TRANSACTIONS

of the

# TWELFTH NORTH AMERICAN WILDLIFE CONFERENCE

**February 3, 4 and 5, 1947**

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**San Antonio, Texas**

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The Wildlife Management Institute wishes to express its appreciation to The Wildlife Society, the many individuals, organizations and agencies that contributed to the success of the Twelfth North American Wildlife Conference.

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# THE NORTH AMERICAN WILDLIFE CONFERENCES

The annual North American Wildlife Conferences constitute a national clearing house for the discussion of current problems, new techniques, and the latest developments in the field of conservation, restoration, and management of North America's natural resources. The series of meetings held each year, both general and technical sessions, are conducted as an open forum wherein all who desire to participate may express their views on the important subjects scheduled for consideration. In formulating the program for this international conference provision is made for the acceptance of papers on all pertinent topics of public concern. The prepared talks accepted for presentation, along with the recorded discussion from the floor, form the text of the published Transactions.

A brief review of the history of the Conferences will reveal the tremendous progress that has been made in the utilization and management of the nation's resources. This, the Twelfth North American Wildlife Conference, actually is the thirty-third consecutive annual assembly. The First National Conference on Game Breeding and Preserving was held in New York City, March 1-2, 1915, under the auspices of the American Game Protective and Propagation Association (better known as the American Game Protective Association or American Game Association). Unlike the present conferences, the attendance at the early meetings consisted mainly of game breeders and interested conservationists, rather than the high percentage of scientists, research workers, and state or national administrators seen today. The papers presented at the first fourteen annual conferences were not recorded in book form, but were either abstracted or published in their entirety in *American Game*, the official organ of the American Game Association. The proceedings of the Fifteenth Conference, 1928, were the first to be published in a volume under the title, Transactions of the Fifteenth National Conference.

In the next year, 1929, the name of the conference was changed, but the numerical sequence of the Transactions was retained. The meeting held in that year was called the Sixteenth American Game Conference and this name continued until 1935. Interest in the yearly conferences had grown to such an extent that it was felt that 2 days was not enough time to discuss the many problems of continental interest.

The Ninteenth (1930) was the first 3-day conference and the Twenty-first was the last of the series of conferences held under the sponsorship of the American Game Association. On August 25, 1935, the American Game Association decided to discontinue functioning as an active sportsmen's agency, but to retain its charter and continue its legal entity. The work in which the Association had been engaged during the previous 24 years, including the sponsorship of the annual conference, was delegated to the then recently organized American Wildlife Institute.

The First North American Wildlife Conference was called by President Franklin D. Roosevelt, and was held in Washington, D. C., on February 3-7, 1936. The Transactions of this Conference were printed and distributed by the Biological Survey of the U. S. Department of Agriculture. The Second (1937) through the Eleventh (1946) North American Wildlife Conferences were held under the sponsorship of the American Wildlife Institute.

Prior to 1936, all conferences had been held in New York City, but beginning with the 1937 meeting, the policy has been to hold the assembly in various cities and regions over the continent so that representation will not become regionalized and so that the meetings will be representative of geographical interests.

On May 8, 1946, the Wildlife Management Institute took over the public activities of the American Wildlife Institute. The name of the American Wildlife Institute legally was changed to the American Wildlife Foundation which is the first national foundation for conservation of natural resources. The program in operation at that time was expanded materially by the Wildlife Management Institute and in 1947, this new organization sponsored the Twelfth North American Wildlife Conference which was held at the Plaza Hotel in San Antonio, Texas, February 3-5.

The program of this conference, recorded in these Transactions, was correlated under the general theme "Americans, Wildlife and Their Land." There were four general sessions, including a waterfowl forum, and six technical sessions. Fifty-eight formal presentations and a vast amount of informal discussion is recorded herein and this and the previous printed proceedings will be in constant use by thousands of wildlife technicians, research workers, sportsmen, students, and educators throughout the year and for many years to come. The varied subjects covered in the program of the annual conferences make the Transactions an invaluable reference library.

For many years the Wildlife Society has assumed the responsibility of formulating the program of the Technical Sessions, Mr. William J. Howard acting as chairman this year. Much credit for the success of these meetings is due to the untiring efforts of the officers and members of the Wildlife Society, the state and federal agencies and national conservation organizations.

This Conference in the Southwest was one of the top-notch meetings, while there was a registered attednance of 685, and, as is always true, many failed to sign up. It is estimated there were between 800 and 900 delegates. Forty-four states were represented, six Canadian provinces and Mexico. The Ballroom of the Plaza Hotel was filled to capacity by 503 guests enjoying the colorful Mexican floor show of 14 acts of singing, dancing, a cock fight, beautiful senoritas and splendid music. Mr. Seth Gordon, executive director of the Pennsylvania Game Commission, was toastmaster.

During the period of this Conference, 14 state and national organizations held their annual and business meetings, thus affording a splendid opportunity to discuss their problems with state administrators, technicians and federal government officials.

Preceding the Conference, the leaders of the 10 Cooperative Research Units held a 2-day conference with representatives from government agencies and state departments, officials of the American Wildlife Foundation, and the Wildlife Management Institute, and technicians to discuss the work carried on by these Units.

At the closing session, Prof. Aldo Leopold summarized the papers presented at all sessions.

The Wildlife Management Institute wishes to express its appreciation to the Wildlife Society, the many individuals, organizations and agencies, and to the State of Texas as host. Particular credit is due to Mr. Howard D. Dodgen and his associates of the Texas Game, Fish and Oyster Commission, Doctor Walter P. Taylor, Doctor William Davis and the staff of the Texas A. & M. College.

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# PART I

# GENERAL SESSIONS

# GENERAL SESSION

## Monday Morning—February 3

*Chairman:* FREDERIC C. WALCOTT
President, American Wildlife Foundation, Washington, D. C.

*Vice-Chairman:* WALTER P. TAYLOR
Leader, Cooperative Wildlife Research Unit, College Station, Texas

## WILDLIFE AND THE LAND

*The Twelth North American Wildlife Conference was called to order by Dr. Ira N. Gabrielson, president of the Wildlife Management Institute sponsor of the conference, at 9:30 a.m., at the Plaza Hotel, San Antonio, Texas.*

## FORMAL OPENING

DR. IRA N. GABRIELSON: In opening this, the Twelth North American Wildlife Conference, I am going to do something that I never have had the privilege of doing before in this kind of assembly. We have asked to preside this morning a young fellow who has been around these Conferences and in this conservation game for some time. He was in attendance at the First North American Wildlife Conference and opened the meeting 32 years ago when they had the First National Conference on Game Breeding and Preserving. As far as my memory goes, which is almost that far, he has been present at every one of them since.

He has introduced me on numerous occasions, and this is the first time that I have had an opportunity to pay him back. I want to present, as the chairman of the first meeting and the man who will take charge of the proceedings from here on out Honorable Frederic C. Walcott, the Dean of American Conservationists.

CHAIRMAN WALCOTT: Good morning Ladies and Gentlemen. I have made this a part of my life—this conservation. The first meeting was attended by only a few people, and some of them from Canada, and we learned our lessons from the gamekeepers of England and Scotland and Ireland. That is all we knew about it. Now we have gotten to the basis and roots of this work and we are considering soil. We have to feed these animals if they are going to live. We have learned that; we must feed to encourage life.

The economists tell us that originally we had 8 inches of topsoil. Now we have little over 4, so we have to be careful what we do with the remaining topsoil. We are losing it slowly.

The record of accomplishments of these annual meetings has been phenomenal. The original meeting was under the sponsorship of the American Game Protective Association, afterward modified to the American Game Association—A.G.A. Later, through the enthusiasm of "Ding" Darling and several others, we stimulated the annual meetings and started a new program with a more scientific and a more intelligent program under the leadership of the American Wildlife Institute.

We were stumbling up to that time. We were groping in the dark. We knew where we were going but we didn't know how we would come out. We gathered together a group of men, sixty or seventy or perhaps a hundred, in Washington and thrashed the thing out; and at that time "Ding" Darling was resigning from the government, and he put in Dr. Gabrielson. Dr. Gabrielson started right away accumulating wildlife refuges, which was a new note in this program. He made a success of it. I think he has done more than any other one man because he came later and knew more about it.

He came originally from Iowa, then from Oregon where he remained for 17 years as the active agent of the Biological Survey. He has done a wonderful job. He retired from the Fish and Wildlife Service last year. He is president of the Wildlife Management Institute. Then they saddled on to me the American Wildlife Foundation. There are foundations for almost everything except conservation and wildlife, so now I am after money. I would like to get a million dollars or two planted away, invested so that it will bring in 3½ or 4 per cent, and let that accumulate so that if the arms and ammunition people have one or two or three lean years they can rely upon the new Foundation to help keep this thing going.

We have never had a foundation for conservation in the history of America. We have foundations for almost everything except conservation of the soil and wildlife—"wildlife" spelled as one word and not as two. Two such words mean wine, women and song. One word means wild animal life, including fish.

We are just about half way, I think, toward our ultimate goal. We are now saddled with two or three million G.I. boys who have come back, who do not feel like taking up the plow and plowing the fields, do not feel like going into steady work just yet, but feel like going into the out-of-doors, where they have lived for 3 or 4 years, and shooting. We have that problem on our hands. We have to teach them that they must conserve, that they must not overshoot, that they must obey the regulations—the shooting and fishing regulations—and I am sure that we can teach them. I am sure that they are going to be decent sportsmen.

That is all I have to say, and I hope that this Conference will be a big success. This morning's session is very well attended. Governor Beauford H. Jester, who was scheduled to give the address of welcome, sent his regrets since it was impossible for him to be here. He has sent the Executive Secretary of the Texas Game, Fish and Oyster Commission in his place, Mr. Howard D. Dodgen. I am going to ask Mr. Dodgen to give us the Governor's message.

MR. HOWARD D. DODGEN: I believe you realize how impossible it would be for the Governor to be here. After all, he has been in office only about 2 weeks. The legislature is in session and there is at least one important emergency proposition before him now which by itself is urgent enough to keep him at his desk. He happens to be a fellow who is very much interested in the conservation business and for him to have been here and to have welcomed you to Texas I think would have been a nice gesture on the part of Texas; but you will really understand how impossible such things can be at times.

I think we Texans are fully aware of the important advantages that are to be had from your being here. We want you to leave with us as much information about your experiences as you possibly can because we are going to try to use all those things that you have learned in applying them to our problems here at home. We hope that you will take back with you a good feeling toward Texas so that you will be willing to give us your continuing assistance, as you have in the past. We hope you have a good time.

I think that, inasmuch as we have lots of business to attend to and we are a little bit late in getting started, I shall yield the stand to the next speaker and we shall begin with the day's work. Thank you.

# WILDLIFE CONSERVATION IN MEXICO IS AN EDUCATIONAL PROBLEM[1]

LUIS MACIAS A.
*Chief of Game, Department of Forestry and Game, Mexico, D.F.*

Conservation of wildlife in Mexico will become an accomplished fact only when the public at large is fully appraised of the value and importance of wildlife in our country. On this concept must be premised all conservation plans and programs.

## IMPORTANCE OF WILDLIFE

*Economic aspect.*—Wildlife in Mexico is a valuable resource in the national economy. A considerable segment of our rural population depends upon game as an essential part of the daily diet. Likewise, numerous persons are engaged in hunting as a profession, and they live by trading the products of the hunt, products (like hides, furs, etc.) that in turn furnish gainful employment to others in their transportation, handling, processing, and manufacture. The Government profits from taxes and levies—directly, by the sale of commercial hunting permits, indirectly by commercial and industrial duties. Recreational hunting brings large additional sums into the public treasury, through the sale of licenses and through hunters' expenditures for arms, ammunition, transportation, lodging, guides, and pack animals.

In Mexico the enforcement of the game laws is the responsibility of the Forestry Service, and not only are their personnel less numerous than might be desired but the primary duties of the foresters are concerned with forest protection and management which leaves little time for game law enforcement. Control of hunting, therefore, is generally inadequate, which means that receipts from the sale of licenses are far below what they could be. Considerable sums are collected annually as demonstrated by the following table which lists gross receipts of the Department from hunting permit sales during the past 5 years:

| Year | Receipts (in pesos) |
|---|---|
| 1942 | $85,567.00 |
| 1943 | 65,027.00 |
| 1944 | 66,264.00 |
| 1945 | 89,882.00 |
| 1946 | 100,621.00 |

[1]Translated and edited by A. Starker Leopold from a manuscript in Spanish prepared by Senor Macias but not delivered to the Conference.

But it cannot be doubted that license sales would be greatly increased with improved facilities for game law enforcement, and the resulting increase in funds would pay not only for the cost of enforcement but for a generally expanded program of game conservation.

The wildlife resource, therefore, not only should be conserved as a productive source of economic wealth to the country, but it should be increased through management and government regulation so that it will yield the maximum possible income to the people and to the government itself.

*Biological aspect.*—Early naturalists thought that it was of little use to attempt to conserve wild species of animals; since the evolution and subsequent extinction of species is a natural phenomenon, the role of the scientist was thought to be the discovery and classification of each form while it was available for study. They considered the disappearance of a species to be of less importance than its classification, and natural history studies were carried on from the purely scientific point of view with no regard to the possibilities of conserving and perpetuating wild populations. Fortunately in recent times a new and more practical point of view has evolved among students of natural history, and it is generally felt that our conquest of nature brings with it a great moral responsibility to preserve and perpetuate all wild species. Recent studies are intended not only to tell species apart and to gather information about their habits, needs, and relationships, but of more real importance to furnish a foundation of knowledge upon which we can base programs of conservation and management. The present game regulations in Mexico represent the effort of the Government to guard our existing wildlife resources by legal protection, and these laws were drawn in accordance with the best available scientific knowledge of the needs of our game species.

But effective conservation must involve more than scientifically based laws; a public feeling of responsibility toward perpetuation of game populations is essential in order for the laws to be effective. It remains our job to create in the general public an awareness of the great importance of conservation and of the practical conservation measures demonstrated for us by scientific investigators.

*Esthetic importance.*—It is true that the esthetic value of wildlife cannot be estimated directly in terms of money, but indirectly it can be shown to be of economic as well as cultural importance. The tourist trade is a source of important income to the people of Mexico, and the interest of the countryside is greatly enhanced if abundant samples of the native flora and fauna are preserved for the visitor to enjoy. Among the travelers are many who wish to observe our interesting birds and mammals which they have known formerly only from books or as museum specimens. Some come as hunters. Others of more serious intent come to study the wildlife from the standpoint of the scientist. There is no denying the importance of wildlife is one of the attractions that draws travelers to Mexico. Efforts to conserve this fountainhead of national income through artificial propagation of game would largely defeat their own purpose since the esthetic value of wildlife tends to be inversely proportional to the artificiality of its origin. It will be far preferable to control and manage this resource in natural ways, thus retaining the flavor as well as the abundance of the wild populations.

## CONSERVATION NEEDS

Granting the importance of wildlife and the immediate necessity of checking its wastage and disappearance, let us consider the gaps that must be filled before an effective conservation program can be instituted in Mexico.

The present legal restrictions on hunting and general utilization of game are based on our best knowledge of current game populations and of the conservation needs of the various populations. Thus, rare species like the bighorn sheep and antelope are fully protected under the law, whereas with deer generous shooting seasons prevail in states where they are still abundant. If these laws could be fully enforced, great progress would be made in restoring some of the dwindling populations of big game. But as mentioned above, game law enforcement is largely ineffectual because of the shortage of enforcement personnel and more importantly the general lack of public interest in game protection. Even with an adequate field staff, the enforcement of regulations that are not backed by strong public support would be virtually impossible. Foremost then among our conservation needs is a sustained educational program that will create in the Mexican public at large a demand for the conservation of our natural resources.

Secondly we need a trained staff of game biologists who can study conditions in the field and advise not only on desirable adjustments of the hunting regulations but also on how to improve environmental conditions for the game populations. This will involve the establishment of a school or training curriculum for wildlife research and wildlife-management personnel. These specialized technicians, with backgrounds in biology, genetics, ecology, etc., could then gradually work out answers to the multitude of biological questions that confront us today and for which we have no solutions. We will need to know, for example, the following facts about each of our important wildlife species:

1. Optimum habitat conditions and ecological relations which determine "carrying capacity" of the environment
2. Extent of movement and migration of populations
3. Tolerances between game species and relations to predatory species
4. Food habits
5. Mating habits, rates of reproduction and productivity of populations, and so forth

When these data are in hand for a given species we can proceed to general inventories of environmental conditions throughout the Republic and on this basis plan a specific management program which will include limitation of the hunting take to current productivity of the population and improvement of the habitat so that the population may be increased.

Naturally, these plans which may be spoken in a few words will require long and painstaking labor to complete, and the whole program will require the strong backing of the government and of the public at large. And the basic element throughout is that of *education*—of the people generally, of a technical staff, and of the landowners and hunters who have in their power the perpetuation or the ultimate destruction of the game resource.

## SUMMARY

1. Wildlife is a natural organic resource of economic, biological and esthetic importance.
2. Conservation of this resource definitely will be in the interest of the people of Mexico.
3. An effective conservation program must include an adequate set of laws, based on scientific knowledge of the needs of individual game species, and personnel to enforce these laws.
4. Provision must be made for the training of game biologists who will supply the technical direction of the program.
5. Management programs must be developed to improve the habitat of game and to increase production of game populations.
6. All of these steps are contingent first and foremost upon creating in the general public an understanding of the problems of conservation and a strong desire to support a conservation program.

# WILDLIFE CONDITIONS IN CANADA

HARRISON F. LEWIS
*Superintendent of Wildlife Protection, Department of Mines and Resources, Ottawa, Ontario, Canada*

Canada is much the larger part of northern North America and has extensive wildlife resources. What is their condition and what are the causes for it?

At first thought one would be inclined to suppose that in such a large country, much of it thinly peopled, wildlife conditions are necessarily good. Of Canada's total land area of 3,462,000 square miles, less than 8 per cent is occupied for agricultural purposes, less than 3 per cent is privately-owned forested land, and most of the remaining 89 per cent is publicly-owned land, either forested or open. Further examination reveals, however, that in Canada, as elsewhere, the principal factors that affect wildlife are in part adverse, in part favorable.

A great deal of Canada, especially the more northern part, has not been favorable to wildlife since it was uncovered by the recession of its last great ice-cap. This is principally due to two things—insufficient heat and extremely scanty soil resources. Good crops, whether of wildlife or of other produce, require adequate warmth and fertile soil, but northern Canada does not receive enough heat from the sun for such crops and, because of the character of much of its bedrock and the intensive scouring that the great ice-sheets gave it, its areas of good soil are relatively very small.

With the growth and extension of settlement in Canada, especially since the development of the prairies, other adverse factors have powerfully affected wildlife. One great group of such influences, including fires, agriculture, and, in some cases, the cutting of forests, has produced environmental changes unfavorable to wildlife, or to some kinds of it.

Fires have, of course, worked their greatest harm in forested country. When the forest and the forest floor are well dried by drought, and the population is too scanty to fight fire effectually, a spark or a cigarette butt may start a conflagration capable of destroying the forest, the wildlife, and even the vegetable matter in the soil over hundreds or thousands of square miles and leaving a scar that will take centuries to heal. Canada has had many such fires in the past 300 years and in some regions they still occur.

Agriculture, particularly on the prairies, and the cutting of forests for lumber and pulpwood, especially in the southeast and southwest, have so suddenly and strikingly altered the original environment over extensive areas as to make conditions there quite unsuitable for some wildlife species that were once conspicuous. On the broad western plains elk and bison are no longer at home and breeding environment for waterfowl has been much reduced. In the forests the woodland caribou, pileated woodpecker, spruce grouse, and other species retreat before the axe.

