also be authorized.

The several park acts prohibit "all hunting, or the killing, wounding, or capturing at any time of any bird or wild animal"; provide "for the protection of the animals and birds in the park from capture or destruction, and prohibit their being frightened or driven from the park," and provide for punishment of violators and confiscation of their guns or traps. The language of these laws is explicit and positive against any molestation of the wildlife, the only exceptions being those described in preceding paragraphs. Therefore any method of reducing wildlife within the parks that might be described as "hunting" has been carefully avoided.

Surplus bears are live-trapped and donated to public zoos or are taken to under-stocked areas of the park where they are released. Vicious individuals that persist in returning to trouble spots are shot by an official executioner. Surplus deer are live-trapped from Yosemite Valley for release in other parts of the Park, while the Zion National Park overflow has been transferred, by arrangement with state and forest officers, to the Powell National Forest. Bisons from Yellowstone and Wind Cave National Parks are live-trapped and sent to public displays, or slaughtered for Indian Agencies. At least one successful wild herd has been established from surplus Yellowstone stock—that of the Crow Indian Agency, Montana. During the past fifty years, several thousand Yellowstone elks have been shipped alive to zoos or for restocking in practically every state of the Union, as well as to Canada and the Argentine. With the approval of the leading conservation organizations of the country, about 500 were live-trapped and slaughtered during 1935-38 for white and Indian relief purposes.

In conclusion: wildlife surpluses exist in several areas of the National Park System. Some of these can be solved by properly regulated hunting outside the park boundaries or by acquisition of winter ranges. In other cases the surpluses must be adjusted by action within the parks themselves, by means that are not incompatible with fundamental biological principles and national park legislation and policies.

By disposal of the present surpluses and elimination of the causes of future surpluses, we hope to compensate for disturbed conditions and maintain a natural and proper balance between the fauna and the flora of the national parks.

DISCUSSION

MR. THOMAS L. KIMBALL (Arizona): I would like to ask Mr. Cahalane if he believes that the predators should be uncontrolled in the national parks in order to help reduce the surpluses.

MR. CAHALANE: We believe that the same policies that apply to grazing animals should apply to the predatory animals also.

MR. SETH GORDON (Pennsylvania): I don't want to prolong the discussion, but I should like to point out one thing. There are a number of states, I guess practically all of the states, which now have state park or state recreational developments under the jurisdiction of the National Park Service. There are some wildlife management problems arising in connection with those units. I am glad to say that in Pennsylvania we have so far had no particular difficulty because the National Park Service has shown a tendency to be cooperative in removing the surpluses. However, there is one warning I would like to record, and that is we must be careful not to apply the standards that are in effect on national parks to these state recreational projects.

DR. WALTER P. TAYLOR (Texas): Are there any further points that should be brought out at this time?

MR. C. N. FEAST (Colorado): I would like to ask the speaker to explain the policy in Rocky Mountain National Park in Colorado, whether there is to be any control of deer and elk on the high glacier.

MR. CAHALANE: Hunting outside Rocky Mountain National Park can at least partially remove the surplus.

MR. FEAST: Considering the conditions that are reported on the fringe of the park, I am wondering if there is a possibility of controlling herd production in that area in part by federal activities rather than entirely by state action.

MR. CAHALANE: That is one of the places where legal authority is needed for correction inside the park when that outside is not sufficient.

MR. FEAST: I would like to have you explain that.

MR. CAHALANE: We need legal authority for removing deer and elk from Rocky Mountain National Park, but we do not have that authority at present.

MR. GORDON: What legal authority is neeeded?

MR. CAHALANE: It should be based upon a federal act that would permit the removal of animals from that and perhaps other parks.

MR. FEAST: I was wondering whether it was state jurisdiction.

MR. CAHALANE: No.

REMOVING SURPLUSES OF WILDLIFE FROM THE STANDPOINT OF STATE ADMINISTRATION

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The purpose of this paper is to show how the State of New Mexico is using its authority and meeting its obligations in removing a part of the wildlife from heavily stocked and over-populated areas.

I have often stated my firm conviction that, except for migratory birds which have been partially alienated from state authority by international treaties, it is the constitutional right and obligation of the Sovereign States to administer their respective wildlife resources regardless of land ownership. I again make that assertion. It must, however, be borne in mind that the use of such authority must not stop with the setting of seasons and bag limits, issuing of licenses to hunt and fish, enforcing game laws, making refuges, and doing predatory animal control work.

It must also embrace full and detailed management of the wildlife resources. I conceive proper management to include restoration and maintenance of habitat not only on lands belonging to the state game departments but on all other lands as well, through cooperative endeavor insofar as that is possible. Among many other things, management includes restocking of depleted areas, restoration of species that have been exterminated from the state or local areas, and, what is of equal importance, relieving and preventing over-stocking of ranges, particularly with big game species.

First, it seems necessary to state that the New Mexico Game Department is governed by a State Game Commission of three members with over-lapping terms appointed by the Governor. The Commission has full regulatory powers in the management of wildlife and fisheries resources. This includes authority to provide when, where, to what extent, and by what means any game species may be taken; and also authority to capture, transplant, possess, purchase or sell any game species needed for restocking purposes within the State.[1] Without such authority it would have been impossible to have made even the meager progress that we have achieved.

Lest any one gain the erroneous impression that New Mexico, as a whole, is or ever has been over-populated with game, let me emphasize the fact that such is not the case and that the problems of removing surpluses have so far been purely local, having little bearing on the

[1]Chapter 117 of the 1931 Session Laws, and Sections 57-102, 103, 104, 107 and 108 of the 1929 Statutes Annotated.

general situation throughout the State. By surpluses I refer to numbers of game in excess of the carrying capacity of ranges as well as excess numbers of either sex in relation to game herd as a whole. I do not refer to the annual harvest of game of various species through hunting during general state-wide seasons.

In New Mexico we do not operate a game bird farm, although we do occasionally buy some farm-raised birds. Our policy has been to maintain a refuge system for protection against over-shooting and from some of these refuges as well as from posted lands, which often serve the same purpose, we trap wild stock of scaled quail (*Callipepla squamata*), Gambel's quail (*Lophortyx gambelii*), and wild turkey (*Meleagris gallopavo merriami*) for restoration and stocking purposes. The numbers trapped are insignificant compared to the number of game birds raised in many states, but we believe the survival percentage to be very high. This trapping of birds is in reality merely removal of birds from areas of plenty to replenish the stock on depleted areas. It does not necessarily mean that we trap only on areas where there is an overstocking of birds for that rarely occurs with either turkey or quail. Yet, we can meet any such situation when it arises.

As to deer, we, like many other states, have had some serious overpopulation problems. We have, however, endeavored to meet them promptly, often in the face of bitter opposition from sportsmen and others. We have never trapped and transplanted any deer. In 1929, in cooperation with the Forest Service, an endeavor was made to trap mule deer (*Odocoileus hemionus*) from a badly overstocked area in the Gila National Forest. Several thousand dollars were spent on the experiment with a trap similar to that used for trapping wild cattle but only one deer was caught and it broke its neck by running into the fence.

In that instance, a very bad situation had developed in the Black Canyon area of the Gila National Forest by reason of the fact that prior to 1931 the Game Commission did not possess the necessary regulatory powers to open a doe season either state-wide or on a limited area. The Legislature had been reluctant to act, and the situation first recognized as serious in 1923 soon reached its peak and the forage plants and deer quality had seriously declined by 1931. Drastic measures were necessary to relieve the situation and were taken by the Commission when it opened 100 sections of the congested area to general hunting for eleven days with a bag limit of two deer, a doe and a buck or two does. A total of 2,833 deer or about 85 per cent of the herd was killed.[2]

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[2]Ligon, J. Stokley. Department of Game and Fish Report, July 1 to December 31, 1931.

Several years of drought intervened and the forage was slow to recover but now has greatly improved and the area again supports a herd of normal deer of perhaps 25 per cent of the former maximum population.

Since that time we have had several local situations where deer herds had to be reduced by the taking of antlerless deer and we have endeavored to meet them before the situation required the drastic action taken in the Black Canyon case. In these latter instances we have, by regulation of the State Game Commission, opened four different seasons on antlerless deer in limited areas and one for a deer of either sex, and issued permits to the number of hunters estimated to be required to take the number of deer desired to be removed. These seasons have been carefully supervised and for the most part have worked out well. Sometimes the permits have been free and in other instances we have made a small charge and got better results. Some well meaning, sincere sportsmen have a habit of taking permits especially when they were free and then refusing to use them in order "to save a doe," thus defeating the very object of the season.

We have also for several years been issuing a few permits for the removal of surplus numbers of bull elk, although we have no serious overstocking of elk. We annually issue permits for trapping of a thousand or more beavers where damage is being done to property or where they are too numerous for the food supply.

I have hastened over these phases of our management activities in removing surpluses of game, although many interesting details could be given, because I want to tell about our pronghorn antelope work of which we are very proud. Opportunity for work in this field was, and still is, great and we have tried and still are trying hard to make the most of it.

Both the American and the Mexican varieties of antelope (*Antilocapra americana americana* and *A. a. mexicana*) originally were very plentiful in New Mexico, occupying more than one-half the State's area or more than 60,000 square miles. By 1916 their numbers had been reduced to a pitiful 1,740 head estimated by Aldo Leopold in about 35 scattered bands. (Bailey, 1931). By 1926, through cooperative efforts at protection by large ranchers, sportsmen and the Game Department, they had increased to 2,900 head. (Ligon, 1927). From that time on the increase has been phenomenal as we now have about 25,000 head.