The settlement of Canada by white men, equipped with their increasing variety of efficient tools, has also subjected the wildlife to greatly augmented direct destruction by hunting and trapping. In recent years, as rapid transportation to all parts of the country has become commonplace, this pressure that wildlife has experienced from hunting and trapping has reached a new peak. In the case of game birds that migrate south of Canada each year, increased hunting pressure in non-Canadian parts of their range has also played a large part.

One condition that, though a negative one, has had much to do with reduction of wildlife in Canada, as elsewhere, is a lack of general public awareness of the basic value of wildlife and of what has been happening and continues to happen to this resource. This serious flaw in man's adjustment to an important part of his world seems to be as prevalent in rural areas as in the city.

Certain elements in the existing situation that are favorable to wildlife must also be noted. Fires, agriculture and the cutting of forests have already been mentioned with respect to the harm that they do to wildlife; at this point it must be stated that they often produce effects that aid some wildlife species. Both the cutting of forests and fire, if the latter is not too severe and thoroughly destructive, initiate a series of ecological changes that are often very favorable, for a number of years to valuable wild creatures. The young growth, whether suckers or seedlings, that springs up soon reaches a state of development in which it provides much more browse for deer and moose than did the mature forest that was removed. In some places and at some stages the second growth provides excellent habitat for woodcock. The extent of forest edge may also be increased, to the benefit of ruffed grouse and insectivorous birds. It is often possible to control the cutting of forests in such a way as to produce these effects intentionally. Fires in marshes may, if conditions are right, destroy vegetation of little value to wildlife and permit more useful plants to replace it.

Agriculture may be very helpful to pheasants, mallards, and some other game birds if it is carried on in such a way as to make available much waste of rich foods, such as grains and soybeans.

In the last few decades, as the pressure on wildlife has increased, a reaction in its favor has grown in strength and in wisdom. Humanity has been forced to recognize that wildlife has value and that purposeful, intelligent action is necessary to maintain it. In this way there arose in Canada, as in the United States, a definite, government-sponsored movement for wildlife protection, which gradually developed into the conservation movement and has more recently metamorphosed again into the wildlife-management movement. The essential educational branch of this thrust to sustain wildlife has grown, of late, both absolutely and relatively, but has still a long way to go in order to become adequate to meet the need for it.

Without the help of this movement for protection, conservation, management, and education, wildlife in Canada would indeed be today in dire straits. Under such conditions doubtless many of the more valuable wildlife species would be gone beyond recall. The movement referred to has retarded the decrease of wildlife and has prolonged the struggle to preserve it. Whether it will develop rapidly and soundly enough to win a satisfactory and lasting victory is a question that often, I am sure, gives us all great concern.

One of the important tools of the movement to maintain adequate stocks of wildlife is the setting aside of various kinds of reserved areas, such as nature parks, sanctuaries, game preserves, and native hunting preserves. Canada has accomplished a great deal along this line, as I related in more detail to the North American Wildlife Conference of last year, and has more than a million square miles in reserved areas.

Another tool that has been developed to aid wildlife in Canada in recent years is water manipulation by engineering, in regions where the natural water supply is often inadequate. Water manipulation on the Canadian prairies by the Dominion Government, acting under authority of the Prairie Farm Rehabilitation Act, by Provincial Governments, and by Ducks Unlimited (Canada) has aided waterfowl and muskrats.

The development of systems of registered trap lines and the increasing adoption and spread of such systems constitute an important forward step in the management of fur bearers.

What wildlife conditions exist in Canada at present as a result of the interplay of opposing factors?

In the west and northwest there still continues a relatively high population of wolves and coyotes, which has gradually built up in the course of many years. The upward tendency in the coyote population is observable in Ontario also and this species has extended its range to the delta of the Mackenzie River and to southwestern Quebec.

Beaver and muskrat are being increasingly produced on reserved areas where they are subjected to rational management methods. These include, in the case of both of these animals, controlled harvesting conducted with respect to stock present as shown by detailed annual counts. In the case of the muskrat, water manipulation by means of engineering projects is also commonly involved. The future of beaver and muskrat under such management seems assured.

The marten is very scarce or wholly absent over vast tracts of its former range, but is still found in numbers in certain limited areas. It has suffered much from forest fires.

The kit fox is now almost extinct in Canada and the fisher and lynx are apparently on the way to commercial extinction.

The wolverine continues to be fairly numerous over a wide range in the west and north and is in no immediate danger of extermination.

Canada still has large populations of other common fur bearers, such as mink, weasel, raccoon, red fox in its various color phases, white fox, skunk, and red squirrel. The otter, while nowhere abundant, is widely distributed and in no particular jeopardy.

With respect to the status of the principal large game mammals of Canada, the report is as follows:

White-tailed, black-tailed and mule deer, mountain sheep and mountain goat are, in general, faring well in their respective ranges in Canada. Over populations of deer are few and local.

Moose continue to be common locally, but in general are decreasing because present hunting pressure is more than they can stand. In New Brunswick and Nova Scotia moose are protected by a complete close season.

Elk or wapiti exist in large numbers in the National Park areas of Alberta, Saskatchewan, and Manitoba. Careful management of these animals, including annual reduction slaughters by skilled park personnel, has become necessary in order to keep the game and its range in balance. There is an annual outflow of elk in varying numbers from the parks when winter sets in.

Pronghorn antelope occur in huntable numbers in southwestern Saskatchewan and southeastern Alberta.

Thousands of bison roam in the wild state in and near Wood Buffalo Park, a reserved area of 17,000 square miles that is partly in northern Alberta and partly in southern Mackenzie District, Northwest Territories. A managed herd of about 1,000 bison is maintained in a fenced area of more than 50 square miles at Elk Island National

Park, near Edmonton, Alberta. A few bison are kept within fencing in other national parks.

The musk-ox is found chiefly on remote islands in the Arctic archipelago. A few hundred animals of this species persist on the northern mainland west of Hudson Bay. The Thelon Game Sanctuary, with an area of 15,000 square miles, is maintained for their protection.

Large herds of migratory barren ground caribou are still the chief support of aborigines in vast remote northern areas. In some parts of the eastern Arctic, such as Baffin Island, however, the caribou population has become so low that, in order to meet the needs of the Eskimos for caribou skins, local supplies must be supplemented by importation from elsewhere.

Mountain caribou remain in a few small groups in British Columbia and are still fairly common in the Rocky Mountains of western Alberta from Jasper Park north.

Eastern woodland caribou are being reduced throughout their range. The only ones remaining south of the St. Lawrence River are a small population in the interior of the Gaspé Peninsula, Quebec. Western woodland caribou are sparsely distributed from Lake of the Woods north and west to the northern edge of timber.

The black bear is common and in no danger, though in some parts of Canada there is a bounty on its head because it is regarded as a pest by farmers.

Grizzly bears are decreasing and are gone from the prairies. They persist in numbers in the mountains of British Columbia and Alberta. On the northern barren grounds, increased industrial activity may be expected to bring danger to the grizzlies.

There is no recent indication of significant change in the numbers of polar bears.

The various species of insectivorous birds that make Canada their home for all or part of each year undoubtedly fluctuate a good deal in numbers, but these fluctuations are seldon recorded. It is fair to presume that the extensive forest fires that have taken place have had a tendency to lower the numbers of species that depend on forest habitat. No species is known to be in danger of extinction.

In western Canada upland game birds, including sharp-tailed grouse, Hungarian partridge, and common pheasant, have recently shown a marked and widespread decrease that is little understood. The true prairie chicken, or square-tail, occurs in Canada only in the prairie provinces, where it has long been rare and local. On the Canadian side of the international boundary across the prairies a small number of sage hens remains. Ruffed and spruce grouse and ptarmigan are fairly common in their respective ranges.

Let us turn now to the migratory game birds of Canada. The search for the nesting grounds of the rarest species, the whooping crane, has so far been unsuccessful. The sandhill or brown cranes still maintain themselves in fair numbers in western Canada.

The population of woodcock remains at a relatively low level, with only minor and local fluctuations in the past 5 years. Wilson's snipe, which experienced a marked reduction in numbers a few years ago, appeared in 1946 to be on the increase, at least in eastern Canada. All other shorebirds have had a complete close season in Canada for many years, which has helped them to maintain themselves, but they have not succeeded in building up huntable populations.

In the case of the whistling and trumpeter swans, prohibition of hunting for the past 30 years, supplemented by feeding and other special measures on behalf of the trumpeter, has resulted in a slow increase in numbers. The Canadian population of trumpeter swans is estimated at 900.

Wild geese that breed in the far north have had poor reproductive success for the past 2 years. This is probably due to unusually adverse weather conditions in the Arctic in the nesting season. The Canada goose population of the James Bay region has fallen off as a result of heavy shooting outside of Canada. Increase in the numbers of nonresident hunters around James Bay results in increased hunting pressure on blue geese and lesser snow geese. No significant increase in numbers of any species of goose appears to have taken place recently.

And now, what of the ducks? My remarks about the conditions relating to these important birds will be based directly on the latest reports of our experienced Dominion Wildlife Officers.

Reporting for Nova Scotia, New Brunswick, and Prince Edward Island, Robie Tufts says that the principal game duck there is the black duck. In the most favored areas for the hunting of this species the open season of 1946 was characterized by a reduced number of ducks and the poorest shooting yet encountered. The hunting of American golden-eyes, blue-winged teal and green-winged teal in these provinces in 1946 was slightly below the standards of recent years. There was no appreciable change in the numbers of salt-water diving ducks, such as eiders and scoters.

From all parts of Ontario and Quebec, says Oliver Hewitt, reports indicate decreases in the numbers of game ducks. The decline in numbers was especially evident in the case of black ducks, pintails, green-winged teal, scaups and ring-necked ducks. Except in local areas of concentration, poorer hunting was the result.

In the Provinces of Manitoba, Saskatchewan, and Alberta, which are of outstanding importance as producers of a large part of the North American population of game ducks, J. Dewey Soper reports that the year 1946 was very disappointing and deterioration of the duck situation was very pronounced and serious. He states that some 60,000,000 acres in Saskatchewan and Alberta were so terribly dry that little water could be found, except in reservoirs constructed under the Prairie Farm Rehabilitation Act and by certain irrigation organizations. Over huge areas there was *no* water and therefore there were *no* waterfowl. Even in parts of these provinces where good natural water areas occurred, many such areas had no ducks, some had only a few, and none had more than its normal quota. In central Manitoba, far from the drought area, there was a notable decrease in the duck population, especially in the numbers of mallard, pintail, gadwall, blue-winged teal, green-winged teal, and lesser scaup.

In British Columbia, J. A. Munro reports that in general the duck population in 1946 was reduced and in consequence most duck hunters experienced fair to poor hunting. Decrease in the numbers of mallard and blue-winged teal was particularly evident.

All across Canada the number of game ducks is down and going lower and the number of hunters is up and increasing. It must be obvious to all that without an adequate increase in restrictions, duck hunting on this continent will soon encompass its own destruction.

# WATERSHEDS AND NATIONAL FORESTS

LYLE F. WATTS
*Chief, U. S. Forest Service, Washington, D. C.*

Basic in any wildlife-management program is the maintenance and improvement of the habitat. Basic in public welfare and fish and game management is the maintenance and improvement of the watersheds. Of particular importance are the forested watersheds. They occupy a key position in the conservation of water and wildlife.

The United States is a young Nation, yet the rapid and wholesale change of the forest and watershed cover on our lands is outstanding in the world's history of land use. This is cause for great concern. It assumes disturbing proportions when viewed in the light of the history of the Old World.

The plight of the people in the ancient land of Phoenicia is a case in point. As this civilization grew and its population increased beyond the productive capacity of the restricted flatlands, cultivation was extended to the slopes. As the forest receded before the ax and the hoe, the stability of the soil became more and more precarious. Under heavy winter rains the slopes were subjected to ruinous soil erosion. The country became, on the whole, barren; civilization crumbled and the people were forced to move elsewhere. In commenting on the virtual disappearance of the cedar forests of the Near East, Dr. Lowdermilk of the Soil Conservation Service has remarked that "The disappearance of these famous forests is symbolic of the decline and deterioration of the resources of the country."

Comparisons are distasteful. But it should be mentioned that much of the United States is, in climate, not much different from the Mediterranean region. Moreover, our growing population will make ever-increasing demands for the products and services of the land.

Many steps must be taken to keep this Nation strong. One of the most basic of these is action towards good watershed management. I want to discuss some of the things which are known to be injurious, and then tell you something about the program and work of the Forest Service. In doing this, I feel that I am also discussing the fundamental problem in fish and game work, namely, improvement and maintaining the habitat.

## RESULTS OF DISTURBANCE OF FOREST WATERSHEDS

*Forest fires.*—Uncontrolled fire is one of the most widespread and destructive agents affecting natural cover. Large fires suddenly and radically alter wildlife food and cover conditions. The adverse effects of fire extend not only to the vegetation consumed or damaged, but also to the water-holding capacity of the watershed itself.

I could mention many instances in which fire on watershed areas has set the stage for ensuing damages. For example, numerous disastrous floods in southern California have resulted from destruction of watershed cover by fire. One of these is the historic flash flood of New Year's Eve, 1934. An overwhelming mud and debris flow from a recently burned mountain watershed caused damage of about \$5,000,000. It claimed 34 lives. Neighboring watersheds received similar amounts of rainfall, but their intact forest cover yielded clear water which caused no unusual erosion and did no damage.

*Harvesting of timber.*—Logging methods that damage or remove the vegetative cover, expose the soil surface, create gullies, or cut through and drain meadows or other stream bottoms, may menace stream flow or watershed stability. In some areas such practices have disturbed spawning beds and in other ways restricted fish and game production. This applies regardless of whether the volume of timber cut is light or heavy. Much logging damage is avoidable even under present commercial methods. In some cases, however, these logging methods are inherently detrimental and should be modified or new methods devised.

*Excess livestock.*—Overgrazing damages the water-holding capacity of critical areas in a watershed, such as the stream bottoms and headwater basins. Well-known examples of this relationship are found in the damaging floods which have occurred along the west face of the Wasatch Mountains in Utah. To cite one instance: In 1930 a flood from Parrish Canyon, in Davis County, caused much loss of property. Farm buildings were demolished, many acres of garden, orchard, and farm lands were surfaced with mud and rocks, and the state highway and an electric railroad were blocked for several days. An examination of the watershed revealed that the flood originated in a small, seriously-overgrazed opening at the head of the canyon. Here, the unchecked storm waters rapidly concentrated and carried their destructive force to the farm lands beyond the canyon mouth. In recent years on this and other drainages in the area, floods have been prevented by reduction of livestock and other measures to restore the plant cover.

These mud flows, deep gullies, and devastated ranges are dramatic and easy to see. The real damage, however, is the never-ceasing soil erosion which is continually reducing the carrying capacity of our wild lands as range for livestock and as a habitat for our wild animals. It is resulting in a rapid "silting up" of our large and expensive publicly-owned reservoirs. It creates stream systems that carry muddy water harmful to aquatic life.

Unfortunately there is a substantial part of the national-forest range which has suffered and is suffering from too heavy or improper livestock use. Some of this is an aftermath of deliberate overstocking to meet the demands of World War I; some is due to protracted droughts; some to poor management of livestock on the range; and some to the fact that estimates of range grazing capacity have been overly optimistic.

*Wildlife.*—In talking to this group it is unnecessary for me to dwell upon those well-known instances in which excessive wildlife use has jeopardized the watershed values and the habitat upon which the animals depend. Even the beaver sometimes floods and reduces the food supply of the colony and other wildlife, and leaves silted and eroded streams when the sites are abandoned.

The case of the winter range of the Gallatin elk herd in Montana is one of too many elk—or too little range. There has been a definite impairment of the watershed values of that area. The deer on the Salt Lake City municipal watershed and the elk herd on the Pocatello, Idaho, city watershed both reached such numbers that special measures had to be taken to safeguard the water values involved. These instances were repeated to a greater or lesser extent in other areas. Although much progress has been made, there are many watersheds where big game numbers should be materially reduced.

*Forest Service interest in watersheds.*—The Forest Service is charged with the administration, in the public interest, of nearly 180 million acres of federal land. Because water is often the most valuable and essential product, the protection of watershed values is a basic purpose of the national forests. But the Forest Service interest in good land management as a means of conserving and protecting watershed values is not confined solely to the lands for which it has direct responsibility. Rather, it believes that the proved public interest requires that upon all of our lands, regardless of ownership, Americans should effect those minimum land-management measures which are necessary to prevent execssive runoff and erosion, and to maintain beneficial timber and other vegetative cover.

Demands for more domestic, irrigation, and industrial water and heavier—sometimes unwise—use of our uplands cause us to renew emphasis of this point. This interest of the Forest Service in preservation of watersheds is not new. In fact, protection and conservation of watershed land was one of the first objectives in establishing the national forests. A law of March 3, 1891, authorized the President to reserve any part of the public lands, wholly or in part covered with timber or undergrowth, whether of commercial value or not. The Act of June 4, 1897, included as one of the basic purposes for establishment of forest reservations "securing favorable conditions of waterflows." Similarly, the Weeks Act of 1911, under which the national forests in the Eastern, Central, and Southern States have been and are being acquired, has for one of its two basic purposes the regulation of the flow of navigable streams through the protection and reforestation of lands within their watersheds.

The Forest Service has long recognized that wildlife benefits from maintaining and improving watersheds. Food and cover is provided. From stabilized watersheds flow attractive, clear, and fish-filled streams. Conversely, it has been said that erosion has done so much damage to our streams, ponds, and lakes, that it is the greatest single factor in depleting the fish resources of this country.

## WHAT IS THE FOREST SERVICE DOING IN WATERSHED MANAGEMENT?

*Research programs.*—Organized watershed-management research by the Forest Service dates back to 1909 when the Wagon Wheel Gap Experiment in Colorado was begun. A major purpose of this project was to determine the effects of clear cutting on stream-flow quantity and seasonal distribution. The experiment was continued until 1926. It did much to stimulate interest in watershed research.

Subsequent investigation in this field has been greatly expanded and intensified. Today on many carefully-selected experimental areas, research on watershed management is under way. Outstanding in working out basic principles is the 400-acre Coweeta Experimental Forest in the Nantahala Mountains of North Carolina. High and well-distributed rainfall, deep soils, perennial stream flow, steep slopes, and a uniform drainage pattern make this one of the finest outdoor hydrologic laboratories.

Throughout we are giving much attention to the interrelations of climate, soil, cover, and water. We are testing and measuring the effects of different types and intensities of land-use practices—good and bad—on soil stability and stream flow. And we are developing better methods of watershed management.

A special study of direct interest is the newly-organized cooperative game-livestock-range investigation on forest and range lands of Utah. Its purpose is to help resolve the question about the relation between big-game and livestock use.

*State and private forestry.*—As I intimated earlier, one phase of our program, which may be of special interest to this audience, is the financial and other help given the states in the prevention and suppression of forest fires on nonfederally-owned forest and watershed lands. The principle of extending federal financial aid for the protection of state and private forest lands was established by Congress 36 years ago. The program was strengthened and broadened in 1924 by the enactment of the Clarke-McNary law, which is still in effect. In 1925, the protection of certain nontimbered watershed areas that are highly important in supplying water for community or general public use was included. Today we are carrying on cooperative protection work embracing about 320 million acres. I do not need to point out to you folks the many benefits that wildlife receives by having the privately- and state-owned woodlands kept green and productive.