During eight permit seasons, 2,172 bucks have been killed and since 1937 more than a thousand head, a large percentage being does, have been trapped and released to start 50 new herds. Our objective is to produce two or three antelope per square mile on the 60,000 square miles of natural range. When that is done, we should be able to harvest through sport shooting 30,000 antelopes each year, which would mean taking a number equal to the annual increase, estimated at 25 per cent. Possibly that is an over-optimistic statement, yet the production of a herd of such size would mean only a 500 per cent increase over present numbers, whereas we have witnessed a 1,400 per cent increase in the last 25 years.

How this increase has been brought about is too long a story to relate here, but suffice it to say that cooperation of landowners and users, the sportsmen, and federal and state land administrative agencies in the Game Department's program of protection and predator control has made the increase possible.

By 1931, through total protection for a long period of years, some concentrations of antelope were noted, with an apparent preponderance of bucks. Investigations were made and, based upon the facts obtained, our first season was opened from October 1-5, 1932, with 300 permits offered at $5.00 each. Only 63 were taken but each hunter bagged a buck. The next season 149 out of 150 permits offered were taken. Since that time we have had six additional seasons with an increased number of permits offered each year. Antelope hunting has become a very popular sport and there has been a great increase in the number of applications so that we have to hold a drawing each year to determine who gets the permits. From 80 to 90 per cent of the hunters usually are successful. The seasons are established by regulation of the State Game Commission, based upon facts obtained each year by field investigations. The dates, and the number of permits to be issued for each separate unit of range, and the manner and means by which the antelope may or may not be taken are provided and the hunts are well supervised. So far these seasons have included bucks with forked horns only, which in most cases eliminates the killing of yearling bucks.

From the very start we found that the hunting served two desirable purposes. First, it removed the actual surplus of old bucks and, second, it definitely broke up some serious concentrations and scattered the herds over a wider range. In some instances, the disturbances caused small units to drift to entirely new locations.

In some areas, however, where our best increases had occurred, serious overstocking developed with as many as 20 antelope per section in spite of open seasons. This was in coyote-proof enclosures where sheep are run loose in the pastures, and antelopes confined by the fences could not spread out to adjacent ranges. It might seem that hunting antelope in these sheep-proof enclosures would be like shooting game in a pen, but let me call your attention to the fact that in one ranch alone they have 150 square miles enclosed by the fence. To reduce the population of does and young animals in these pastures, only two courses were open. One was to declare a season for does and the other to trap and transplant the surplus animals to new ranges. As we had perhaps 40,000 square miles of natural range with no antelopes on it, we decided upon the trapping program.

This was a new field and we had to pioneer in it as no one had ever successfully trapped and transplanted as many as a dozen antelopes. We had been carefully observing antelope habits and reactions, particularly during hunting seasons for several years prior to 1937 when we finally made our first trapping endeavor. Our first efforts and equipment, viewed in the light of later methods, were crude, but we succeeded in moving 34 animals that year.

With our District Deputy Warden, Paul Russell, in charge of the work, we revised and refined our methods until by 1939 we had developed a most efficient technique and the operation was progressing smoothly. In the spring of 1939 the Texas game department sent two of its men to observe our work and get specifications of our equipment and since then have been doing successful transplanting in that State.

To date we have trapped and released alive more than 1,000 antelopes, largely does and young animals, and have started some 50 new herds. Losses have not been heavy at any time, not more than 4 per cent in trapping and moving and about 5 per cent after release.

In the coyote-proof enclosures, and there are many of them embracing from 10 to 150 square miles, intensive management must be done, for with the predator loss eliminated the increase is very rapid. We find it most desirable to have very heavy hunting of mature bucks precede the trapping operation. This enables us to move mainly does and young bucks with a ratio of about two and one-half does to one buck. Thus we get a higher breeding potential from the number of animals moved than would be the case if the old bucks were not first removed by hunting. This procedure is desirable also because the old bucks are aggressive in the pens and often injure does and fawns and sometimes kill them.

There is not time to detail the trapping technique. I may briefly state that the antelope are driven into long V-shaped wings of wire netting with the apex opening into a long cord net pen and from there the antelope are put into a small cord net crowding pen. From this enclosure, which is darkened by canvas curtains, the animals enter a narrow cord net loading chute one or two at a time, where they are caught by hand and put into individual crates for shipment.

I might state that we found in our first trapping operations that wire fences were too severe on the antelope, hence we tried cord nets.