*Fire control.*—Through the years we have shown that forest fires can be controlled and that any wild land can be protected from fire. But hard experience has taught us that the only way to make fire control really successful is either to keep fires from starting or else to extinguish them while still small. Much scientific planning has been devoted to making that possible. Forest roads, trails, fire lookouts, fire crews, and back-country smokechasers all play a part. By such a process the size of the average fire when controlled has been reduced from a thousand acres in 1910 down to 26 acres in 1945.

We began experimenting with aerial patrol in California in 1919. In 1928, airplanes were used to drop small cargoes of emergency supplies and tools, this without benefit of parachutes. In 1935, Army parachutes were first used for dropping supplies. In 1939, the first experiments were made in dropping fire fighters by parachute. From that time we have gradually expanded the use of these "smoke jumpers" in fighting back-country fires. In 1946, 230 of them were so engaged. The helicopter may also have a place. These developments have meant much to the preservation of natural conditions favorable to wild game and to natural stream flow.

In connection with our fire studies and our search for more desirable practices in the management of forests, ranges, and wildlife, we have come to recognize that fire is not always entirely destructive, and that under close control, in certain conditions and areas, it can be turned to useful purposes in managing wild lands. So far only a beginning on this has been made. We still have much to accomplish also in getting control of wild fire. As we establish complete control we will then be in a good position to actually use fires at times and under the conditions where it can promote the purpose of management.

*Timber management.*—National-forest cutting is planned so that only those trees ready to be harvested are removed from the stands. Treatment is varied to suit the conditions of the particular area being logged. Where tree selection is practicable only a few mature trees are marked for removal. Under other circumstances, the best silvicultural practice is to clear-cut all trees on small areas. From the point of view of wildlife food production, this clear-cutting in small blocks is frequently the most desirable.

Conditions in some watersheds are improved by partial removal of dense old-growth timber stands. In other cases, particularly on steep slopes where the soil is easily eroded, any timber cutting may be quite harmful. In such instances no operations are permitted. Special provisions are written into timber-sale agreements, as needed to protect watershed and wildlife values.

Planting by hand seldom is necessary on a national-forest timber-sale area. Nature is relied upon to "replant" them and does so almost entirely. But we have a large planting job on areas so intensely burned that nature cannot reforest them satisfactorily. The national forests now contain about 1¼ million acres of plantations, but nearly three times that much planting remains to be done in order to provide better watershed protection and more timber for the future. In some areas, notably the Lake States, the planting job is on land acquired in a cut-over and burned condition, often in large blocks. Our planting objective is to produce mixed stands and openings in so far as possible. Such practices are helpful to wildlife.

*Range management.*—Your national forests now furnish pasture for 1,225,000 cattle and 3,893,000 sheep, or about 50 per cent of the 1918 level, the all-time high. Sore spots on the range vary from those of simple character which can be cured by minor changes in use or management practices, to severely overgrazed areas of considerable size on which the forage resource is being destroyed and the soil is washing away. These more aggravated situations require substantial adjustments in use, usually including a considerable reduction in the number of livestock grazed.

It has been a long, rough road but the Forest Service has consistently tried to get on top of its range-management problems. Corrective measures have been in progress for many years, but are still considerably short of meeting the needs of the situation. Administrative improvements and reseeding projects include many miles of range fences and corrals, 14,500 range-water developments, and the artificial reseeding of over 75,000 acres of range land.

To a group of "wildlifers" the figures I have given are not without significance. Some of the fence was built to reserve and protect wildlife winter range and to revegetate stream banks. Water developments have been instrumental in extending the range of game animals.

*Wildlife.*—We are striving for a better-adjusted utilization of forest wildlife. We are working with the states to develop methods of increasing the take in areas where there are excesses. There is also well-recognized progress in actually producing wildlife on areas of former scarcity and where there is a heavy hunter and fisherman pessure. The recently-publicized results on the national forests of the South and Southeast are only indicative of progress that is being made in many areas of former underpopulation. These and other programs are founded on cooperative plans that have been carefully developed by cooperation of state fish and game or conservation departments and the Forest Service.

During 1945 some two million anglers fished in national-forest waters. This use, I am certain, will expand considerably in the future. But the quality of fishing in the years to come is, to a marked degree, dependent on the manner in which the watersheds are managed, and the streams kept in a productive condition.

*Recreation.*—The recreational advantages are definitely an important resource of the national forests and are enjoyed by some 18 million Americans each year. Besides the many facilities for mass recreation the Forest Service has provided, it has set aside 14 million acres in 76 areas which are preserved in primitive condition as wilderness, wild, or primitive areas in which no development is permitted. These areas serve the needs of many people who delight in getting off into the back country for hiking, riding trips, and hunting and fishing.

*Importance of maintaining healthy watersheds.*—All sincere students of history recognize that the basis of any successful civilization has always been a productive soil and a stable source of water. Neither is possible without healthy watersheds. Again let me emphasize that this is true from both economic and social points of view.

To a group of professional wildlife managers such as this, it is indeed gratifying that in forcefully promoting and carrying out those measures that are indispensable to maintain our country's leadership in the family of nations, we will also be furthering the wildlife program. Healthy wild-land habitat is everywhere recognized as the key to successful wildlife management. Healthy wild-land habitat and healthy watersheds go hand in hand—they must not—they cannot—be separated.

# AMERICAN WILDLIFE AND THE LAND

HUGH H. BENNETT
*Chief, Soil Conservation Service, Washington, D. C.*

Never in the history of mankind has the preservation of our natural resources been so essential to our well-being. At long last many people have awakened to the fact that our productive land and most of our resources, too, are exhaustible. We have no choice but to accept the principle that we cannot live for today alone. We know that demands for our survival give each of us an important trust to perform. What we as individuals do to carry out that trust will depend partly on our own initiative and partly on how well we are educated.

The trust I am talking about is the wise use and conservation of all our resources, whether it is land, water, wildlife, grass, forest, or minerals. Originally, we were blessed with such wealth of resources, we as a people got into the bad habit of thinking these resources were available in limitless quantity. As the result of this false assumption, we became great wasters—most of us. From now on we have got to use what is left on a sound conservation basis.

Here today we have a common cause in the work that we have to do. Your major interest is in the conservative use of our nation's wildlife; we soil conservationists have as our major interest the protection of the nation's agricultural lands. Conservation of wildlife and conservation of productive land are basically interlocked. Without productive land, there would be no wildlife of any kind; without beneficial wildlife in nature's balance, insects might defeat us.

It is a good time today to take serious thought of what we have done in our work and how we can go forward faster in getting our mutual conservation job accomplished.

When, from 1924 to 1931, I was studying soil conditions and working on the establishment of improved varieties of cane in Cuba, following the disastrous spread of mosaic disease through fields of the old crystalina cane in that country, it was very evident that bird life had greatly depreciated in those areas from which practically all the forest had been removed—formerly luxuriant forest. In passing from cleared country—as cane fields—into remaining stands of timber, the change from bird poverty to abundance was about as noticeable as the change from a treeless condition to heavy forest. I was interested while in South Africa to find vast areas where cultivation of the land had been followed with severe erosion and the drying up of streams; local names were all that was left to remind one that formerly hippopotami, rhinoceros, buffalo, lions, elephants, and other forms of wildlife once were abundant where now no such animals live.

We can see similar unfortunate results in many parts of our own country without going away for examples. Big game, of course, was the first to give way before the onrush of settlement and man's misuse of land. We are truly fortunate that respectable populations of the more valuable species of the birds still thrive in our forests and other sanctuaries which foresighted conservation leaders, working together, have managed to provide. But in too many instances small game birds and animals, fur bearers, and fish that once were plentiful on our farmlands and in our streams until recent years too often have gone the way of the old swimming hole.

I do not have to remind you how many species of wildlife that once were abundant are now extinct or endangered, and many that once ranged widely now are found only in limited areas. Birds may be nearer former numbers, although several species have disappeared. The heath hen, once abundant along the Atlantic seaboard from southern New England to Virginia, is virtually extinct. The bobwhite has increased, I am told, until there are probably more bobwhites today than before the advent of the white man. And there have been introduced game birds like the ring-necked pheasant, which has multiplied so rapidly in areas like South Dakota. Deer have greatly increased in parts of their former ranges. After the forests were cut, new growth in some localities has provided a habitat of much greater deer-carrying capacity than did the virgin woodlands.

But when we balance the losses with the gains, the number of game birds and animals is generally smaller than in the past, I am told. A great part of this reduction, directly or indirectly, probably has come about as the result of erosion. Today widespread application of soil- and water-conserving practices and proper land use is basic for an increase in their numbers.

Wildlife habitat is reduced and the yield is lowered by just that much every time we let a gully eat its way into our fields or allow the soil to wash out of our fields to pollute streams and silt up lakes, reservoirs, and harbors.

In 1880, the Chesapeake Bay is reported to have produced 13 million bushels of oysters, but the annual harvest today has shrunk to only about 3 million bushels. For the nation as a whole, oyster production has dropped 50 per cent in 50 years. In some parts of the Chesapeake Bay increased runoff from erosion-stripped uplands apparently has reduced the salinity of the water sufficiently to kill the oysters; it may be that increased quantities of silt from the same eroding lands may have done much damage also.

We are fortunate that other wildlife agencies recognize the injurious effects of silt on fish and other aquatic life. Silt destroys their food and spoils their spawning grounds, except for some fish which thrive in muddy waters. Among other things, it is found that silt screens out light in the waters of streams and lakes so that the environment is made unfavorable for the better fish. Erosion over the watersheds of streams now constitutes perhaps the most acute problem having to do with fish in our inland rivers.

Similarly, we consider the control of erosion to future fish and wildlife numbers so essential that flood-control plans now being studied or developed by the Soil Conservation Service in some three fourths of the states under the nation's Flood-Control Program are reviewed by the Fish and Wildlife Service whenever fish and wildlife welfare may be involved.

We are continuing to let some 500,000 acres of our cropland go down to ruin each year as a result of erosion, although today we have only about 450 to 460 million acres of good cropland left. This includes, in addition to that now in crops, about 100 million acres that need drainage, irrigation, clearing, or other improvements. And all but about 100 million acres of this area of good land is subject to erosion if it is not protected.

What specifically has happened to the rest, you may ask? Our conservation surveys show that we have ruined for further practical cultivation about one fifth of our original area of tillable land. About a third of the present remaining tillable land has already been badly damaged by erosion. More than half of the remainder is subject to erosion. We must remember that eroding acres are as much an enemy to wildlife as are those inconsiderate hunters who break the rules of good sportsmanship. Eroded cropland, grassland, or woodland does not provide the food and shelter for birds or game that protected, productive land does. Nor does it constitute the well-covered watershed land we must have if our streams and lakes are to be kept supplied with clear water.

The prospect would be dark, indeed, if we still did not know how to take care of our productive land and stop the sheet and gully erosion, silting, and other damage that hurt man and his wildlife friends alike. Fortunately, we have learned in time how to treat the land, the only way it can be treated effectively, and we know and use the most economical and efficient way of treating it. That way is to give each acre the kind of erosion-control treatment it needs and then use the land only for the crops it is able to go on producing safely. That may be for cultivated crops, grass, timber, or wildlife, according to the land's needs and capabilities.

Virtually every soil- and water-saving practice being used by the technicians of the Soil Conservation Service working in soil conservation districts, on flood control projects, or elsewhere benefits wildlife in some way. The records show gratifying recognition of this fact in the activities of the Izaak Walton League, the Fish and Wildlife Service, the Audubon Society, and other local, state, and federal wildlife interests who are working shoulder to shoulder with the farmers. An outstanding example of this recognition can be seen in Cambria County, Pennsylvania. The Conemaugh Valley Sportsmen's Association bought a farm near Johnstown. The purpose was to attract wildlife, and to do that the sportsmen saw to it that food and cover were provided. For one thing, they are using on this farm contouring, strip cropping, and contour hedgerows, principally of barberry and hybrid filbert, in the strip-cropped fields, to provide food, cover, and safe travel lanes for wildlife.

Another outstanding example of wildlife benefits derived from soil conservation farming is that coming from much of the gully-control work. As an example, on a farm in the Piedmont section of the Southeast plantings of shrub lespedeza and other woody plants practically stopped erosion the first season. During the following winter, a covey of nine bobwhite quail established headquarters in one end of the protected area. Despite heavy snows, they went through the winter without loss. A second covey of 15 birds utilized the other end of the gully. In a neighboring gully a covey of six birds did the same thing. Also, cottontail rabbits quickly established themselves in the stabilized gullies. On this farm the final score showed an addition of three coveys of quail to the three coveys originally present before the adoption of a conservation program. The number of individual birds, as well as the number of coveys, was practically doubled. The number of quail rose from 30 to 58.

More than 50 major soil- and water-conservation practices are used by farmers and ranchers today in various combinations over the country. These practices are applied by the farmers according to completely-coordinated conservation plans for whole farms worked out cooperatively by the farmers and the soil conservation technicians out in the field (not indoors) together, with all procedures based on detailed land capability surveys of each farm. At least eight of these practices directly concern the use and management of wild plants and animals. They include: Marsh management, beaver management, growing hedges, management of odd or corner areas and spoil banks, pond management, planting wildlife borders, and stream-bank management. An additional dozen practices specifically influence wildlife, although they might not be established for that primary purpose; and the rest of these practices may benefit wildlife to some degree.

So, you can pretty nearly say, I think, that always our work of treating entire farms according to needs and adaptability benefits wildlife; so that it isn't necessary to think just in terms of several practices. Nevertheless, I will give a few specific examples:

In Ohio, C. A. Dambach and E. E. Good, who have studied the effect of strip cropping on bird populations, found 140 per cent more breeding birds in fields strip-cropped with corn, small grain, and hay than on equivalent acreages of similar land planted solidly to a single crop. J. K. Terres and E. C. Murdoch found that breeding birds in strip-cropped fields in New York outnumbered those in a single-cropped field by two to one.

Another conservation device which increases fish, game, and fur-bearing animals is the farm pond, primarily built for storing water for stock, fire control, orchard spraying, and other farm uses. When properly stocked and fertilized, such a pond annually will yield up to 250 pounds of edible fish per surface acre—a welcome addition to the family food supply, to say nothing of the fishing sport provided. To the value of ponds, we must add other forms of recreation such as fishing, swimming, boating, and picnicking.

Putting out field border plantings and hedges of woody and other plants develops an ideal arrangement for providing wildlife with food and shelter. And fish in farm streams are much affected by all conservation measures that keep muddying soil out of the water.

But I have by no means listed all the wildlife benefits derived from soil and water conservation. Fur-bearing animals, for example, help control insects and mice that damage or destroy crops and plantings for erosion control. Moreover, any considerable improvement with respect to numbers of song and game birds is beneficial. Most of these birds feed partly on insects harmful to agriculture and partly on weed seed. Properly-stocked range and pasture lands, on which there is a good grass cover, have fewer troublesome rodents than over-grazed range.

I think you probably are acquainted with the principle of proper land protection I mentioned a moment ago—that is, the completely-coordinated method of farm conservation on whole farms, acre by acre, according to the needs and capabilities of the land. Some people have used the substitute word "balanced farming" for what I have just said. Well, the only possible way to have balanced farming is to use and treat land as I have indicated. That is just another of those physical facts set up by Nature, like gravity. There cannot be any other way to keep land productive, and if you don't keep it productive you can't have any kind of farming, balanced or otherwise.

May I point out here that the Soil Conservation Service was the first agency, public or private, that I know anything about, to recognize a distinct type of agricultural land best suited for the production of wild animals. Of the 1,060,000,000 acres of land in farms in the United States, all but about 33 million acres are primarily suited to cultivate crops, grazing, or tree production. This 33 million acres is best suited to wildlife, and 13 million acres of this needs conservation treatment to bring it around to permanently-productive use.

I think the trend toward better protection for wildlife is indicated by the attention now being given to the use of odd areas for the production of cover and feed for wildlife and also for production of berries, nuts, and honey, which are good for human use, too. In some places, these odd corners are being designated by state conservation commissions for controlled-hunting areas.

The 13 million acres of Class VIII land needing conservation present some problems in the solution of which farmers and ranchers need help of our wildlife technicians. Some of the problems, such as streambank and spoilbank protection, are of a community nature beyond the scope of the individual land operator.

In all our conservation work it is the productive capacity of land, not its surface acreage, that counts most. That is why we have divided the land into eight practical classes, depending on the soil, slope, amount of erosion damage, and other factors.

Classes I, II, and III are the best lands, capable of being cultivated continuously—though the latter two classes need conservation treatments if they are to be kept in cultivation safely. Class IV land, more sloping with thinner soil, etc., is the critical land, which should be kept in protective cover like grass or hay crops, but which may be cultivated occasionally if needed. Then there are Classes V, VI, and VII that may be used safely only for growing grass or trees, and Class VIII that has value only for wildlife and recreational purposes. This includes certain marshland, coastal dune, rocky, and other areas.

You can see from what I have just said how this classification of our agricultural lands according to capability gives us a ready guide, also, to their wildlife possibilities. When they are used in accordance with these capabilities, with grass and tree crops figuring prominently in the pattern, the opportunities are almost unlimited for developing beneficial wildlife habitat. So great is the opportunity, it seems to me that I sometimes pretty nearly let the idea run away with me that here is perhaps the greatest chance we have for the betterment of wildlife. And it isn't too late at all to do great things in this direction.

In a recent issue of the *Pennsylvania Game News,* Dr. Ira N. Gabrielson, president of the Wildlife Management Institute, mentioned a discussion he and I had concerning the nation's soil conservation districts as a medium through which wildlife men and soil conservationists can get together and help each other accomplish this conservation job faster. You may have read it, but I should like to bring you up to date on what these soil conservation districts are doing to extend conservation of our country's land and water resources at a faster rate than I ever would have dreamed of as recently as 10 years ago when the first such district was voted into being by the farmers of my home county, Anson County, North Carolina. Today, all 48 states and Puerto Rico have laws or similar legislation which enables farmers and ranchers to organize together to obtain the technical assistance of the Soil Conservation Service. Already, 1,750 of these farmer-managed soil conservation districts have been voted, embracing nearly a billion acres and nearly three out of every four farms in the United States. Dr. Gabrielson, you may recall, referred to these districts as additional machinery which can help materially in restoring and in maintaining higher populations of resident small game.

These districts form the backbone of the nation's soil- and water-conservation program. The landowners' and operators' only inducement for organizing these democratically-conceived and operated soil conservation districts lies in the demonstrated benefits of the soil- and water-conserving practices they can put into effect more efficiently through the districts. Among them are: Conservation of their irreplaceable soil; an increase in per-acre crop production; savings in machinery, labor, power, fertilizer, and other items; increased diversification; and more flexibility in farming operations to meet changing markets and other demands.

The item of increased production, and thus of increased income, is not insignificant by any means. More than 9,000 representative farmers and ranchers throughout the country who have kept records of their operations have reported that the average annual production of all major crops was increased nearly 36 per cent per acre as a result of conservation farming. When this kind of work has been applied to all our lands needing treatment, the net result will be pretty close to the equivalent of discovering a new continent the size of Australia—with respect to increased production. Through December 1946, Soil Conservation Service technicians had helped farmers in soil conservation districts and other programs in which it has participated plan for treatment of 171 million acres. As of that same date, these same farmers had completed the acre-by-acre treatment of 95½ million acres.

Through June 30, 1946, farmers and ranchers in soil conservation districts and other conservation programs had completed nearly 5 million acres of strip cropping, 15 million acres of cropland mulched with crop residues or seeded to cover crops, and 13 million acres of contour cultivation. Nearly 52 million acres of range land had been properly stocked for improved growth of grass, more than 3 million acres of farm woodland had been improved, 48,000 ponds had been constructed, and 85,000 acres of field and woods border strips completed. These are only a few of the wildlife benefiting accomplishments being done in districts through which the Soil Conservation Service now provides virtually all of its technical or any other assistance at the request of the some 8,500 farmer supervisors who direct district affairs. Incidentally, I suggest that these district directors are key conservation leaders, who are well worth your getting acquainted with.

It is in this manner that the nation's farmers and soil conservationists are writing what amounts to an "insurance policy" on the land. It is a policy that, when it is paid off in the basic soil- and water-conservation work we hope to see completed in another 20 years or so, will return continuing dividends in better farming, better living, greatly-improved wildlife conditions, and many other ways.

I said in speaking to one group the other day—and I think it is worth repeating here—that during the next 20 years I look for the United States to make the greatest soil conservation effort that has ever been undertaken in history. The very interest shown by important bodies of our society like yourselves, plus the rapid strides we have been making on the land all down the line, bears me out, I think, in this forecast. We simply must do this, if we are to survive as a permanent and prosperous nation.

Furthermore, the cost of not going ahead with such scientific, acre-by-acre soil conservation during the next 20 years probably would amount to not less than 20 billion dollars, or an average of around a billion dollars a year, at least. That is the minimum price, mind you, we would pay for not doing the job, as well as we can estimate it, though actually the chances are the bill would run even higher. It would be levied against us in terms of higher feed costs, reduced yields, lost plant food, reduced productive capacity, and various other costs—not forgetting waste and depletion of our highly important wildlife resources.

Contrast to this cost of NOT doing the job the relatively inexpensive cost of DOING IT: In all probability, the total cost to the government and the farmer of doing the job would be less than one third the cost of not doing it. Meanwhile, the Federal Government's share of the cost of protecting our farm land during the next 20 years would amount to only about one twelfth of the nation's total bill if the conservation job were not done.

After the 20-year period, you understand—after the basic conservation measures are applied to the land—the bulk of the task will be finished, and the always necessary maintenance and improvement work will be much cheaper and easier.

Let me emphasize as strongly as I possibly can as my concluding thought, however, that there is long and hard work ahead of us in accomplishing this objective, because actually we only have made a good beginning so far. A careful study made by the Soil Conservation Service has shown us how much there is ahead to do—still nearly 90 pre cent of America's farm land remaining to be conservation treated as of 1945. We know the needs, practice by practice and state by state, as well as the amount of technical and other man power, machinery, and materials that will be required.

Agriculture is probably the only business in the world which never has set up a plant-maintenance charge to be included in the selling price of its products. To be sure, when you buy a loaf of bread, let us say, you doubtless are paying such a plant-maintenance charge in the cost—but it is the charge fixed in by the miller or the bakery, though certainly not by the farmer who produced the wheat that went into that loaf of bread. As a result, where do we find ourselves today from the standpoint of this simple item in ordinary good business management?

I think the answer is: We find ourselves with a staggering total of "deferred maintenance" work that must be done on our land.

Though it sometimes seems we never can push ahead as rapidly as we should like to in our impatience to bring every possible acre under this badly needed conservation protection, we nevertheless are chalking up new records of accomplishment each year. The job of planning was completed on 20 million acres by the Soil Conservation Service in 1945, and application work was completed on 13 million acres that year. Last year (1946), approximately 30 million acres were planned and work application was completed on approximately 19 million acres, on the basis of reports so far tabulated. Most significant, though, is the fact that by the end of 1946, under all programs in which the Soil Conservation Service had participated, 171 million acres had been planned all together, and 95½ million acres had received complete conservation treatment.

This is the world's all-time record for soil conservation put on the land. And the low cost, too, is an all-time record. Nothing has ever approached it—$1.50 per acre cost to the Federal Government.

Among the minimum treatments needed, these eight basic wildlife practices may be of particular interest to you: The management of 698 thousand acres of marsh; 670 thousand acres of hedges to be planted; more than 5 million acres of odd-corner areas to develop; 195 thousand acres of spoil banks to treat; the construction of 770 thousand acres of ponds; 831 thousand acres of stream-bank management; and 3 million acres of wildlife border planting. Here again I am not listing the vast amount of other basic soil- and water-conserving practices which almost all are beneficial to wildlife.

The urgency of soil, water, and wildlife conservation does not permit that we take separate paths to reach our goal. We must go forward together, everybody. By pulling together, all of us, we will reach our goal that much faster.

## WILDLIFE CONSERVATION IN THE POSTWAR WORLD

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It is indeed a pleasure to attend this Conference and take part in the discussion of conservation problems of a Nation again at peace. For 5 long years the winning of the war was the most important job ahead. Now that we are approaching a normal life again, we can survey the wreckage and see what can be done to repair the damage.

The war cost us much in the way of natural resources. The train loads of iron, copper, magnesium, and coal that went into the manufacture of ships and guns and tanks and airplanes—many left on foreign soils or lying at the bottom of the seven seas; the millions of barrels of precious oil that had to be burned to keep the vast military machine moving—these resources are gone—and are irreplaceable. Other resources of equal importance can be restored, but it will require intelligent management and the wherewithal to do the job.

Take, for instance, the foreign resource. The war made heavy demands on the country's forests, accelerating the depletion of timber resources that had been going on for many decades. Lumber, paper, and many other forest products are in short supply today. And the Forest Service says that the shortage will not be a temporary one.

It will last until the growth rate in our forests can be greatly increased.

Development and improvement work in the national forests was largely suspended during the war. Little could be done to maintain recreation facilities, improve wildlife habitat, advance flood control work, or reforest denuded lands. Although the mistakes of World War I were avoided, when national forest ranges were greatly overstocked with cattle and sheep, many ranges are still in run-down condition. Range rehabilitation, reseeding, adjustments in use, and other improvements now need to be greatly increased.

And think of the drain on our most basic of resources—the soil. Steady progress has been made in recent years in a better public understanding of the need for soil conservation, and there has been a continuing increase in the formation of soil-conservation districts. Yet the wartime demands for certain crops retarded soil-conservation practices in varying degrees. Clean tilled crops were grown on sloping lands without adequate conservation measures in some places in the South. Increased soil losses by erosion took place in parts of the corn belt. Elsewhere pasture and hay lands were converted into crop and vegetable fields. In spite of the fine achievements of recent years, the Soil Conservation Service tells me that 500,000 acres of land still go to ruin each year through erosion, and that scarcely 10 per cent of the job has been done.

Pollution of our streams—always bad—became worse during the war. New industrial plants sprang up overnight, and the disposal of their wastes was given little consideration. Plants using new manufacturing processes dumped new types of wastes into the streams, and time did not permit adequate study to devise safe disposal methods. War housing communities grew up overnight, and the treatment of domestic sewage lagged because of shortages of critical materials. We slipped a long way in the fight to correct a pollution situation that was already growing worse instead of better.

Fish and wildlife fared better, I think, than did forests, streams, minerals, and soils. Oceanic fisheries, which provide the bulk of the commercial take, were highly important in our domestic economy during the war years. We all ate fish until we grew tired of it, but I don't know what this country would have done for proteins in the diet if it had not been for fish, nor what the armed forces and allies would have done for meats had the fisheries here been unable to substitute for the red meats sent broad. The diversion of boats, equipment, and man power for military use decreased the fishing intensity so that little actual overfishing occurred. During the past 2 years, though, there has been over-exploitation of a few fisheries, particularly shrimp, and this may become even more severe if prices remain at present high levels.

Wildlife and the sport fisheries had a rest during the early war years but have been taking unprecedented punishment in the past three seasons. License sales have been increasing steadily and are still on the climb. Hunting license sales increased 20 per cent in the fiscal year 1946 over those sold in 1945 for an all-time high of approximately 9,850,000. Some states report increases of as much as 50 per cent during the past year. Duck stamp sales increased 45 per cent during the 2 years preceding the present season. In 1944, there were less than 1¼ million sold. This year sales will probably exceed 2 million. Production of game and fish has been unable to keep pace with the demand. So long as economic conditions remain good and the trend is toward shortened work weeks with more leisure, there will continue to be greater demands on fish and game. Hunting and fishing are by far the most popular of all forms of American recreation. Administrators of the wildlife resources of the Nation have rough going ahead indeed.

America has no new frontiers in so far as hunting and sport fishing are concerned. We have already exploited all of the available areas within the United States, and it is now up to conservation interests to see that our present lands and waters produce as much as possible consistent with other domestic needs. Because there are no new areas to which we can turn to satisfy the ever-increasing demands, we must make certain that any changes we now make in land and water use take into consideration the protection and production of fish and wildlife.

There are many factors that go into the making of a sound national wildlife-conservation program. Protection of existing and restoration of destroyed environment are the most important items. Law enforcement, research, public understanding, education, sportsman-farmer relations, and numerous others are highly important. In the space of time allotted me, I wish to discuss the phase that makes all of these component parts fit together into a well-rounded whole. That is the matter of finances. I fear that the American people generally do not realize that the protection and conservation of our natural resources cost money. Also that in these modern times, with the increasing competition between wildlife and other economic uses of land and water, the costs have increased accordingly. It takes real cash to produce, protect, and manage fish and game. During the stress of battle, we willingly spent billions to exploit so we might build the tools of war. Are we now willing to spend a small fraction of that cost to repair the damage? We hope there may never be another conflict, but can we afford to forget that some day we may again desperately need those very things that contribute so much to victory?

During the past 5 years, conservation agencies reduced their programs drastically. Personnel joined the military services; equipment was unavailable; funds were held to absolute needs. The result was rapid depreciation in facilities and physical structures. Now, swollen wartime budgets are being slashed—and rightly so. The danger, however, is that when cuts come, they will fall on all alike. Instead of increasing expenditures to help clear up wartime pollution, to restore forests, to increase soil-conservation operations, to make wildlife areas and fish cultural stations more productive, the trend is apt to be to cut costs here as in war emergency agencies. A good example of this philosophy can be found in the appropriations for the Pittman-Robertson Federal Aid Act. There is now in the Federal Treasury, earmarked and available only for wildlife restoration purposes, almost $14,000,000.00. The income from the excise tax during the last fiscal year was in excess of 5¼ million dollars. The states need the money, but how much and how soon it will be made available still remains the $64 question.

Wildlife management—just like the management of any other big business—must have the wherewithal to do a decent job. If people want more and better hunting and fishing they must expect to see it better financed. Many states are talking about increased license fees to raise additional funds, while others are approaching the problem from the standpoint of securing legislative appropriations for the purpose.

Recent federal legislative attempts to meet this all-important question of finances have been slanted toward special charges assessed against the sportsmen—rather than additional drains on the federal treasury. Bills introduced with the 78th and 79th Sessions of the Congress, to provide the machinery for raising more money for fish and game restoration largely followed that trend. Few of them passed, due to more pressing matters, but they may again come up for consideration.

H. R. 7104 introduced in the 79th Congress by Congressman, now Senator, Robertson of Virginia as Chairman of the Select Committee on Conservation of Wildlife Resources of the House, would have provided federal aid for sport fisheries. It failed of passage but the idea has wide support in many quarters and similar legislation may be reintroduced in the new Congress recently convened. It was similar in philosophy to the Pittman-Robertson Wildlife Restoration Act. There is at present a 10 per cent excise tax on fishing tackle which may be repealed within the next few months. Proponents of the Bill suggest that instead of repealing the existing tax, it be continued and held in a special fund for fishery restoration programs.

Such funds, if made available, would be applicable to projects having material value in connection with sport and recreational fishing in both marine and fresh waters of the United States, and would include research into fish management and culture, acquisition of facts needed to guide and direct the regulation of fishing, restocking waters with food and game fishes, and rehabilitation and improvement of fishing waters.

As in the Pittman-Robertson Act, 75 per cent of the costs would be paid from the federal excise tax funds, and 25 per cent would be supplied by the state fish and game departments. The federal tax derived from this source would probably amount to about $1,000,000 per year, and together with the state contributions would go a long way toward providing more and better fishing.

Stepping up the waterfowl-restoration program was contemplated in a proposal embodied in H. R. 5021, of the 79th Congress, introduced by Representative Biemiller of Wisconsin. This bill proposed an increase in the price of duck stamps from $1 to $2. The funds would be used for the purchase of "wildlife management areas," rather than "inviolate migratory bird sanctuaries." The bill provided that in the discretion of the Secretary of the Interior not to exceed 50 per cent of areas so acquired with these funds might be excluded from sanctuary status. That is, the Secretary would have the authority to open portions of the areas to shooting when the waterfowl supply justified such action.

There is definite need for increased wintering areas to take care of the ducks and geese and other waterfowl that must spend half of their lives on the wintering grounds. The increase in the price of duck stamps would furnish funds for more rapid purchase of suitable areas, would provide for better enforcement of the annual regulations and also for additional observers to keep abreast of year-round conditions.

A program to encourage better wildlife production on agricultural lands was contemplated in a bill known as S. 1060, introduced in the 78th Congress in 1943 by Senator Clark of Missouri. This bill proposed to provide funds and authorization for the employment of wildlife specialists who would work with the Extension Services, Soil Conservation Districts, and agricultural organizations of the various states to encourage better wildlife practices on the farm. The great bulk of wildlife in this country is produced on agricultural lands, and the landowner is about the only one who can do anything to improve conditions for fish and game on his own holdings. The greatest gap in present day conservation is that between the wildlife technician, or administrator, and the landowner. Many improved practices of soil conservation and land management are helpful to wildlife, but there is a lack of contact between wildlife and agricultural interests. S. 1060 was designed to assist in filling that gap. Funds for the employment of Extension Wildlife Specialists were to be provided from unexpended portions of the Pittman-Robertson Federal Aid funds which now revert to the Migratory Bird Conservation fund. The states now have 2 years in which to expend their Federal Aid allotments, and if unused at the end of 2 years the moneys revert to the Migratory Bird Conservation fund. S. 1064 would have authorized the use of a portion of these reversions for the employment of wildlife specialists to work with agricultural interests. This bill could be broadened to aid in farm-fishery programs by using similar reversions from funds provided under the fishery restoration bill should it become law.

As to pollution, several bills were introduced in the last session of the Congress, which failed of passage. Already a few have been reintroduced and will be considered in the 80th Session. Pollution has always been a major problem and has grown worse during the war years. With the increasing demand for better hunting and fishing it becomes more imperative that our filth-laden streams be cleansed and kept pure in the future. One bill, of the 79th Congress, known as the Mansfield Bill was the outgrowth of hearings where all interests fairly well agreed to work toward reasonable pollution control. It would have given the states the opportunity to handle pollution in the first instance, but if they failed, the Federal Government would have had authority to enter the picture and see that pollution control was established.

I have discussed what are probably the most important federal legislative needs in the national conservation program. These or similar approaches are items for future consideration. It is gratifying that considerable progress was made even during the war years. The last session of Congress passed one of the most important conservation laws that has ever been enacted. This is known as the revised Coordination Act, Public Law 732, and was sponsored by Senator Willis Robertson, then chairman of the Select House Committee on the Conservation of Wildlife Resources, and Senator Guy Cordon of Oregon, of the Senate Wildlife Committee.

This Act provides that when the waters of any stream or other body of water are impounded for any purpose by any department or agency of the Government, fish and wildlife interests shall be recognized and their protection made a part of the project. For the first time in history the Fish and Wildlife Service and the state fish and game departments have an obligation to work with the construction engineers in the early planning stages of river basin developments to see that wildlife's needs are met. This Act does not give either the federal or state conservation agencies the power to veto a project but it does insure that the wildlife interests have a chance to look at the projects and be granted a hearing on their merits or demerits.

Much progress has been made in the short times since this Act has been passed. The present federal budget contains an item of $350,000 to enable the Fish and Wildlife Service to employ aquatic and wildlife biologists, engineers, and other personnel to be assigned to this important task of reviewing the plans of the construction agencies. This proposed appropriation is in addition to a special item for studies in the Missouri River Basin. Close cooperation between the state game departments and the Fish and Wildlife Service is being maintained. Worth-while results are already evident.

Another important achievement for conservation was the Presidential Proclamation of September 28, 1945, which contemplated the establishment of conservation zones for the protection of fisheries and other marine life on the high seas. Under this new policy the United States clearly recognizes the need for the conservation of the fisheries that heretofore have been exploited without regard to sound principles of sustained yield.

Progress has also been made toward protection of the Great Lakes Commercial Fisheries. A treaty with Canada was signed on April 2, 1946 and is now awaiting ratification by the Senate.

We recently saw the fifth anniversary of the Atlantic States Marine Fisheries Commission which has to its credit notable results in state cooperation. Considerable progress has been made toward uniform regulations, size limits, and protective measures in waters of the member states. The plan of interstate fishery compacts to handle problems of this nature is expanding, and other states, particularly in the South, are showing interest in the idea. The Fish and Wildlife Service has a very direct interest in the Atlantic States Marine Fisheries Commission since it is looked upon as the agency furnishing technical advice to the member states.

Although the conservation movement has come a long way in recent years and although there is probably a better understanding of wildlife needs now than ever before, the demand has outstripped the supply in so far as fish and game are concerned. As we look ahead we must exert every effort to see that existing areas are made to produce better environment. Every acre of marsh drained for agriculture or damaged by commercial development detracts just so much from existing habitat for marsh loving species. Conversely, every acre restored to productivity adds just that much to the lands needed for production. Every acre of soil saved from erosion brings us that much nearer to that far away balance between destruction and restoration. Every acre of timber permitted to stand to maturity comes that much closer to replacing the saw timber that has been felled so heavily in recent years. Our whole program for conservation of natural resources must be accelerated for the national welfare.

All of these things require finances. True we do not know the answers to many perplexing problems even though research workers in all fields of conservation have made considerable progress during recent years. But whether we have all the answers, or only part of them, many things can now be done to restore environment to improve natural conditions and to hasten the processes of reconstruction. These *must* be done if the ever-growing demand is to be met.

## WAKE UP, AMERICA!

MELVIN O. STEEN
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If you would know the true story of Americans, their wildlife and their land, look first to history. On its pages you will find that story, revealed in the critical light of historical fact. To better understand this story, however, it is necessary to first scan the history of other men and their land. It is necessary to look at yesterday as well as at today.

Look at history, and you will see nation after nation march across its pages, to rise and flourish on the rape of a fertile land, and to pass on into national decay or oblivion with the depletion of that fertility. Look at history, America. When you do, you will see that civilized man has always misused the land. There are many unproductive scars on old Mother Earth, starvation-ridden lands that once adequately fed great nations. Look at the history of any nation that has ever tilled the soil and you will see that man is not worthy of his stewardship of the land. He always despoils the land, and the degree of his destruction can be measured in terms of his tenure plus his so-called civilization.

When the source of man's sustenance and material glory will no longer sustain his way of life, he does one of two things; he sinks into individual and national decay, or he takes, by force of arms, more fertile land from some other nation. *That* is history!

Van Loon defines history in this short but tremendously significant sentence: "The history of man is the story of a hungry animal in search of food." But man is not possessed of physical hunger alone. His hunger engulfs the whole array of human desire, and he uses the land to satiate that hunger without much regard for the future. Man's philosophy with respect to the land is "Rip it off the hills; gouge it out of the soil; get it into the bank in one generation if possible." His slogan is "To hell with tomorrow, I want *mine today!*"

These are searing words, but they are not my words. I only quote from history. These are not my words, these words are written on the sands of time; they are scrawled across the pages of history—that "story of a hungry animal in search of food."

So much for yesterday, now let us look at today.

You are young and you are strong, America. You are progressive, you are wise. Your way of life is different, your ideals are high, you will not do these things, you say. Let us look at the record—at your history.