They were 6 feet wide, and as long, of course, as needed. They were made of 108 cord, 3-inch-square mesh. An antelope can hit it just as hard as it can, and the net will bag and throw him back more or less gently on the ground without injury. It operates just about like a safety net under a trapeze performer.

Our seasons have been established on private, state, public domain, and national forest lands. Our trapping has also been done on private, state, and federally owned lands in varying combinations. Releases have been made on private, state, national forest, public domain, national park, and Indian lands. Everybody seems to want antelopes and the future of this species looks rosy despite the fact that 25 years ago many conservationists predicted its early extermination.

From the foregoing it will be seen that we in New Mexico have demonstrated definitely that we are able to control surpluses of big game species, as the mule deer, elk, and antelope through special permit seasons for local areas. We have also demonstrated that depleted areas may be restocked with elk, turkey, quail, and antelope through trapping and transplanting and thus in a single operation remove surpluses from one area and restore the species to another. We also conclude that when intensive management is necessary it is often desirable to apply both special seasons and trapping operations.

In such wildlife activities the fullest cooperation of all land administrative agencies is sought and welcomed just as we seek and enjoy the cooperation of private landowners. However, from our experience in removing surpluses of wildlife of several species, we conclude that New Mexico can at all times fully meet its obligations under existing legal authority to keep game within the carrying capacity of the range on private, state and federal lands. And while we want their co-operation, we have definitely demonstrated that intervention of any federal agency into the field of non-migratory wildlife administration is wholly unnecessary either to restore game or to remove surpluses.

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DISCUSSION

DR. WALTER P. TAYLOR (Texas): Does anyone wish to ask Mr. Barker a question or to make any observation with reference to his contribution?

MR. THOMAS L. KIMBALL (Arizona): I would like to ask Mr. Barker how important he considers the control of coyotes in promoting the return of the pronghorned antelope.

MR. BARKER: I consider the control of coyotes and golden eagles very important if you expect to build up your herds. Antelopes will hold on for years apparently without losing much, without gaining any in the absence of predator control, but we have observed that the coyote and the golden eagle are both very detrimental to antelope restoration.

The Jornado Range Reserve under the jurisdiction of the Forest Service in New Mexico embraces about 200 square miles of land, which for more than twenty-five years had all the protection accruing from federal and state refuge status. It had the advantage over most of our other ranges of being under careful supervision, being very conservatively used, and having water development and grazing control; in fact the antelope was given every advantage possible, except for one thing. During that 25-year period, there was no control of coyotes, or of golden eagles. At the beginning of the 25-year period they had from 40 to 50 antelopes on the area and at the end of the period when they started controlling coyotes they still had about the same number. There had been no appreciable gain.

On another area about 100 miles distant, on the Flying H Ranch, in 1922 we had a total of 30 head of antelopes. This tract was slightly smaller than the Jornado Range Reserve, having a little more than 150 square miles. Sheep were pastured there, so they were controlling coyotes as best they could, and then along in the '20's they enclosed the ranch with a coyote-proof fence. From then on the increase in antelopes was unbelievable. Since 1922 when there were 30 head, we now have a thousand on the area; we have trapped and removed some 600 from the area, and we have killed 672 bucks during open seasons, but the herds are still going strong under absolute predator protection. I would say that probably there have been no depredations by coyotes but possibly an occasional loss from golden eagles.

MR. J. R. BENJAMIN (Ohio): I would like to ask Mr. Barker what method you use in trapping wild turkeys.

MR. BARKER: Sometime in the very early spring they are baited with grain on some part of their winter range where pens have been built. We use logs 6 or 7 inches in diameter, peeled as smooth as possible, and make a pen with plenty of cracks in it, just not wide enough to let a turkey go through. We cover that with poles but leave a door in each end, and in baiting them we scatter feed right through the enclosure. Then after they get used to going through freely, we put up some poles or a netting across one end, and place on the other end a net door, rolled on a piece of pipe that can be sprung with a trigger. Then someone lies in a blind nearby and when the turkeys come down to feed, and enough of them get into the pen, the door is dropped.

RESPONSIBILITIES AND LIMITATIONS IN REMOVING GAME SURPLUSES ON NATIONAL FOREST AREAS

DR. H. L. SHANTZ

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While we have quite an elaborate responsibility, we haven't very much authority, and therefore, can almost express the opinion of a disinterested outsider in the control of surpluses of game on the national forests.

In the first place, we must ask, What is a surplus?

Many people in the United States are still haunted by the idea that game animals as such will ultimately disappear. Therefore, their approach to the problem of surpluses is influenced partly by emotion and partly by reason. Many quite honestly believe that total protection or a sanctuary status is the surest guarantee of perpetuation of the species. To such people there is and can be no surplus.