You are young, America. This land has been under your control some three hundred years, more or less. For about one hundred years you have used it intensively. Tonnage yields to feed the world has been your goal. You have produced, but at a price. You have produced, but you have also ruined, partially or completely, more than half the fertile topsoil you possessed. It took the Chinese ten times as long to do as much to China!

You are strong, America. But may I remind you that your way of life, your institutions, and your society are builded on, sustained by, and no better than the land on which you live! I remind you that adequate nutrition requires more than mere bulk, that nutrition is a qualitative as well as a quantitative thing. I remind you that your hillbilly is a hillbilly because he grows his food on hillbilly land. In the light of present day knowledge there can be little doubt that the true hillbilly is what he is because of malnutrition; qualitative malnutrition that dulls his mind, saps his strength, and smothers his ambition. This American is already in the process of degeneration. Do you not see him raze, and burn, and hack, and gouge the impoverished soil on which he lives, further depleting its ability to nourish him? Can you not see the vicious circle in which he lives, a circle that moves relentlessly around and around, a circle from which few escape? Must I remind you that there are other groups within your society which suffer a like fate? What are your "Tobacco Road" and your "Grapes of Wrath" if they are not symbols of this truth?

You are progressive, America. When your land fails to produce the tonnage you desire you fix things up with chemical fertilizers. But you pay no attention to the warnings of scientists whose long experience in tilling the land leads them to say that chemical fertilization is only a delusion, a stop-gap, a tonnage producer that does not restore essential, life-giving elements inherent in a fertile soil.

You are wise, America. When your overworked corn lands lost much of their fertility and their ability to produce, you came forth with hybrid corn. Your corn yields skyrocketed, and you are still congratulating yourself on your ingenuity. But you fail to take note of one significant thing. You overlooked the fact that history will record hybrid corn as being *that* corn which had the ability to take fertility out of the soil twice as fast as any corn that man had ever grown before!

The truth is, America, that your own land-use history records you as the greatest spendthrift of all time. You have developed bigger, better, and faster ways of using up soil fertility than has any nation in all the world. You are the champion playboy of all history, and your extravagance is exceeded only by your disregard of the consequences.

"And what," you may well ask, "had all this to do with wildlife?" Simply this, that nature makes no distinction between wild and tame life in so far as soil fertility is concerned. In Old Mother Nature's book nutrition is nutrition, and life is life. It makes no difference whether that life be wild or tame.

It is true, however, that misuse of the land is a two-edged sword in so far as wildlife is concerned. It reduces protective cover as well as fertility. Adequate protective cover and adequate nutrition are the two big essentials of wildlife production, and both these essentials are impaired by misuse of the land.

At the present time prices of farm products are very high and the economic incentive to squeeze every last pound of production out of the land is great. Our land is being squeezed, and protective cover is being reduced to a minimum. The immediate effect is to increase erosion and reduce wildlife, but the long time effect is to reduce land fertility and, hence, all production.

The simple truth is that man can not reduce soil fertility without all life suffering the consequences. That truth is supported by evidence which grows steadily in volume and significance. This evidence puts the emphasis on qualitative rather than quantitative nutrition. Soil fertility determines the quality and contents of foodstuffs, and the quality and contents of foodstuffs affects all life. The evidence is overwhelming. When insane men are made sane through the avenue of nutrition alone, one can no longer doubt that quality counts. Some day foodstuffs will be valued on the basis of quality, not quantity. When that day comes we may have the economic incentive that will save our soil. Until we do, we must save the land by any means we can.

The simple truth is that the growth, vigor, survival, and reproduction of all life is wedded to the land by unbreakable bonds. The truth is that America should maintain, without impairment, the fertility of all her lands. To do otherwise is unthinkable, and must eventually lead to disaster. It is not wildlife alone that hangs in this balance, it is America herself that is at stake.

If this be true, what are we doing to maintain the fertility of America's land. Let us look at the record. Let us look at history—today's history.

As individuals we are doing relatively little. Here and there an individual has learned that he can maintain the fertility of his farm and make more money in the long run than if he misused his land. But that individual is relatively rare. The masses know nothing of this. In fact, the masses, including the vast majority of those who till the land, know little or nothing of the true significance of land fertility and the real dangers of land abuse.

As a nation, we have done very little to save our agricultural lands. Our most effective governmental actions have been the establishment of the Soil Conservation Service, and the initiation of benefit payments to American farmers for soil-conserving practices. But neither of these are the result of any united desire or action of the American people. The first came into being largely because of the inspired leadership and dogged persistence of a single American citizen. The second came into being as a device to circumvent the law. Benefit payments for soil-conserving practices in America came into being by chance—they were initiated because the Supreme Court of the United States said we could not pay public money to American farmers for plowing under crops and killing little pigs. *Thus* was born America's principal national efforts to save her soil.

If this is not enough to convince you that America does not know the truth, look to the seat of your government—look to Washington. There you will see your government appropriating 45 million dollars to the Soil Conservation Service to finance their work of holding America's water where it falls and soil where it lies, and, at the same time appropriating 185 million dollars to the War Department with which to make down payments on dams designed to stop the water that doesn't linger where it falls and the soil that doesn't stay where it lies.

Forty-five million dollars to the doctors who feverishly strive to sew up your severed and gushing arteries, America—and frankly admit that they are waging a losing fight—45 million dollars to the doctors who feverishly strive to suture your severed and gushing arteries, and four times that sum to the tinsmiths who beat out buckets with which you propose to preserve your life's blood.

That is not—as some may assume—an indictment of tinsmiths. It is an indictment of *you,* America, *you,* who entertains and tolerates such a twisted, distorted, cockeyed concept of national values and national needs!

If you are not yet convinced that America doesn't know the truth, look again to Washington. There you will see many of your leaders and representatives sponsoring a movement to slash, by one third, the appropriation for soil-conservation benefit payments. You will see the scalpels poised and ready to cut the heart and backbone out of America's principal effort to save her land. These men contend that you can not afford to pay for saving her soil, that you have other and better things to do with public money. You can afford, it seems, 11 billion dollars plus for national defense, but you can not afford 300 million dollars—2½ per cent as much—to save the very thing you propose to defend. You can afford to subsidize navigation, aviation, hydro-electric development, flood control, and other special interest groups, but you can not afford to subsidize the saving of the land, in which every living American has a stake, as do all the generations yet unborn!

America, you can afford to mobilize your manhood into armies that you count by the millions, to equip them with implements of destruction that stagger the imagination, you can afford navies that swarm the seven seas, you can afford aircraft that figuratively—and literally —blot out the sun; you can afford 200 billion dollars in the prosecution of a single war, you can afford barrels—nay rivers, of American blood; all this, and more, you can afford to save America *danger* from *without,* but a little lip service, and a token gesture here and there is all you can afford to save America *disaster* from *within!*

America, you go the way all men have gone. You are a living symbol of the truth, that history repeats itself. You are not young, you are not strong, you are not wise, you only dream these things. You live an old, deceitful dream, that blinds your eye against the truth, that leads you down Disaster Road!

You have one chance, and only one! Wake up! Shake off this dream! Wake up! Shake off this spell, that you may see, that you may take a *better* road!

# GENERAL SESSION

## Monday Evening—February 3

*Chairman:* Harold Titus
Chairman, Michigan Conservation Commission, Traverse City, Michigan

*Vice-Chairman:* Frank C. Bellrose, Jr.
Associate Game Technician, Illinois Natural History Survey, Havana, Illinois

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## IS WILDFOWLING ON THE WAY OUT?

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## INTRODUCTORY REMARKS

Harold Titus

I have a decided feeling that this session, which I have the honor to open, may be a historic event in the history of the North American conservation movement. The general subject, "Is Wildfowling on the Way Out?" affects every state and province represented here.

All our species of shootable wildlife present definite and pressing problems to the game administrator today. However, except for the migratory waterfowl, they are of local or, at the most, regional interest, but when it comes to ducks and geese, all of us involved are involved because of the migratory habits of the birds. These birds have been for generations the largest single item in the hunter's bag. Interest in maintaining shootable stocks has been restricted on this continent only to those areas uninhabited by man.

In the memory of this generation we have passed through two crises in the condition of our waterfowl population. We have met, so we thought, two major contingencies and, so we thought, have licked them both. The first instance was in the second decade of this century when overshooting was held responsible for a serious depletion of duck and goose populations. Conservationists rallied around. The migratory bird treaty was perfected and the day, so we thought, was saved.

In the 30's when prolonged and unprecedented drought brought tragically to our attention what had been let happen to natural breeding areas, it made us stop and think about what to do. Magnificent achievements followed and we felt that a serious alteration in duck population would never happen again, but apparently at least an approximation of such an unhappy state of affairs has taken place. We are all aware, now that the duck season has ended, that in most of our areas most of the ducks and at least some of the geese are not appearing in the abundance which we had expected and which we need. Some of us and some of our responsible agencies were aware of this situation before the shooting season opened. Others could not or would not see the picture.

During the late summer, we listened to much debate, some of it marked by deep acrimony, by charge and countercharge. State and federal agencies could not all agree. The opinion of earnest sportsmen-conservationists covered a wide range. The only item on which most would unite was that something was wrong either in estimate of supplies or in the management of those stocks and what to do about either or both.

Tonight we are to listen to four speakers, each representing a specialized point of view. These are able men, sincere men. Some of what is to be said may shock some of you. Still others may feel that the picture is not stark enough; or that the suggested remedies are improper, but I believe that the Wildlife Management Institute, which arranged this program, has made an excellent choice in both persons and papers.

# WILDFOWLING CAN BE SAVED

CHARLES E. GILLHAM
*Chairman, American Waterfowl Committee, Edwardsville, Illinois*

Duck hunting comes as No. 1 on my list of outdoor sports. I write about ducks, dream about ducks, and for 8 years I followed ducks as biologist for the U.S. Fish and Wildlife Service. From the deep Arctic to the tropics of southern Mexico, I studied the web-footed clan. Few of you realize the trials and tribulations that a duck or goose faces in bringing off her brood of downy youngsters—inclement weather, predators, lead poisoning and disease—then to run the gauntlet of hunters to the wintering grounds.

I am of the opinion that if we even partially correct the evils brought on by man, that waterfowl will ever be with us. We can do little with any act of God, so I am of the opinion that droughts, fires, floods, freezes, and even predators, are of secondary consideration. At that, even some of these pressures are a direct result of man's carelessness or shortsightedness.

In order to have a place to shoot, a friend and I purchased a property in Missouri several years ago. We have 16 lakes upon the place, and they are immediately adjacent to one of the largest pools on the Mississippi River. In the past, this pool was one of the greatest wildfowling spots in our area. I shot but twice on our place this year. We had so few birds I felt guilty when I shot one.

A federal refuge a few miles below us held twice the ducks it did last year. A successful operator a short way above the refuge took out 200 hunters. Their kill was 176 birds, or less than one duck per man-day. Often in the past, these hunters bagged their limit, when it was 10, and even 15 birds per day.

On an area open to the public and adjacent to the refuge, 600 hunters threw hundreds of pounds of shot into the air on opening day. They averaged about one bird brought to hand for their efforts, and the resultant cripples is a matter of speculation. At the close of the season when ducks returned to this public shooting place, wholesale lead poisoning was soon in evidence.

In order to get material for shooting stories, to have something to shoot, and to find out more about the duck situation, I hunted in western Nebraska, west Texas, and in Arkansas. Out West I shot flight ducks in an area of low human population. In Arkansas I was in the rice country that is practically a wintering ground.

Even in these areas, shooting was not up to that of previous years. Hunters complained, and swore at the government, the states, and each other. I came to one conclusion about ducks, that is, they are rapidly changing their habits. This is especially true of the mallards and the puddlers. Also it is a good thing as conditions are today, or they would be close to extermination.

While my hunting activities have been confined to but two of the flyways and is not a gauge to conditions nation-wide, I am of the opinion that something need be done if we are to continue to have even a minimum of shooting in the not too distant future. Also I realize that I am sticking my neck out in maintaining that wildfowling can be saved. Under present methods and conditions, I am equally certain that duck and goose shooting is on its way out.

I will not deplore previous shooting practices, large bag limits, bait and live decoys. They are gone and I hope they will never return. It is also futile to stress the large army of postwar hunters—good roads making wildfowl more available—the restricted marsh and water areas left for our birds. Rather, we must face the facts at hand. We know what we must combat. Are present methods doing the job? What need be done if wildfowling is to survive?

Let me immediately go on record that I do not attribute waterfowl conditions, as they are today, to any gross negligence on the part of the U.S. Fish and Wildlife Service. Compared to the majority of federal agencies, they have done a remarkable job. I do not believe all I read in the papers as being direct quotations from this organization. Oral speeches and printed words are often misconstrued either by deliberate intent, or innocently.

I know the majority of the personnel of the Fish and Wildlife Service. They are not bureaucrats. They are sincere men trying to combat one of the biggest headaches ever wished upon such an organization—the administration of waterfowl. It is my honest conviction, that without this service since 1934, our waterfowl would only be a memory so far as shooting is concerned.

Books might be written around individual problems of waterfowl habitat and maintenance. Different species, localities, and other conditions, all might call for special treatment. In general however, the following points seem applicable to all conditions, and contribute to the good of the whole:

1. Sane water- and land-use practices
2. Adequate enforcement of existing laws
3. Public relations, education
4. Necessary legislation continually brought up to date
5. Research and immediate application of it
6. Moral responsibility, sportsmanship

Let us look at these six points one by one. We will break them down a bit more, and leave the rest to your further thinking.

*Sane water and land-use practices.*—What are these? Are they complicated? Are their requirements impossible to achieve? Here are a few necessary steps to aid wildfowling if it is to continue to exist.

1. No further drainage of natural marshes or other waters
2. Restoration of drained areas wherever possible
3. Reforest, revegetate, practice soil saving farming on all watersheds. Prevent erosion and resultant silting of lakes, streams, and bays
4. Maintain constant water levels in dammed areas, not fluctuating ones as practiced by some government agencies dealing with flood control, river channels, reclamation or irregation
5. Purchase areas with state and federal money to be used as combination refuges and public shooting grounds
6. Control pollution of lakes, streams and tidewaters
7. A nation-wide farm-pond program such as Missouri has. A lake program as contemplated in Illinois
8. Where botulism, leeches, drought threatens nesting areas, either drain them, or impound additional water

*Adequate enforcement of existing laws.*—Enforcement of game laws is only secondary in the waterfowl picture to the proper utilization of land and water. State and federal agencies handicapped by lack of funds have been unable to see that the rules were obeyed. An increase in the price of the duck stamp to $2.00, with 50 per cent of it earmarked for enforcement will go far towards aiding waterfowl restoration. Remember, enforcement is public relations. Prospects are sold on what is right, either with the billy club, or by logic, whichever their preference might be.

Game laws are of such necessity that a substantial sum must be spent in their enforcement. Laws relative to pollution need equally stern measure.

Is it too advanced to hope that the day will come when proper utilization of land and water will be subject to fixed rules? The future of America is important enough for it to be unlawful to exploit soils, forests, ground cover, and water. Think that over. Why should we ever in the world go for anything that is going to eventually exploit the basic thing we have—our soil, our ground cover, and our water! Think it over. You can beat China in a very few years.

*Publicity, public relations, education.*—How can proper treatment of the waterfowl problem, wildlife necessities, or anything on a national scope be dealt with, without proper understanding of it by the nation as a whole? Unfortunately, the papers from this meeting, magazine articles, or treatises on the needs of wildlife are seen by but a few of the millions who should know about them. Newspapers, radio, and movies are common mediums of education in America.

The Outdoor Writers of America feel that they have much to tell the public through the daily press. Unfortunately, the shortage of paper, and many unresponsive publishers, have done much to keep this avenue of public relations a closed door. We had a condition in my country last week where a lot of ducks were poisoned with lead. The paper put out a number of blurbs on it. The whole community was indignant. If you had written that in a journal of wildlife management or various outdoor publications, nobody would have known a thing about it.

Educational movies, particularly those used in the public schools, could be cause for a wide awakening as to the needs of conservation and restoration. Most people do not know that our natural resources are threatened. Many of them never even heard of the term.

A study of our natural resources—what is happening to them, what we need to do to restore lost ones and keep those we have—should be a required subject in every school in the land. First though, we must teach the teachers.

*Legislation continually brought up to date.*—Wildlife problems are not static. They are ever changing. Legislation must keep pace with these changes. Senate and House wildlife committees are imperative in Congress. State governing bodies should have a similar setup geared to take care of all natural resource problems immediately.

In the past many vicious practices went unchallenged. Overgrazing is one. Another was stream pollution. The dumping of oil waste in coastal waters smells higher than the oil. We must have legislation to stop this sort of a thing. It must be mobile to keep pace with changing conditions. Stalling on a vital problem with reference to one of our natural resources is un-American, and those guilty of such should be widely publicized.

*Research and the application of it.*—In this ever-changing world, research is vitally necessary. Unfortunately, some of it seems of an endless nature, taking a lifetime to complete. Some forms deal with subjects that are not immediately important.

Let research findings that seem workable be given a tryout. It is better to make a few mistakes and get started, than to dilly-dally forever to exhaust all possible elements of doubt.

*Moral responsibility, sportsmanship.*—This duck season, Al Day, director of the U.S. Fish and Wildlife Service, appealed to sportsmen to take less than the bag limit. Undoubtedly many did and countless birds were saved. We need more of such a thing. Do you make every effort to retrieve a duck in heavy cover, or a wounded one? Do you use a dog to cut cripple losses? Are you one who preaches law enforcements, but shoots a 2-day limit in one, or birds for the poorer shot when you can get away with it?

Moral responsibility has to do with the teaching of proper hunting ethics to the young. Is your boy, or the neighbor's, being brought up to know that wildfowling can only continue if the rules are obeyed? Do you wink at infringements of the law and pass these ideas along to the youngster? Do you a hunter, familiar with but one area of the United States, feel disgruntled with the regulations and decide to get away with anything you can because the laws are not as you think they should be?

Lastly, are waterfowl creatures we wish to exterminate, or are they a heritage of a great country to be taken with discrimination and in great wisdom? Morally a great responsibility is ours. Money is not available to put a warden behind every blind, nor should such be needed.

To sum up again if we wish to keep wildfowling:

1. We must have a sane practice of land and water use.
2. We must enforce our laws.
3. Publicity and education is necessary.
4. Legislation must keep pace with changing conditions.
5. Research must be active and findings immediately applied.
6. Sportsmanship and moral responsibility is paramount.

Remember that wildfowling can be saved. The things that will save it guarantees our own existence in this world as a first rate power.

A nation of barbarians can not long endure.

## DISCUSSION

MR. ANDY ANDERSON (Texas): Charley, I would like to know what you mean by lead poisoning?

MR. GILLHAM: Andy Anderson asked me what lead poisoning is. Lead poisoning is the result of a waterfowl eating the shot that has usually been dropped in a marsh. We have found as few as 49 shot will constitute lead poisoning, and, Andy, whenever you have a duck that eats a certain amount of lead, he usually, if he gets enough of it, kicks off. To put it in the words of an old duck hunter we had 6 days of very severe weather and these birds, these ducks came out of the refuge and went into this area where I told you hunters shot thousands of pounds of shot and after the season was closed every one of these birds went in there and picked up a lot of this lead. It is very obvious what happened. It took them a few days and they began to fall over. We lost two or three thousand ducks in the area that we know of. It wasn't starvation. It is purely a matter of the birds picking up lead. You can tell by the green feces of the birds. They get paralyzed and fall down. It is lead poisoning.