Many nature lovers and even some of the biologists feel that man should not interfere and that if left to themselves animals will work out their own salvation and that the balance of nature will assure the perpetuation of desirable species and, that if they do not survive this natural process, extermination is a part of nature's plan and that man can do little about it. The loss of many species, genera, and families of animals before man appeared on the earth would indicate that the natural system is no assurance of perpetuation.

Many biologists are by nature not husbandmen and react adversely to any attempt to aid nature or to avoid what they regard as natural losses.

A prominent wildlife administrator said five years ago that he could not conceive of deer ever becoming too abundant. He was not alone in this opinion and he honestly felt that he was right and no argument could prevail against his conviction. Now he is worried by the practical problem of harvesting the excess crop. Prominent zoologists took nearly the same view and stoutly opposed any effort to reduce Kaibab or eastern Oregon deer populations.

Is it any wonder then that great masses of people in our larger cities and commercial centers often are slow in accepting the recommendations of even their duly constituted officials on matters of game control?

To many people, therefore, there never is a surplus, and evidence that there are more deer or elk on the land than it will support is difficult or impossible to present.

How can a surplus be detected? Only half a dozen years ago, the condition of the herd was about the only evidence which could be presented. But deer have always died from one cause or another and the mere presence of emaciated carcasses on the ground was not convincing evidence. They might have died of disease, or some obscure shortage of an essential element in the diet. Even the presence of only sticks, sagebrush, or pinon needles in the stomachs of emaciated dead deer was not proof that they had starved. The absence of fat on the mesentery or the heart had little value as an argument. Most of the animals showed parasites such as nose bots and to these parasites was ascribed the death of the deer. Any cause other than shortage of food seemed to be readily accepted. Even if convinced that lack of food was the cause there was still the animal husbandry escape by feeding on the ranges.

Attempts to maintain populations of grazing animals on the range by supplemental feeding have generally failed for two reasons. If successful they carry over too large a herd that further destroys the range, and if unsuccessful, as they usually are, they are expensive experiments, accomplish no good purpose and delay the solution of the problem. The same amount of money put in any one of a hundred other wildlife projects would have brought results of value while here money is spent often to cause additional death for in many places feeding only hastens death by starvation and disease. Ten thousand elk are being trained to hang about Jackson Hole and beg for food.

In general, one may regard as surplus the annual increase above the safe carrying capacity of the range.

Increase among deer is rapid. Some herds have doubled in a year, but often the increase amounts to a third or half of the herd. There are some losses in the ordinary course of events. This is often not noticeable and if noticeable is difficult to eliminate. Predator loss may be great or small and can be controlled to a great extent. It may be very heavy. In many areas it is accounting for what should be a surplus and there are no animals left to increase the herd or for the use of hunters. Predator loss is probably accountable for the rapid decrease of many of the herds of antelope, bighorn, and Arizona white-tailed deer. The mule deer and Columbian black-tail also have suffered heavy loss by coyotes at fawning time and in times of deep snow and at all times by mountain lions where these great cats are present in appreciable numbers.

Poaching is similar to predator loss except that the meat is used for human consumption. In places it is difficult to suppress but respect for game laws is growing and poaching losses on the national forests as a whole are by no means as great as the predator losses.

Hunting is the recognized legal means of keeping deer and elk in balance with the available forage. In some places it is heavy enough to control the population. This is probably true on the Allegheny National Forest in Pennsylvania where in the last three years the kill has been 11.7, 33.8, and 35.3 per cent of the total herd for the respective years. A wise provision of the Pennsylvania State Game Commission has kept this herd in check and provided a large number of animals for Pennsylvania hunters. On the Pisgah National Game Preserve also the take has amounted to 35.7, 25.6, and 31.6 per cent for the last three years. In both of these cases it is desirable not only to control the herd but reduce it slightly. In Utah also the last three years the hunter take has been 11.8, 13.4, and 17.6 per cent. On the Malheur National Forest of eastern Oregon the herd has increased from 23,000 in 1937 to 36,000 in 1939, or 56 per cent, and the kill has been 9.6, 9.5, and 24.7 per cent.

The hunter take for the Modoc National Forest in northeastern California was 7.6, 5.6, and 5.6 per cent and the herd increased from about 24,000 in 1937 to 41,000 in 1939, or about 70 per cent in three years; for the California National Forests 6.1, 6.0, and 6.1 per cent; for the Colorado National Forests 4.8, 4.8, and 4.8 per cent; and for the Arizona National Forests 3.7, 3.6, and 3.3 per cent. The average for all the national forests was 6.0, 8.0, and 8.4 per cent for deer and 8.3, 11.7, and 8.4 per cent for elk. It should be higher for deer than for elk. This low hunter take indicates a failure to control the herds by hunting.

A basic consideration is the carrying capacity of the range. That problem is being considered in another section of this program. It must be evident to everyone that the capacity of the range to support deer or elk must not be exceeded if the herds are to be preserved. The cattleman and sheepman can drive his herds and flocks to better pastures but elk and deer must live on their range. It should also be borne in mind that the crop of forage fluctuates and is high one year and low another. Often there is a reserve of browse that can be used but use of which damages the range. In some cases there is little reserve. Therefore, a safe herd size is the greatest possible assurance of perpetuation of a favorable range and of a continuously productive herd. Measurements have shown great fluctuation in the amount of annual forage production. Range authorities regard 25 per cent below the average as a necessary margin of safety in utilization.

When the range is deteriorating either in quantity or quality due to use by game animals, there is a surplus. Numbers are not in themselves indicative, for 100 animals on one range may be too many and a surplus of 50 should be taken, while on another range 10,000 may be safely carried and there may be no surplus as far as the range capacity is concerned.

When the range is no longer menaced by depletion, determination of the number of animals to be harvested may rest on a number of factors. Where hunter demand is light in proportion to the harvestable surplus it must be stimulated and the desirability of taking does and bucks indicated. A reasonable cropping may improve the herd and certainly makes administration of the areas easier for both the Forest Service and the State Game Department. A steady income from hunting licenses indicates that the annual hunt is on a sustained yield basis rather than controlled by a feast or a famine policy. If the game areas are close to big cities, it may be necessary to limit hunter take to a predetermined number of animals.

It is not easy to place the responsibility. As national forest areas are dedicated to more than one use, you may say that the Forest Service should be responsible for determining the number of deer and elk to be supported, of determining how heavy the use of forage should be, and that the State Fish and Game Department is responsible for removing the surplus in excess of a safe carrying capacity of the range. You may go farther and say that the Forest Service is responsible to the people of the United States to see that the forests are properly used and protected and that the courts have held that if game animals become too abundant they can be killed to protect the range, that in some ways we are not supposed to be so lenient as the rancher or private landowner since the land is ours only in trust and we must see to it that damage does not occur.

Then you may say that if the regular hunters licensed by the State Game Department do not take off a sufficient crop the State Game Department is responsible for killing off the surplus by special hunts. That is not always the case. In too many cases the people have not given the State Game Department legal authority to use its judgment in the matter. Therefore, all the people are responsible. Even when the authority is given the State Game Department, pressure groups or even an uninformed public may successfully circumvent a proper management approach. Appeals to the Courts for injunctions, to the Governor demanding the removal of the commissioners, or to the commissioners demanding the removal of the warden are common enough practices to show that often the commissioners or wardens themselves are not free to act and that judgment counsels doing the best that can be done under the circumstances. In short, authority is often lacking for a removal of what can safely be designated a surplus from a biological point of view. This authority is withheld partly because a great number of voters have no adequate understanding of the problem and of the necessity of placing the responsibility in the hands of duly constituted authority such as the State Game Department. But we must not be too impatient. Only a few years ago the laws and authority were far behind the present and 20 years ago many states had no game set-ups worthy of the name.

It would take all day to describe the limitations involved in the removal of surplus animals.

Where only a few animals are involved, they can often be trapped and moved to restock new areas. Everybody is in favor of this method except possibly the local sportsmen. As a means of procuring stock for new areas, trapping is thoroughly justified. But where thousands of deer or elk have to be removed, this method is all but useless and is unnecessarily expensive.

Everybody concedes, or should concede, that the State Game Department should have full authority to remove the surpluses as dictated by biological need. Still such great game states as California and Michigan are still denied this type of administration by the voters of the state.

Often, although the Forest Service has the responsibility of determining use of its lands, it is limited by the State Game Departments refusing to accept its recommendations and requiring a long delay before anything can be done to protect the range. This is often due to the pressure on the State Game Departments from the outside and it is at least expedient and often actually necessary for them to delay action until they can get public support. Local sportsmen's groups sometimes insist that their recommendations be taken rather than the judgment of the State Game Department's experts.

A great city population may want to dominate action in a distant part of the state. A far-sighted and efficient State Game Department is often restrained by powerful reactionary or radical groups which delay or hasten action to damage a well-considered program. National organizations anxious to serve as experts are sometimes helpful and sometimes not. Again, the Forest Service or the State Game Department may be caught between the livestock men's and the sportsmen's interests, which are sometimes not identical, and both sides suffer by the prolonged and sometimes acrimonious conflict. Again the Game Department may not be able to supply sufficient hunter demand to control isolated herds which may suffer starvation and decimation on that account. Public opinion is usually most dangerous to any program when not fully informed. The recent emphasis on wildlife conservation has backed protection, sanctuaries, and research. The danger of excess populations has played a very unimportant role in the educational program. In fact protection has been hailed as the solution of the wildlife problem, and for that reason many refuges and sanctuaries have been established and no thought given to the necessity of utilizing the crop.