MR. ANDERSON: The reason I asked the question is that I was wondering if the ammunition companies have done anything towards the research of a chemical that might neutralize the chances of lead poisoning. It seems to me if that is such a serious thing, the munition companies get so much out of duck shooting that they ought to institute a program of chemicals to neutralize that and help us solve that problem rather than it being a thing over which to cry our eyes out.

MR. GILLHAM: I wish you would get about six strong men to get Andy Anderson out of here so I won't have to talk about that, but the ammunition companies have developed a shot in the past that can break down in solution with water or in animal tissue and not be too lethal. As far as I know, it is not being done, Andy, and the ammunition companies have not pushed this thing.

It is very important. I am really all for it. It could be done if there is enough heat or pressure brought to bear. So far, I will say this, that no ammunition people, to my knowledge, are loading shot that would break down when it is dropped in a marsh, but I know that such things have very favorable possibilities.

CHAIRMAN TITUS: Are there other questions?

MR. F. H. KORTRIGHT (Ontario, Canada): There is no point in questioning the broadness of the paper. I just wanted to ask a question on the matter of the time element. Assuming that your whole program were put in immediately, which is an impossibility, but assuming it were, what lapse of time wuold there be before such a program would be approved?

MR. GILLHAM: I know that gentleman; he is my left-handed cousin from Canada. (Laughter) Why did you ever ask me that question? It could be done. I can't speculate as to the length of time that it would take. Incidentally, it is a great deal like somebody preaching the gospel to this audience. I imagine even this audience, as nice as it is, if somebody preached the right words of wisdom, it wouldn't take too long to have you all on the sawdust trail. I doubt whether we will ever get on that sawdust trail for a good many years. I wish we would, Mr. Kortright, but I don't like to answer that question. It is impossible to improve the areas and do a great many things in a short time, but if you do them the only thing in God's world is public sentiment behind it and we are not reaching the public.

# THE EFFECT OF CONCENTRATED HUNTING PRESSURE ON WATERFOWL BREEDING STOCK

H. ALBERT HOCHBAUM
*Delta Waterfowl Research Station, Delta, Manitoba, Canada*

As I glance from my window, pondering the subject of this Session, my eye follows the pattern of the vacant winter marshland. There before me are all the familiar sloughs and potholes, beyond them the bays, then golden reeds to the horizon. Beyond that to the Rockies, millions of acres of land—part for man, part for ducks, part for neither, part for both. There is much one might say about land use and ducks.

Where shall I begin? What can I say about land use that will help ducks in 1947? Here is my bailiwick ducks need help in a hurry. I shouldn't waste my breath nor your time unless I can say something that can be translated into action shortly. What can I say about land use concept that will help ducks right now?

My eye still is on the marshland. Here is a large area before me, the Delta Marsh, where the usual questions of land use are pretty well on their way to being settled. The problems related to grazing, hay cropping, trapping and so on are being handled very nicely by the Manitoba Game and Fisheries Branch regardless of what I say here.

Of the wheat prairie to the south I can say very little about land use. This is dictated by the weather and will be so for many years to come. Dry years the farmers use it all. Wet years ducks stake claims to a myriad small waters that break the fields.

Loucksy's Pothole catches my wandering eye. As with countless other tiny areas, problems of land use are neither here nor there with Loucksy's. No farmer, nor haymaker, nor cattleman, nor city slicker has his eye on Loucksy's Pothole. It is an obscure little spot used by a few pairs of ducks, several coots and other marshlife April 'til November. The rest of the year, except for muskrats, it is lifeless. It has its ups and downs, to be sure, according to the yearly weather patterns; yet there is little we can do to "manage" it. But Loucksy's Pothole has an ailment—an ailment closely related to land use—***marsh*** land use. It is an ailment that affects every square yard of marsh water in the Lake Manitoba basin; an ailment that now affects a very large per cent of the waterfowl breeding grounds on the prairies. It is a serious and deadly ailment; Loucksy's Pothole is losing its breeding ducks.

Gentlemen, Loucksy's is not losing its breeding stock because it has become the less attractive to waterfowl; nor because of crows; nor because of skunks; nor because of mink or hawks or jackfish or ground squirrels; nor because it needs more water or less water; nor because of fire or drought or grazing; nor even because "seven out of ten" are lost before they grow. Loucksy's is losing its breeding stock *because there are not enough breeders to go around.*

Last spring our careful and season-long study of the vast and beautiful marshes of the Lake Manitoba basin revealed a scarcity of breeding ducks so pronounced that some fine water areas did not have one single pair the whole season. Most areas held less breeding pairs than in 1945. In some excellent marsh areas, little changed physically, the loss in breeding pairs was 80 to 90 per cent of the 1945 population. This thin spread existed despite a regional reduction of transient waters which held breeding birds the previous year; we had fully expected more rather than less ducks on the stable marshes.

This scarcity of breeders must make you stir in your chairs. Picture yourself, if you will, in the heart of the finest breeding grounds in the land. You pull your car to a stop beside a bulrush-bordered slough and walk to its edge. There is a pied-billed grebe, a pair of coots and a few blackbirds. A prairie marsh wren stutters nearby, but there is not a duck in sight. You clap your hands loudly over your head. A sora rattles, but there are no ducks. You let out a holler and your wife honks the horn—no ducks. You pull up your boots, walk out to open water and slush around a bit. Not a duck stirs. *There are no ducks here!* Visit the area again in early June—no ducks. Come again the middle of the month—no ducks. It is like an apple orchard without bluebirds; like a lawn without a robin.

Mind you, such duckless areas are not just here and there; there are many such areas. And 1946 is the first year we have found perfectly good breeding sloughs minus ducks. The areas that held only half of their 1945 populations are legion.

The loss of breeders is by no means confined to the Lake Manitoba basin. Harold Titus (1946) found similar scarcities when he made his survey of the north Prairie States last spring. Lyle Sowls[1] found an abnormally-thin breeding population in his survey of southern Manitoba. Dewey Soper, Arthur Hawkins and Robert Smith,[1] ranging widely over the breeding grounds—Smith flew his plane more than 300 hours over marshlands—found thin populations general far and wide.

Some, of course, have a ready answer for this scarcity which is reasonable enough except the same answer has failed so many times before with other declining species. We are told that the prairie ducks

[1]Field reports

moved elsewhere—that last year they went north beyond the prairies. It was Seton, I believe, who pointed out long ago that no matter how far one travels toward the pole, the ducks, according to local authority, are always farther north. But after 3 years of reduced spring flights, of drastic declines in breeding numbers, of smaller movements of autumn transients out of the north, I wonder where our ducks are. Last year, we had by fair measure, far less breeding pairs than in 1938 when waterfowl were beginning their rise from the last "depression." This does not concern Delta alone. It is something for the citizens of Detroit Lakes, Havana, Stuttgart and Havre de Grace to think about as well.

This brings us to the subject of land use—of *marsh* land use. For the last few years we have been trying to operate on a sort of "pay-as-you-go" basis with ducks. On both sides of the line there has been a development of breeding grounds to better conditions for waterfowl production. And as we paid for these improvements, we have expected (and have been promised) returns on our investment. This marsh-improvement work is a vital part of the waterfowl program, yet more marshes cannot mean more ducks if there are not enough breeders to fill up existing areas. *"It takes ducks to make more ducks."* If land-management plans are going to function for the increase of waterfowl, if land use is going to have meaning for ducks, then duck hunters must return more birds to the breeding areas. No matter how grand our plans for new and better marshes, waterfowl will continue on the downgrade rapidly if we do not protect the "seed stock."

From Iowa and Nebraska right on north as far as trails pass bulrush, the breeding areas are man-used as hunting grounds each fall. It is like an agricultural crop, we are told: Sow in the spring, harvest in the fall. There are two things wrong with this widely-published formula: (1) The cropping is too early; (2) the harvest is too heavy. This early and heavy harvest on a breeding area adds up to one thing—a "burned-out" marsh.

"Burned-out" is the gunner's term for an area that has been so heavily shot that hunting there is not worth-while. Generally, it is used in the present tense—one speaks of an area that was burned out this month or this autumn. Tragically, however, the burning-out of a marsh is a long-time and eventually a permanent process that leaves a once-good breeding area without its seed stock. Take the marshes of northern Illinois or southern Wisconsin or Minnesota and other central regions. History tells us these once bred ducks in great number. Our eyes tell us that many of these areas that are left are still in condition to produce ducks; all they need is a breeding nucleus.

But that is nonexistent; the breeders for these areas have perished from the earth. The birds that bred there, their progency and all their associates have been shot long ago in the days of early, late and heavy shooting. There are no ducks left awing in which the experience is associated with these areas. To put it simply: a breeding tradition has been broken; all the ducks that kept the breeding traditions alive from one generation to the next are dead and gone. A vital portion of the flyway population is actually extinct. When spring flights move, the birds pass right on through, heading northward to regions their living traditions carry them. This burning-out process started down in the central tier of states 60 or 70 years ago. Gradually it worked northward; and now, the war over, it is gaining at a rapid pace on many fine northern state and Canadian marshes, particularly where commercial shooting, beginning in some areas the middle of September, attracts great numbers of hunters from far and wide.

It is not unlike a local pigeon population, to draw a crude analogy. As long as a fancier keeps a group of pigeons at his barn, the stock of "using" birds is assured. But should he kill every last pigeon that bred or was raised in the barn and then in the next few years should he kill every pigeon that chanced by, his facilities would no longer be used by the local dove population even though the barn was just as good for pigeon raising as ever before. The same with ducks. We killed off the breeders; and our early-season shooting, together with the over-all heavy kill, usually does away with any stray pioneers that now and again might break away from the main northern flight.

The reason we have not realized this is because we calmly accept the decline and disappearance of breeding ducks from our civilized terrain as our national heritage. We have come to believe that we cannot have ducks breeding in southern Wisconsin or Minnesota in any number because we live there—because breeding ducks and man just don't get along together. Yet some of the finest breeding grounds of the Canadian prairies are little different physically from those of Illinois or Wisconsin. For the present, at least, ducks and men live side by side over a vast portion of the north country. One sees breeding pairs of several species using the cattle hole near the farmstead as breeding territory. Roadside ditches are favorite sites for blue-winged teal, shoveller, mallard, and pintail. Indeed there are numerous breeding areas with ducks in Manitoba that actually are in every respect *inferior* to duckless marshes in Wisconsin. There are many thousand unproductive marshes in the United States that could be just as productive as marshes of northern Minnesota or southern

Manitoba. These central areas lack two things: (1) Breeding stock, and (2) administrative foresight to protect the breeding marsh and its population.

Just as we are willing to accept our duckless areas in the U.S.A., so we carry in our hearts a blind faith that farther north the marshes will continue to produce ducks for us to shoot. I say to you with great conviction—with the evidence at hand (Table 1) for you to read and examine—that fine marshes of the Northern States and Prairie Provinces are now in the process of having their breeding stock burned-out just as the marshes of southern Wisconsin were burned out a generation ago. Marshlands there are well on their way towards becoming as unproductive as those of Illinois. This is no idle chatter! On the Delta Marsh alone our bag tally shows that, despite a terrific drop in population, the 1946 kill was the heaviest on record. Modern shooting, with the convergence of a great gathering of shooters from far and wide on one marsh, is so efficient that the kill increases despite a drop in numbers. With such shooting, beginning the middle of September, the drain on native stock is terrific, particularly in the canvasback and redhead. More redheads left the Delta Marsh for Chicago, St. Louis, and points south in frozen packages than departed in migration. More redheads were shot on the marsh than were raised there (Table 1).

TABLE I. BREEDING-SEASON PRODUCTION AND HUNTING-SEASON LOSS OF REDHEAD AND CANVASBACK ON THE DELTA MARSH, MANITOBA[1]

| | Redhead | Canvasback |
|---|---|---|
| Number of young produced on the marsh | 750 | 500 |
| Total approximate kill for the season[2] | 2,648 | 5.720 |
| Number examined in opening-day bag on the marsh | 149 | 160 |
| Total approximate kill on opening day | 600 | 640 |
| Number of birds examined during the season: | | |
| 1st week | 297 | 284 |
| 2nd week | 88 | 112 |
| 3rd week | 190 | 469 |
| 4th week | 52 | 414 |
| 5th week | 31 | 109 |
| 6th week | 4 | 34 |
| 7th week | 0 | 8 |
| Total number examined during the season | 662 | 1,430 |

[1]Table prepared by Lyle K. Sowls.

[2]During the season not more than half the hunters' bags were examined. Hence, the total "take-home" bag was at least twice the examined bag. Crippling loss of diving ducks is great. Observations of hunters in action and the questioning of many gunners convinced us that one crippled bird was wasted for every bird bagged. Thus, the total kill is estimated to be four times the examined bag.

This same type of shooting—early and heavy slaughter with concentrated pressure on breeding areas—goes on in many other areas.

In terms of history, this can't last long. The days of lush shooting on the prairies are numbered. If the hunting of ducks, particularly of the diving ducks, continues along the same plan, then regardless of what we do to maintain the land and marsh for ducks, the breeding stock will continue to decline. We can't push the redhead and canvasback much farther north. When we burn out the northern prairie region, when the burning out process reaches the parklands, then we will have destroyed the great body of their breeding population.

Here, then, we see two sides of the same story: The breeding marshes in central regions, with few exceptions, have thin or nonexistent populations because of the early and heavy gunning pressure of the past. On many areas of the north the burning-out process is advancing under the pressure of early and heavy shooting. In the old days the marshes were shot-out by a relatively few hunters taking large bags. Now, they are being shot-out by many hunters whose individual kill is smaller, but whose total bag is just as big or bigger than in the old times.

This burning-out process is difficult to detect, in fact it is impossible to detect unless production and harvest are measured through survey and bag tally. We are killing off local populations, yet there are enough birds still coming out of the north to obscure this harm. While apparent now in a careful measurement such as we have made at Delta, it will not be apparent grossly for a number of years to come.

Clearly, however soon or late we may get out of our current waterfowl "slump," a repeat decline is inevitable in a few years if we continue to operate on the same plan as now. Unless we check this burning-out process by a radical change in waterfowl legislation, any curtailments now merely halt for the moment the terrific inroads we are making on our brood stock.

The destruction of breeding stock does not advance at the same rate with all species because of specific variation in breeding potentials (Hochbaum, 1946). It proceeds most rapidly in the diving ducks, notably the redhead which has lost much of its breeding population during the last 5 years. One reason for this is the late development of young in the diving ducks. These young are shot in great numbers on their natal marsh only a short time after they have taken their first flights and before there is any great dispersal. Another reason the brood stock in diving ducks is burned-out earlier is their tolerance of heavy hunter concentrations. Many of the river ducks tend to disperse and become more wary as hunting pressure increases; but on the breeding areas the redheads and canvasbacks do not retire as readily under crowded conditions. Again, there is a greater tendency for the diving ducks to foregather on the larger marshes, their concentrations drawing hunters to the favored loafing and feeding areas.

Let us study the sampled kill of redhead and canvasback on the Delta Marsh (Table I). Surveys conducted by Lyle K. Sowls indicated a redhead crop in the neighborhood of 750 young reaching flying stage at Delta. On the first day of shooting in the 1946 season, 149 redheads were *examined* in hunters' bags. Thus on the first day of shooting the number of redheads we *saw* in bags was one fifth the total production. Since the crippling loss accounted for as many birds again[1], and since not more than half the bags were sampled, we are safe in assuming that the total "take-home" bag was twice the examined bag and that with a 50:50 cripple ratio, the total kill on opening day was approximately 600 redheads. More than three fourths of local production were killed opening day. The total redhead kill for the season was approximately 2,650 birds or three and one half times the local production.

There is little reason to dwell on the same material for the canvasback. Local production was 500; one third that number was *seen* in the opening-day bag, while the approximate bag for the first day was 600 birds; more canvasbacks were shot opening day at Delta than were raised there. The total number of birds *seen* in bags was 1,430, or nearly four times local production. The approximate canvasback kill for the entire season was 5,720 birds or more than 11 times local production. All this is at the headwaters of the flyway at the beginning of a season that places these birds under 3 months more of hunting pressure, some of it as heavy or heavier.

This is local data, to be sure. But there are no data of the same kind from other marshes in the breeding range to deny that similar conditions exist elsewhere. The ever-increasing concentration of hunters in many parts of the land, and the tremendous increase of transient gunners on northern areas is a solid fact. More than 40 years ago Sanford (1903:125) wrote that many young redheads were killed near their nesting places in Minnesota, the Dakotas, and Montana where the redhead still bred commonly. Now, according to Williams (1944:251), "there are only a few areas in the United States where the redhead still breeds in appreciable numbers." The diagnosis is local, but the symptoms are country-wide.

What does this mean? It means that we must begin to change our ideas about the breeding grounds. It means that we must re-examine and test some of the so-called "basic concepts" of waterfowl management with new ideas and better techniques. Sometime (soon if we are wise) we must realize that we can't keep pulling ducks out of the north country forever, particularly with the northward surge of hunters that is developing so rapidly. We must realize that the duck breeding grounds of the Canadian prairies are not productive simply because they are *north;* these northern regions are productive now simply because they have not yet been *exploited* as have the areas farther south. And we must realize that there is a vast potential breeding area in the United States that could be brought into production.

What it all adds up to is this: we must save the populations of the north; we must build up populations in the southern and now largely unproductive portion of the range. Today we are doing neither. The marshlands of the north are being exploited; there is little effort to improve breeding conditions in southern areas. As long as we exploit, as long as we operate under the present plan, new marshes in the north (however vital and important they are in the over-all waterfowl program) cannot long delay the continued decline of waterfowl numbers.

This saving of seed stock and building up of the central breeding range is dependent upon a new type of waterfowl legislation. Neither the saving nor the building can take place unless we break sharply away from old methods and conceive a new plan for waterfowl regulations. What it amounts to is stepping from the time-worn plan of *restrictive* regulation to the modern plan for *constructive* regulation. Let us stop a minute to think about this!

Waterfowl regulations have never gone through any fundamental change in pattern. All we have been doing all these years has been chopping branches off the same old tree. A few years ago we tacked some of these branches back on, then hastily cut them off again. Now in 1947 we are right down to the bare stump of the old tree, with the stolid group of wildfowlers trying to stay the administrative ax from chopping off the last few twigs.

In the light of present waterfowl conditions we have but two moves to make: (1) Hack away at what is left by further reducing the bag and the season, and (2) cut the tree right down and start with a new plan.

The first move is the traditional one; the move of compromise with the future. But we need only glance at the record to realize that cutting regulations from an unsound plan gets us nowhere in the long run. We have cut the old regulation tree right down to its roots and still we are in trouble. The fundamental weakness of this old plan is that, while it limits the number of ducks one man can take at one place in one day, it places no restriction on the number of ducks that many men can take at one place in one day. Even if the bag is reduced to three or four birds, more can be killed on a given area than were produced. Regardless of how far bags are reduced, we are but momentarily delaying the burning-out of breeding populations.

The current plan is unsound at its very roots. Regardless of how far it reduces bags it still fosters a type of shooting that in many areas is more deadly than market shooting. Indeed, there is no fundamental difference between market hunting of old times and commercial camps of today. Whether it is a Better Business Bureau or a dude lodge, the only change is that now the birds are bought and sold on the wing (Buckingham, 1946).

If we continue to operate on this old plan; if we continue to govern only the individual's kill without some plan to limit the number killed by many men, then clearly the story of the past tells us that duck hunting is on the way out. In 20 years or so, perhaps earlier, the redhead will be gone; the canvasback will follow close behind; and the prairie marshes, regardless of how many there are, will be as duckless as the former breeding areas of the Central States. The picture of the future is mirrored in the record of the past. Bag tallies, such as ours at Delta, are only milestones that tell us how far we are along the way.