Management, with the guidance of research, is concerned with utilization, with the manipulation of the resources of land and wildlife so as to produce a surplus for man's use. Perhaps "surplus" is not the word since it almost suggests a luxury basis. Management must produce a crop, a crop needed for man's welfare and the objective of any wildlife program is human welfare. Deer and elk are produced for the hunter and the meat, fur-bearers for the trappers and the fur, and fish for the fisherman and for food. There is probably no more danger of our losing our deer and elk by extirpation or extermination than there is of losing our cattle or sheep. Still, neither type of animal should be allowed to destroy our lands. They will enrich us economically and socially only if properly managed. The removal of the crop, the surplus, in this case by licensed hunters, affords one of the most effective means of improving the herd and protecting its habitat of food and cover. The land must be maintained not by disuse but by productive use for man's welfare today and tomorrow. A few illustrations may make this matter a little clearer.

The Kaibab is a well-known case. Originally a good game country, it was likewise attractive to stockmen. It was set up as a federal game preserve in 1906. In 1913 President Theodore Roosevelt said that he thought it should be opened to limited hunting with strict control under the Act establishing the refuge. In 1920 the Forest Service noted areas over-used by deer and in 1923 when the herd was estimated at 25,000 an effort was made to get the State to agree to a reduction of the herd. In 1924 an investigation by outside experts recommended a reduction of 50 per cent of this herd estimated then at 27,000. The State refused to agree. Zane Grey was prominent in an effort to drive the herd across the Colorado River to the South Kaibab. One hundred and forty men, mostly Indians, failed to drive even a single deer of the thousands in front of the driving line over the first big saddle. The attempted drive established fairly firmly the fact that deer cannot be driven from the range as can cattle and sheep. Trapping and fawn removal were practiced and there was some hunting of buck deer. All of these activities removed only 3,370 deer during the period 1924 to 1927. The State would not allow the hunters to take doe deer and the matter was taken to the Courts in 1927, which decreed on November 19, 1928, that the Forest Service could kill the deer to protect the property. A total of 1,124 deer were shot in December, 1928, and 813 carcasses were distributed to settlers of adjacent towns and to Indian schools. The remainder were so poor that they were not saved. But all this was too late and insufficient to help either the deer herd or the forage. The herd was on a starvation basis. Nearly 19,000 deer were removed between 1929 and 1940. Gradually the forage and the quality of the deer herd have been improving. This year the aspen shoots are abundant in the woods and in many of the open meadows. The herd is again on the increase but must be held back to enable the vegetation to make a complete recovery. In 1928 the deer were so poor that "you could slit open the hide and shake out the bones." In 1940 of the 672 deer taken, 75 bucks hog-dressed over 200 pounds each.

This is a deer management area and the State of Arizona and the Forest Service are cooperating in making it one of the outstanding hunting areas of the United States.

The South Fork of the Flathead National Forest in Montana is an elk range. Here the herd spends the winter on what might be summer range since the high mountains enclose the area and afford the elk no chance to get away from deep snow by going down-hill. It was once a beautiful area with openings and grasslands. The openings were filled with cherry, maple, willow, and chokecherry and with many aspen thickets. It was an ideal elk range, far removed from human habitation. But as has so often happened, the elk increased rapidly and the hunter take fell behind. Recommendations were made to open the area to the killing of cows as well as bulls. Most of the local people who knew the area agreed, but opposition came from some of the larger cities. An editor in a southern paper objected seriously and insisted that the live animals be shipped to his city. It was a 2-day pack trip to the area from the nearest automobile road but the difficulties of a 2-day, horse-back transportation of a bull elk in no way dampened the enthusiasm of the editor. The upshot of the whole matter was that hundreds of fine big elk died of starvation after having partially destroyed the maple, willow, cottonwood, Douglas fir, and other plants on which they fed. One such depletion changes the character of the vegetation and always leaves the range less desirable for the species that overbrowsed it. Probably no place in the United States is more ideal for a herd of about 2,000 elk than the South Fork of the Flathead National Forest. But it can be destroyed by the elk themselves if denied the population control which man alone can supply in that area.

A great story could be written about the Malheur National Forest in eastern Oregon. This was back country. Deer were a source of food. Five deer were allowed to each hunter. Then the hunter take was reduced to one male animal, and deer increased rapidly. No one thought then of the possibilities of over-population. After a time some of the range men thought deer were abundant enough. Others pushing the reserve idea placed two game refuges in an area already well supplied. By 1934 the forests began to show signs of over-use and increased hunter take was recommended. For four years nothing could be accomplished. Trained biologists could not agree that more deer should be killed. The heaviest winter concentration centered about Murderers Creek on private land. Here almost all surface growth was removed, bitter-brush destroyed, and juniper trimmed as high as deer could reach. In places the grass cover was excellent but all deer food was eaten out. Nevertheless, many pointed to the grass as evidence that the deer were not starving. Strange as it may seem, deer will die of starvation in a good stand of bluebunch wheatgrass in Oregon or in blue grama in Utah. In fact the deer are a real factor in changing Utah range from bitterbrush, juniper, and sagebrush to a nearly pure stand of blue grama, thus changing good deer range to good cattle range by over-population of deer. Even the finding of 1,200 dead fawns on an area of 6 square miles was not sufficient evidence. Some thought that the deer should be fed. Some felt sure that they were dying from a shortage of mineral nutrient and demanded years of research before anything should be done. Others said it was disease and nose bots, some that the cattlemen and sheepmen were to blame and that they had over-used the range. It took four years to argue through these various stages. It should be said that the State Game Department tried to follow what they thought was the best advice. Western Oregon, the home of most of the hunters, was not much concerned with the over-use of eastern Oregon range and for a time the State failed to give its Commission authority in the matter. Now, however, the Game Department has power to act and the over-population is being gradually adjusted. While the livestock men are able technically to see the approaching over-use of the range, they are often accused of seeing it in their own interest and therefore what would be a help to proper management often proves a disadvantage when sportsmen and stockmen each feel that they must win their point before attempting to work out a compromise.

Much of the winter range adjacent to the Malheur National Forest is in private ownership and the cattle and sheep men use it as well as the summer range. Cattle permitted on the forest have been reduced from 17,272 in 1937 to 15,466 in 1939, sheep from 53,851 in 1937 to 48,490 in 1939, while deer have increased from 23,000 in 1937 to 36,000 in 1939. The livestock men feel that by furnishing winter feed and by sharing the summer range as a result of livestock reductions, they are doing their part. On the other hand, those only interested in game feel that cattle and sheep are unnecessarily abundant.

The Modoc National Forest in northeastern California is one of the most complicated cases, presenting many limitations and possibly too few responsibilities. In other words, authority is divided and interests varied. It is an old cattle and sheep country. A few deer of exceptional quality did not trouble in any way in the early days. But the deer herd increased from 5,000 in 1921 and 1922 to 41,000 in 1939, that is eight fold. The range was probably over-used from the first. Reductions in cattle and horses have been gradual from about 35,000 in 1924 to about 22,000 in 1939 and sheep have been reduced from about 97,000 in 1930 to 51,000 in 1939. The effects of heavy use by domestic livestock and by the great deer herd were aggravated by a series of years of low precipitation and of decreased forage production. In addition, there was a further complication created by the migration into the area in winter of about 20,000 deer from the Fremont National Forest in Oregon. The California Game Commission has been helpless in that it could not control the herd by licensing hunters to kill does. The cattle and sheep men blame the deer for over-use of the range. The sportsmen say the cattle and sheep have consumed the forage and are responsible. Oregon is not too much concerned over the condition of the California range and California sportsmen cannot kill Oregon deer since they migrate to California after the hunting season. The hunter take has been low and the kill limited to bucks which does not reduce the rate of increase.

To sum up, Oregon, California, the livestockmen, the hunters, the Forest Service, and the ranchmen who have the deer on their lands in winter are all interested and there should be some way of solving the problem. The Forest Service knows that the range is being overused. But the solution of the problem lies largely in the field of economic and social adjustments of the interests of the various groups concerned. But even if all had agreed that the deer herd should be reduced, the California legislature would have had to be convinced for they alone have the authority to authorize hunting and they have maintained that the constitution of the State of California does not permit them to delegate the authority to the State Game Department.

On the Fishlake National Forest in Utah the aims and interests of livestock men and sportsmen have not been reconciled and the National Forests are suffering, and although the State Game Department has the authority, the sportsmen can by pressure on legislation and the Governor prevent remedial action. One year sportsmen purchased 1,000 doe licenses and did not kill a doe. However, they clamored for such licenses the next year. Economic and social surveys should, like forage surveys, aid in pointing to a reasonable solution of some of these problems. They should not be solved by pressure groups or by the decision of those little acquainted with conditions but by a consideration of the future welfare of the resource and of the equities involved.

The most important factors in the production of a good crop, which we may call a surplus are: (1) A place to live—the land with ample food and cover, and (2) a herd of high-quality breeding animals.

In order to insure these requirements the herd must be controlled as to numbers and quality. This control should be by licensed hunters and the crop taken regularly to insure a sustained income to the State, the licensing agency and in such a manner as to afford the best recreational results, the best game animals, and leave a breeding stock of sufficient number and above all of superior quality, within the capacity of the local range.

Control of the environment and control of the harvest are the implements of management.

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