We will break away from the old plan, of course. It will not be easy to break away. Administrators are just as leary of breaking traditions as hunters. Nor will it be easy to conceive a new plan, for we do not have all the information at hand upon which to build a new plan. But one thing stands out as clearly as green bulrush in yellow prairie: *The new plan must protect the place and the bird at the same time.* The two are inseparable, albeit the duck is migratory. The *unit area* and the *unit population* must have equal protection. What does that mean in simple terms? It means that the new plan will discourage or even prevent the present concentration of fire power on marsh areas. In terms of *saving* birds it means that provinces or states or cities cannot longer exploit their native marshes to outside interests. In terms of *building* lost breeding marshes it means tight protection from guns until a breeding population is established, and controlled shooting thence forward. It means that shooters in areas which have held their marshes will have better shooting. It means that gunners in cities that have drained out their ducking areas will have to start making improvements in their respective bailiwicks. It means that the improvement of breeding conditions is just as important in the U.S.A. as in Canada. It means that states must take a far greater interest in their waterfowl populations than they do now. It means that we will have the same number of true wildfowlers, but far less "trigger-happy" duck hunters. It means that the old wildfowling traditions and ethics will again be dominant enough to regain their rightful place in waterfowl conservation. It means that eventually (probably very soon) waterfowl kill would be regulated by "incentive" controls as much as by restrictive measures—which is just another way of saying that there would be room for a man's conscience to operate again. It means, above all things that we will not be shooting more ducks on the Delta Marsh or on any other breeding area than were produced there. It will place waterfowling on an equitable basis with upland game-bird hunting. It might even save the redhead if the plan comes in time.

Such a plan that protects the place as well as the duck is by no means new; it simply is new to American waterfowl history. It already is being applied in the management of other marshlife, such as muskrats, and in many areas, such as Manitoba, has meant the difference between poverty and plenty for both rats and men. It would be the same for ducks, and wildfowlers would benefit the same as ducks. That waterfowl are migratory and rats are not, makes no difference in the need or benefits from such a plan.

Now? or later? that is the question. The change cannot be postponed much longer; we cannot much longer hold that a community does not have the same responsibilities to its waterfowl as it does to its muskrats.

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## DISCUSSION

CHAIRMAN TITUS: Well, Al told it to you. Who wants to ask a question?

MR. J. L. BAUGHMAN (Texas): Do I understand Mr. Hochbaum to say, or do you believe that under the plan outlined by you it will be possible to bring the ducks back to their former abundance in the northwestern provinces?

MR. HOCHBAUM: I know nothing about those areas. That is most of our shooting population now. All I believe is that such a plan could save what we have for the future.

MR. BAUGHMAN: May I say that 36 years ago, probably before many of you were interested in ducks, I lived in the area that Mr. Hochbaum is talking about. I am thoroughly familiar with Manitoba, Saskatchewan, and Alberta. I saw the ducks raised there. I saw that country when it was prairie country and when every clump of grass in that area and every pond was producing ducks by the thousands and by the millions. I saw the country go down. I saw these provinces plowed. I saw them changed from prairie land to plowed land where there were no ducks and no nesting ground. I wondered whether you thought it would be possible to restore that enormous duck population?

MR. HOCHBAUM: The first part of that—my answer in one way would be by saying that first before we do that we have to fill up the marshes that we already have. The breeding populations are far below the carrying capacity in most of the marshes of our area.

MR. BAUGHMAN: Mr. Hochbaum, you will pardon me for a minute. I am sincerely interested in this. Do you find in that area that the marshes are the principal carriers of the ducks?

MR. HOCHBAUM: The marsh areas, yes.

MR. BAUGHMAN: I was curious because it may be of interest to you to know that in the early days the marshes were not the chief carriers of the ducks. That is, what I consider the marsh. I don't know how familiar you were with that 36 years ago but at that time the prairie, the run-off on the prairie, which was still short grass country, filled those lakes and ponds and they held until July or late August. The ducks did not breed in the marshes to any great extent. They bred on the prairie, all over the prairie. You could kick them out almost anywhere within a quarter of a mile from these ponds. You would see one duck mother after another at the beginning of the breeding season headed for the ponds with the little fellows in a row, one behind the other, and when you walked up on them she would quack and they would all hide.

They were not at that time in the marshes. Do you think that the decline in ducks is attributable alone to the destruction of the marsh areas and the fall in the marsh population?

MR. HOCHBAUM: I believe it is the destruction of a great many small areas you speak of, yes.

MR. BAUGHMAN: They were not marshes, though.

MR. HOCHBAUM: When they come back with wet springs that is where we find a great number of our river ducks but the diving ducks are in a large measure in the marsh areas.

MR. BAUGHMAN: I am speaking of mallard, chiefly, and pintail ,bluewing and that type of duck. I was just curious.

MRS. C. N. EDGE (New York): Mr. Hochbaum spoke of commercial shooting and commercial areas.

MR. HOCHBAUM: That is simply instead of having their own equipment on the marsh, they go to a man who provides it for you at anywhere from 8 to 25 or 30 dollars a day. It also means instead of a small number of people using an area, a large number of people can come and shoot without any responsibility of ownership of themselves for the land.

MR. H. B. HICKMAN (Louisiana): I think you were being modest when you said there was one duck. I would say out of every three ducks there is probably one that is kept. We have been trying to promote everybody to get a retrieving dog. I think that is the best thing that could happen to this counry. If all the camps had retrieving dogs, we would save thousands and thousands of ducks every year.

SENATOR F. C. WALCOTT (Connecticut): I was up there the last week in September and I was there 3 years ago about the same time. I am shocked at the duck population. I heard shooting all around and I told Albert Hochbaum that it was shocking, that I was perfectly astonished at the amount of killing. I think it was the first day of the season or the second or third day and the shooting was like the Battle of the Marne. They would shoot at ducks flying well out of range and leaving some lead in them. That poisoning was probably a serious factor afterwards, but I tell you that every word in Albert Hochbaum's paper is absolutely true.

MR. HOCHBAUM: I want to make one thing clear, that what I have spoken about is something very new and which, I am sorry to say, has come into my country, my region in Canada, not from Canada but from this side of the line. I speak of something that is happening in Canada that is brought in there from the outside.

MR. GEORGE A. MONTGOMERY (Kansas): How many years have they been coming from this side of the line to Canada?

MR. HOCHBAUM: In our area, this crowding-in started about 1940 or 1941 and it has grown steadily ever since. It is not a local condition. It is something that is happening in many areas all over the country, but it just really dates back to 1940.

MR. JOSEPH HOGAN (Arkansas): How do you propose to allocate the number of ducks to every hunter so that every season one man will get so many?

MR. HOCHBAUM: How are these ducks to be rationed? In proposing a change, I can't in a short period give an answer that should have taken years of study. We should have been working on it to have the answer to meet this crisis right now. It isn't right. It isn't fair for hunters all over the country to concentrate on some one area. Perhaps by some regional control we can do it.

We have found at Delta that the farther the hunter comes, the less is his responsibility so that when men come from far away they have no responsibility. They leave the islands like hogpens, littered with trash so that not even a bird would nest there. How that can be rationed I don't know, but it has been done with other marsh lakes.

CHAIRMAN TITUS: The Chair will accept one more question from the floor on this paper now.

MR. H. L. SIMM: (Alabama): According to scientific theory, do you mean to say that ducks were burned-out and they could not return to their breeding ground while the G.I. was in the service and there was a shortage of ammunition, which developed the shortage of ducks during the past season; that we must go out and change the theory that the ducks through generations return to their breeding grounds, and that we must develop new breeding grounds and go into a new scientific theory?

MR. HOCHBAUM: To answer the first part of your question, the decline began in 1944, perhaps in 1943. The second part, if we don't, we can't look at some of our old concepts with new scientific methods and find new things, then we are not progressing.

# WILDFOWLING IS NOT NECESSARILY ON THE WAY OUT

JOHN H. BAKER
*President, National Audubon Society, New York, New York*

In his address this morning Dr. Lewis of Canada concluded with a phrase that seems to me very apt. He said, "duck hunting will soon encompass its own destruction." I think that is true. Perhaps, no man has ever put more truth in fewer words—unless Calvin Coolidge when he said, "I do not choose to run."

What is the question that you and I run into everywhere we go this winter? Where are the ducks? *Where* are the ducks? Well, it seems they must be everywhere except where the local questioner has been; somewhere in the North, or the South, or the Atlantic or the Pacific! I will venture to answer that question "Where are the ducks?" They are dead—dead as doornails, no matter from what cause.

Now, no matter how successful the waterfowl restoration progress, there can never be unlimited hunting opportunity. No matter how continuous closed seasons, there can never be unlimited ducks. At intervals, combinations of favorable circumstances bring about cyclical peaks of waterfowl abundance, and combinations of unfavorable circumstances bring about cyclical valleys, or bottoms. These are bound to occur in spite of man's best efforts in the control of habitat or deliberate take. The waterfowl population ceiling is set by the carrying capacity of the breeding or wintering grounds, whichever is smaller—whichever is *smaller*. Hunting pressure cannot raise the ceiling, but can appreciably lower the floor.

It, therefore, seems to me to follow logically that knowing the exact total number of waterfowl is not so important as sure knowledge of the trend. It is the trend of population that is vital in the consideration of proper hunting regulations. If we know that the trend is up, our conception of sound hunting regulations is far different from that when the trend is known to be down, even though the population figure and the volume of hunting pressure be the same. The rub comes in picking the top of the upswing and the bottom of the downswing and, unless science can prove that the duration of the waterfowl population cycle is always the same, or has a regular rhythm, picking the top and bottom of the trend will inevitably remain in the same scientific category as selling at the top and buying at the bottom of the stock market. Did any of you ever try that? If you did, I think you will agree that criticizing the regulating agency for failing to call the turn would be rather naive.

If we were able to decide upon and maintain the waterfowl hunting regulations solely on the basis of known facts as to trend of numbers and volume of hunting pressure, we might succeed in removing hunting as a serious threat to waterfowl survival on this continent and, incidentally, make it possible to perpetuate the sport of wildfowling. However, political and economic, as well as biological considerations, are normally taken into account.

Are the hunters, the guides and boatmen, the manufacturers of equipment, guns and ammunition, and the labor in their plants prepared to back regulations based strictly on supply and demand? That would mean frequent extreme fluctuations in opportunity, jobs and volume of business. Are the state fish and game or conservation departments, which derive so much of their revenue from the annual sale of hunting licenses, prepared to back such strictly biological basis? Are the farmers, whose crops are damaged by waterfowl, going to agree as to the desirable number the regulating agency should seek to maintain? If not, they are going to make their views known through their congressmen, some of whom will get on the neck of the regulating agency. Will that agency be willing to back such strictly biological basis if it means foregoing some $2,000,000 of refuge acquisition and maintenance money a year, in the absence of duck stamp sales during closed seasons?

In the last analysis, the answer lies in whether or not these elements in our 140,000,000 population are more interested in "getting theirs while they can" or in limiting present take to assure future supply. It is the same old basic difficulty that slows down conservation progress in all natural resource fields. Opposition to conservation is rooted in two dominant characteristics of human nature—fear and greed. We're not going to change human nature, but we can convince people that it is to their selfish interest to conserve. The present drastic decline in ducks, seemingly bringing the continental population below the bottom of the previous cycle in 1934-5, forces those who have striven in recent years to successfully manage and harvest our waterfowl to admit that they have not succeeded. New times call for the application of new methods and new ideas. They call for an upsurgence of sentiment on the part of wildfowlers to back the wisest and most practical policy in their selfish interest.

Wildfowling is not necessarily on the way out, but the adoption and support of a hunting regulation policy based on the facts of life and needs of the waterfowl, rather than the desires of those exploiting them, would seem requisite to its survival.

DISCUSSION

MR. KORNFIELD (Texas): All the speakers talked about the hundreds of hunters throwing thousands of pounds of shot and putting the ducks under tremendous fire power and that there are too many hunters for the ducks to stand such tremendous fire power very much longer. The gentleman from Shreveport suggested that everybody hunt with a dog, which would be a wonderful thing, and I will go further and suggest that everybody hunt with a single-barrel gun so they will have but one shot.

MR. FRANK C. ALLEN (Texas): I would like to know if there ever has been anything done regarding production of ducks on an artificial basis for the duck population?

MR. BAKER: The question is, has anything been done by way of artificial production of ducks? Is that right?

MR. ALLEN: Yes.

MR. BAKER: I think it would be far more suitable if Dr. Cottam here would answer that question. I have had no personal experience with such artificial production.

DR. CLARENCE COTTAM (Illinois): My answer is yes. There have been many attempts at artificial production of ducks and nature convinces us that her ways are better. Natural reproduction is infinitely better and more successful than artificial production of ducks so far. Mallards, for example, are easily raised in captivity. When they are released, they come back to the barnyard and are domestic. It has been utterly unsuccessful to date. The other specie' don't take to captivity.

# WATERFOWL AT THE CROSSROADS

CLARENCE COTTAM
*Assistant Director, Fish and Wildlife Service, Chicago, Illinois*

America is great because her resources are great. Her security and future progress are possible only so long as these resources remain solvent.

Migatory waterfowl constitute one of the more important renewable resources. This resource has been estimated as representing a capitalized investment of 1½ billion dollars. The expenditure in harvesting the annual waterfowl surplus aggregates at least 300 million dollars yearly. This estimate, based upon expenditures for licenses, guns, ammunition, clothing, transportation, lodging, and numerous associated incidentals, was made 2 years ago. Today, it should be increased considerably because of the much greater number of hunters in the field and the higher costs of living. Of direct economic value are the millions of ducks and geese taken annually representing many more millions of pounds of choice red meat.

Great as are these economic values, the aesthetic or spiritual and recreational values of our waterfowl probably represent the greatest worth of the resource. Values which are reflected in better health, better citizenship, and more abundant living cannot be computed on a dollar and cents basis; yet these values are just as real as bank notes or stocks and bonds. America would not be the same without them.

It is highly desirable that responsible citizens, wildlife administrators, managers, technicians, and research men all meet to consider the welfare of this valuable continental resource; to speak frankly of its present condition, its requirements and its future prospects. From the facts at hand it is apparent that we have reached the crossroads. Upon our judgment and action, largely rests the fate of America's migratory waterfowl. We are greatly indebted, therefore, to Dr. Gabrielson and the Wildlife Management Institute for calling and sponsoring this meeting, so that an objective appraisal of the waterfowl situation can be made known to the people.

*Sources of data regarding our waterfowl.*—Before relating the facts of our present waterfowl conditions, it would seem well first to bring to your attention the ways and means by which the U. S. Fish and Wildlife Service is recording the pulse of this resource. To anyone who knows duck and goose habits, the problem of determining the status of their populations will be recognized at once as most difficult. The birds are on the wing during most of the year. They are stationary only during the comparatively short breeding and wintering periods. While obstacles are many in checking the birds at all seasons, we make every effort to keep currently informed by drawing upon the following sources and methods:

1. Annual inventory of all the major wintering grounds and of a large percentage of the less important areas. This inventory, which is not to be considered as an inerrant census, is taken by more than 1,000 observers, as competent as we can find. The observer corps is made up of persons who know bird habits and who are drawn from federal and state organizations, colleges and ornithological clubs. Many of them have participated in these inventories for a long period of years covering the same sections of the country. Better than anyone else, therefore, they know where the birds are to be found in their sections and what fluctuations have occurred; consequently, the data they submit have great comparative value from year to year. The corps is organized by U. S. Game Management Agents who are relied upon to know where the birds are located in their respective regions. Observers travel afoot and also make use of boats, airplanes, and automobiles in covering different areas. With time, will come greater and greater coverage that is made possible through the use of airplanes. We have excellent cooperation from the Army, Navy, and Coast Guard who have made their planes available for the survey. In addi-

tion, state conservation commissions, private organizations and individuals have furnished air coverage.

The inventory is made during January each year at a time when the ducks and geese are most likely to be settled for the winter and are more concentrated because the wintering areas available to the birds are more limited in extent than during the fall flight. The figures which result from this operation should *not* be regarded as accurate-to-the-last-figure counts. Few wild animal inventories are perfect. Instead, the survey reflects trends in the populations at a time when the closest approach to a total count is possible. The Service recognizes many of the faults of the inventory as a sampling method and is attempting to improve the techniques and organizations involved. We feel, however, that it is the best method so far developed to determine population trends on a nation-wide or continental scale and until some better means of getting satisfactory management information is worked out we shall have to rely upon it.

2. Another means of gaining management data about waterfowl revolves around the Fish and Wildlife Service flyway biologists. We now have six of these experienced men following the birds constantly from the northern breeding grounds to the wintering areas in the United States and, when possible, to the countries south of our border. They accomplish their objectives by means of cars, boats, and airplanes. Two Service planes, now assigned to these men, enable them to keep in closer contact with the birds along the migratory routes. From the activities of the flyway biologists and their cooperators, the Service receives a constant flow of essential data about the condition of the breeding grounds, productivity, flights, sex ratios, hunting success and other factors that are important to the welfare of the birds.

3. Some 180 waterfowl refuges (in the aggregate, more than 3½ million acres of marsh and waterfowl habitat) are managed by the Fish and Wildlife Service. On these refuges the managers, technicians, and research workers keep accurate records on waterfowl and their numbers, their movements and their habitat requirements. We estimate that about one fifth of the ducks wintering in the United States, or in the land south of our boundary, find food and sanctuary on these refuges and managed areas during a part of each year. From these refuge areas flows an abundance of valuable management information.

4. Some 70 game-management agents or law-enforcement officers are employed by the Fish and Wildlife Service. These men are full-time employees who cooperate with state wardens for the protection of the birds. Each man has a circumscribed territory and is intimately

acquainted with the principal waterfowl concentration areas within his district. Each of these men has a large number of helpers from whom he obtains additional data. The Service's other field employees in other lines of activity also supply information on waterfowl abundance.

5. Numerous cooperators supply the Fish and Wildlife Service with invaluable assistance in checking over-all waterfowl numbers and conditions. The following are particularly worthy of mention: state fish and game departments, Canadian and Alaskan conservation agencies, American Waterfowl Committee, The Wildlife Management Institute, The Illinois Natural History Survey, Ducks Unlimited, colleges and universities, especially those having schools in wildlife management, other agencies of the Federal Government including the Army, Navy, Coast Guard, Bureau of Land Management, and the Park, Forest, Soil Conservation and Indian Services. All of these have effectively cooperated with us and in the future we hope to expand this source of our information. In addition it would be amiss not to mention the help received from game clubs and wildlife federations. These organizations are beginning to employ waterfowl biologists to get practical management data. For their benefit as well as ours we hope the trend in this direction will continue.

From the above it may be seen that the Service is constantly obtaining authentic information, even though admittedly incomplete, on the condition, abundance, and distribution of waterfowl.

*Appraisal of present waterfowl populations.*—Let us now take a look at a sample of the information which has been coming to the Service about waterfowl since the time of the last breeding season. The picture generally is not a bright one largely because of drought conditions on the nesting grounds and overshooting during the past few years. All of the reports from the principal breeding grounds in Canada were of much the same tone. No recent reports were received from this important section that indicated conditions were on the upgrade.

From the Canadian Atlantic came this statement from our flyway biologist: "A summary of my findings during 1946 indicates a decrease of approximately 20 to 25 per cent in the nesting duck populations in New Brunswick, Prince Edwards Island and southern Quebec from numbers present in 1945." A flyway biologist in Manitoba writes: "We have covered much additional territory, areas that were heavy duck producers in 1942 and '43 even 1945, but the story is the same everywhere, greatly reduced populations in some marshes and pot-holes that look ideal but have no ducks at all." From Saskatchewan breeding areas: "I hate to be constant bearer of bad news but that is all I have to report. The duck situation in southsrn Saskatchewan is bad. Although surface water is at a premium there are more water areas than there are ducks to use them. There are local areas where water conditions are excellent but these support only normal numbers of waterfowl whereas one might think that the ducks would be crowded into places having good water levels.'' In central Alberta: ''The waterfowl situation is slightly better than in the other provinces, but for the province as a whole the population is down. The entire southern part is dry and there aren't enough ducks up here to make up the difference.''

Those are reports from flyway biologists but they are substantiated by the findings of other reliable observers. Mr. H. Albert Hochbaum, director of the Delta Waterfowl Research Station in Manitoba, has reported that there was a decrease in mallard, pintail, blue-winged teal, redhead and lesser scaup, and that the gadwall, baldpate, green-winged teal, shoveller, canvasback, and goldeneye were about the same as last year. An increase was recorded for no species. ''The breeding population is the lowest at Delta since the middle 1930's. It is considerably smaller than it was in 1938. Individual water areas we have checked from year to year are greatly reduced in the number of birds they carried this year . . . the marsh has never been so seriously underpopulated. Considering the fact that the total breeding area is greatly reduced and that the remaining waters are underpopulated, it is clear that duck production in the Delta region will be the poorest in years.'' Then from J. Dewey Soper, Dominion Wildlife Officer for the Prairie Provinces of Canada, come these comments. ''. . . over an enormous territory in southern Saskatchewan and Alberta the situation could not be any worse in respect to ducks. One can drive hundreds of miles without seeing any water or ducks, whatever, except the P.F.R.A. projects where water has been successfully stored and conserved.'' In Manitoba: ''On the whole, I have found conditions in various parts of the province ranging from only fair to poor. An occasional area was observed that supported a normal population of waterfowl.'' In Saskatchewan: ''I consider the waterfowl situation far from encouraging. In fact, it has deteriorated alarmingly. Parts of the prairies are in very good shape with many sloughs holding a good supply of water and attractive to duck populations but against this are enormous areas in Saskatchewan and Alberta where drought has brought havoc with sloughs dried up . . . The majority of the lakes are practically in the same category. I doubt if there is an average of one slough with water today where formerly 200 existed. As a matter of fact large areas are completely destitute of surface water.'' From Alberta: ''In general cruising about the country the sight of duck, or other waterbirds, was a rarity. In view of the scarcity of water, one would naturally expect a notable concentration of ducks in such areas as were favored by a good water supply. This, however, was not the case. One was either impressed by the apparent fact that the areas concerned supported no more than a normal complement of birds, or worse—that the waters were strangely underpopulated . . ." In summary, Mr. Soper has stated that "The surface water and duck conditions are extremely poor over a tremendous area of the Great Plains Region over a southern territory of at least 60 million acres. The situation is nearly as serious as it could well be. . . . over most of this area there has been a wholesale drying up of sloughs and pot-holes until the loss is now nearly 100 per cent. Naturally this applies to the duck aggregate also."

The above quotations, from reliable and experienced men actively engaged in appraising the conditions for breeding waterfowl, cannot be discounted. They all add up to the fact that waterfowl populations on the breeding grounds got off to a very bad start. The production was much below par and thus it was inevitable that the flight south over most of the continent would reflect this setback at the source. Such was the prediction of the observers on the breeding grounds last season. Information which came to the Service during the fall migrations and during the hunting season substantiates these convictions. Let me quote briefly excerpts of the reports to give a general tone of the waterfowl flight south:

Michigan: "This has been the warmest hunting season we have experienced and while we had no cold weather to influence the birds we did not have any birds to influence."

Maryland: "Figures are 75 per cent below normal." "Excellent feed; few ducks."

Alabama (Mobile Bay): "Comparing numbers of waterfowl present at this period last season there is a decrease of about 25 per cent."

North Carolina: "Most of the hunters are leaving Currituck Sound as there are not enough game there to justify hunting."

New York: "To say that ducks are scarce is to put the situation mildly."

Kansas: "Much water, very few ducks."

Louisiana: "Ducks are especially scarce in north and central Louisiana with only a moderate concentration in southwestern Louisiana."

North Atlantic Coast: "The usually heavy migration did not occur."

Minnesota: "There are not the number of ducks apparent in the the state that I have seen in former years."

Georgia: "25 per cent decrease in waterfowl as compared with last year. Savannah and Okefenokee Refuge report show normal population of waterfowl."

We have had many letters from all sections of the country describing the serious waterfowl situation that exists and indicating a marked decrease during the past year. The reports of normal or increased populations are relatively few. The latter do occur, however, scattered at more favorable locations across the country. They are more frequently found in Nebraska and the Pacific and Intermountain States and it is my understanding that Ducks Unlimited has reported excellent nesting conditions in parts of the Parklands and in the far north. Parts of Alaska also seemed to have normal waterfowl populations. Nevertheless, after completing the review of all the fall reports received one can but conclude that this year the bright spots for hunting and above par populations were few and far between and that they did not appreciably alter the situation which breeding ground appraisals predicted.

*Reasons for our waterfowl shortage.*—Many factors have contributed to the decline in the waterfowl populations. Some of these factors are of long standing; their effects have simply become more noticeable as the supply of birds diminished. Two factors are the principal immediate causes of the present alarming shortage of ducks and geese. These are overshooting and unfavorable climatic conditions, particularly drought on the breeding grounds. The one factor—adverse weather, especially drought—reduces the population at its source; the other—overshooting—gets the birds which are left to fly south in the fall. While both of these factors, to a degree, lend themselves to correction by intelligent, forthright action, hunting pressure is the only major factor over which man may exercise any pronounced, immediate control. If wildfowling is to continue we must regulate the take to below the season's increase. It must always be remembered that so long as the duck population trend is noticeably downward, any appreciable kill by the gun must be regarded as overshooting. Despite the apparent decline in the waterfowl population, the total kill has progressively increased during the past 3 years because of the progressive increase in the number of hunters afield. Even with the generally unsatisfactory hunting season just passed available data indicates that the total kill has been staggering because of the great army of hunters. The following table gives a concise picture of events pertaining to waterfowl populations and the take.

STATISTICAL DATA REGARDING WATERFOWL

| Hunting year | Duck stamps sold | Excise tax on arms, ammunition | Waterfowl bagged[1] | Waterfowl after hunting[1] | Duck bag, possession limits | Length of season |
|---|---|---|---|---|---|---|
| 1942 | 1,380,222 | 1,149,332 | 16 million | 120 million | 10—20 | 70 days |
| 1943 | 1,169,352 | 1,061,044 | 12 " | 125 " | 10—20 | 70 " |
| 1944 | 1,487,029 | 3,132,402 | 20 " | 105 " | 10—20/5 | 80 " |
| 1945 | 1,725,505 | 5,232,464 | 26 " | 80 " | 10—20 | 80 " |
| 1946 | 2,000,000[1] | | | | 7—14 | 45 " |

[1]Estimated

We do not yet know exactly how many Duck Stamps were sold during 1946, but judging from a 20 per cent increase in the sale of all hunting licenses sold by the states we are confident that the stamp sale will approach, if not exceed, 2 million. If so, this will represent an increase of not less than 16 per cent over 1945. The hunting pressure is now more than three times that of 1935, and more than 70 per cent greater than that of 1943. The figures presented on the number of waterfowl bagged were determined by compilation of data collected from the various state game departments and Federal Game Management Agents. The figures for the various years listed for the number of waterfowl remaining after the hunting seasons, were obtained in the January waterfowl inventories.

Data are now being compiled from the "score cards" that were designed by the Service and published widely in state and sporting magazines. Supplementary information also is being compiled from the reports of our fieldmen resulting from personal contacts with the hunters themselves. These data represent information obtained directly from several thousand hunters of all classes. The detailed results of this study will be made public by the Service at a later date. At present, however, it may be stated that the preliminary study indicates an alarmingly heavy kill of ducks during the past season. It seems obvious that this was much greater than any of us anticipated would be the case and that it probably exceeded that of 1945. While we all know that duck hunting generally was poor over most of the country, it also appears true that the greatly increased hunting pressure resulted in a very high kill.

I should like to say at this point that our Vice-Chairman, my friend Frank C. Bellrose, Jr., felt that he has data that does not support that conclusion and from the bottom of my heart I hope he is right. He does not feel that the ducks killed this year are anywhere near as serious as the situation was a year ago. The incomplete data we have seems to me to indicate that the kill was just as bad as it was a year ago. Our data are just coming in and perhaps in another week or two, we will have more specific data in regards to this.

As would be expected there was a vast difference in the take in different sections of the country. Based upon about 1,000 hunter reports from 16 of the Northern States, Nebraska hunters were the most successful. The average hunter, reporting from that state, went afield 11 times, bagging 2.24 ducks each time with a total of 24.64 birds for the season. In contrast, Pennsylvania hunters had the poorest success with an average daily bag of only 0.35 and a total bag for the season of 2.87 ducks per hunter.

Hunting is permitted on parts of seven of our federal waterfowl refuges. This is possible because of provisions of Acts of Congress or from circumstances under which the refuges were acquired. On these seven refuges (Bear River, Utah; Bowdoin and Medicine Lakes, Montana; Ruby Lake, Nevada; Tule and Lower Klamath Lakes, California; and Mattamuskeet, North Carolina), the average number of ducks taken in 1946 per man-day, decreased a little in every case, yet there was a startling increase in the total take. In 1945 the average bag was 4.7 while in 1946 it was 4.2 ducks. Grouped together, 15,878 hunters bagged 75,381 waterfowl in 1945. In 1946, however, the number of hunters on these same areas increased to 32,081 and their total bag rose to 138,071. Thus, the hunting pressure more than doubled and the total take increased 83 per cent in these favored managed areas despite a lowered average daily hunter bag.

A serious and very important factor associated with the harvest of waterfowl is the crippling loss which we know is high. Incomplete data indicate that about one bird out of every seven that are shot and drop in the marsh or water area is *not* retrieved. This, of course, does not include the great number of birds that sustain body wounds but which continue their flight. One of the major problems confronting conservationists is elimination of the waste that results from crippled and unretrieved birds.

More discriminating and sportsmanlike hunting, shooting only when the birds are within range, using a retriever, and otherwise making greater effort to retrieve the birds, will go a long way in eliminating this unnecessary waste.

No one knows the extent of the mortality of those birds that receive body wounds during a hunt, but which continue their flight. We suspect it may be serious as evidence indicates that the number or per cent of birds receiving body wounds is much higher than has previously been thought.

The Illinois Natural History Survey in cooperation with the U.S. Fish and Wildlife Service began a study of the incidence of lead in apparently healthy ducks trapped on the Spring Lake Refuge near Savannah, Illinois. By means of x-ray, it was learned that 39 per cent of 181 ducks examined carried lead shot in them. In future years we shall keep some of these leaded-birds in captivity to learn something of their length of life. As high as 57 per cent of the leaded ducks had one shot only, and from that point the level of shot incidence scaled down to 4 per cent carrying six pellets.

A drought that is so severe as to wipe out or noticeably impair or constrict hundreds of square miles of choice breeding habitat of ducks and geese obviously is a major factor reducing the total waterfowl population. While man has no means whatever of controlling drought he can by proper planning and management insure a minimum water and marsh habitat on the breeding grounds. He can build reservoirs, pools, and pot-holes in many of the favored breeding areas and maintain at least a minimum of nesting, brooding, and feeding habitat. He can prevent unnecessary wasteful, and destructive drainage that destroys wildlife habitat and lowers ground water levels. While the results of improved marsh management may not be immediately noticeable, the benefits from it will be proportionate to the extent of such management.

Unfavorable climatic conditions act in a number of ways to reduce the production of a breeding ground. A general hailstorm can destroy in a very short space of time the potential production over a wide area, such as happened to Canada goose breeding flocks in 1945 in parts of the Intermountain area. Continual precipitation during the egg laying and incubation periods is often reflected in a high rate of desertion. Floods caused by cloudbursts have wiped out nesting grounds along rivers, lakes and marshes. These are a few of the ways in which weather can reduce the hatch. In 1944, the drought on the Canadian breeding grounds was noted; in 1945, it grew worse and we began to recognize its extent and its influence; in 1946, it grew progressively more serious and caused an alarming reduction in the continental waterfowl population.

Many of us have assumed that just as long as we sent a sizable duck population north in the spring we could bank on getting a satisfactory return of juveniles and adults in the fall. Our breeding-ground studies are indicating, however, that if the birds do not find their breeding grounds habitable they are not likely to go an appreciable distance elsewhere to lay their eggs. Rather, the tendency seems to be for females to dump their eggs promiscuously. This may account for the observations last summer that no concentrations of breeding birds were found on areas which still held a fair environment. It may account also for only the usual or normal numbers of waterfowl breeding on areas where water levels have been assured by the activities of the Fish and Wildlife Service, Provincial Canadian Governments and Ducks Unlimited. Reports from these areas may be satisfactory but not reflect the widespread trend.

It is perhaps significant that our refuge data indicates a 12 per cent decrease in the total number of waterfowl using the refuges during the fall migration from 1942 to 1945. Because of habitat development and favorable water levels it was to be expected that the decline on the refuges would be very much less than that throughout the country generally.

The extensive program of reclamation and drainage, I believe, is the most important of those factors of long standing that have brought a more or less gradual decline in the continental waterfowl population. This has destroyed much of the former nesting habitat in Canada as well as in the United States. By 1920, 100,000,000 acres of American marsh, lake and pond area had been drained in the interest of agricultural activities, which too frequently were unprofitable thereafter, and unfortunately, this destruction has continued although at a reduced pace. It is significant to report that America now has approximately 87,000,000 acres of agricultural land in organized drainage districts and, in addition, nearly 45,000,000 acres in unorganized drainage enterprises. A similar trend is recognized in Canada. Dr. Harrison F. Lewis, Superintendent of Wildlife Protection in Canada, has referred to the spread of agriculture, drainage, cultivation and pasturage in Canada as markedly reducing the waterfowl breeding habitats available to the birds.

Predation, especially in the breeding grounds, always takes a toll. Under primitive conditions a point was undoubtedly reached where there was a balance between predators and waterfowl populations; and predators and other natural mortality factors tended to place the waterfowl population at a fairly stable level. But with man stepping into the picture to drain and reclaim nesting grounds, the waterfowl have been pushed into using constricted and less favorable habitats for production and have, therefore, greatly diminished in numbers. The toll taken by predators now is probably not as great as in former times but it may have a greater end effect on the smaller duck population.

Disease is another source of loss among our waterfowl. Botulism, or western duck sickness or food poisoning, causes widespread annual losses. Annually great numbers of ducks succumb to the malady, especially in the Rocky Mountain and Central States and in the Prairie Provinces of Canada. Almost a million birds were reported to have died from this disease in the summer and fall of 1910 and again in 1913 in the Great Salt Lake Valley of Utah. A year ago, within less than a week, botulism caused the death of approximately

50,000 ducks in one relatively small area south of the Bear River National Wildlife Refuge in northern Utah. In the late summer and fall of 1941 one 5,000-acre lake in North Dakota annually producing some 4,000 to 6,000 ducks sustained a loss of 70 to 80 thousand ducks. Obviously, these were largely migrants. Much study has been given to this disease. Progress is being made in the control of the malady where water levels can be manipulated, but much remains to be discovered regarding it. Support of research, I believe, offers the only possible means of finding a satisfactory solution to this complex problem.

Lead poisoning caused by the ingestion of shotgun pellets is a mortality factor whose importance is being recognized more and more with the accumulation of information. The poisoning is becoming a more serious problem with the trend toward concentration of our birds into limited areas. As yet we do not have a measure of the extent of the mortality from this cause, but a program is being drafted to get concrete information about it. A few studies have been carried out to determine the distribution of pellets in shot-over marshes and to learn of the incidence of lead shot in gizzards of waterfowl in local areas, but no attempt has been made to appraise the factor on a flyway or national basis. This is a definite need as is also the the continuation of studies aimed at developing a pellet which will disintegrate in water.

*What can we do about our diminished waterfowl populations?*—The first requisite for improving our waterfowl resources must be the assembling of information that will be as complete and reliable as possible. Because of the wide distribution of our waterfowl and the variety of habitats and circumstances under which the birds are found, adequate handling of the problem requires a larger staff of waterfowl biologists and several more aircraft. We feel that the problem of appraising waterfowl conditions justifies and demands that the United States provides at least two flyway biologists in each of our four major waterfowl flyways and at least three biologists in each of our five regions. Their objectives would be to determine waterfowl requirements and how to provide them. The additional planes are essential to carry on work in the far northern sections where the abundance of water areas requires the use of pontoons or flying boats. In addition, proper handling of the resource also requires careful cooperation from all interested persons and organizations. The stafl of the Fish and Wildlife Service will never, and should never, be large enough to do the entire job alone. It should have help in securing the following types of data:

1. Information on waterfowl conditions and abundance. This will

require a corps of trained, qualified, and interested observers such as may be found in most state game departments and at many colleges, research institutions, and museums. These observers, reporting on waterfowl in their respective areas, will submit data on a systematic, standardized and continuous basis so that records will be comparable from year to year and will be as complete as possible. To encourage this standardization of activity, the Service plans to issue to all cooperators a mimeographed leaflet entitled "Waterfowl News," which will keep cooperators currently informed about what others are doing and will emphasize topics needing attention.

2. Information about waterfowl banded on principal breeding areas and trapped on selected wintering and migration areas. Such information is essential to determine hunting pressure, to measure the population turn-over, to break down migration by age, sex, and species. These data will more accurately delineate the flyways and reflect the effects of refuges and sanctuaries. It is hoped that funds will be available to permit the Service to maintain a few organized banding cooperators—perhaps both graduate students and professional men during the summers for work on the breeding grounds.

3. More accurate information on kill. Cooperation from hunters, the unsuccessful as well as the successful, is required to obtain workable figures of the harvest by gunfire. This is an important figure, especially when correlated with the total numbers of waterfowl at the beginning and end of the hunting season. State game departments should emphasize to the hunters of their states the importance of keeping close records of their gunning success.

Another major requirement for the correction of the present waterfowl situation is the development of more widely distributed wintering grounds. In numbers, total acreage, and distribution, our present system of wintering refuges and shooting areas is inadequate. Shortage of wintering habitat, like the decrease in favorable breeding grounds, has a limiting effect upon waterfowl distribution and will just as surely limit the bird populations. Perhaps the majority of the new areas should be state-managed. I believe the states could administer a system of small areas as well or better than the Federal Service. An effort should be made to re-establish waterfowl use of newly-developed areas on which they are absent. This can be done by developing abundant food supply and possibly even by transplanting waterfowl. This service stands ready to assist in such undertakings. It is important that ducks and geese be more widely dispersed in order to avoid heavy kills that can develop around a refuge and to provide more equitable shooting. More emphasis should be placed on the development of public shooting areas as well as inviolate-sanctuary units. The objective should be to scatter the birds, prevent excessive local slaughter at private and commercial clubs and thus equalize the shooting.

As a means of developing more waterfowl habitat, wildlife interests generally and the state game departments in particular should be alert to secure the maximum use of water-development projects especially those developed as flood-control, irrigation, and hydroelectric-power projects. Whether we like them or not, many of these projects—possibly too many of them—are going to be approved. If we are vigilant, however, through recourse to the Coordination Act, wildlife interests will be given a fair share of consideration in their development.

Efforts at marsh and waterfowl restoration should be encouraged. During the past 12 or 13 years the Fish and Wildlife Service has spent approximately 20 million dollars in acquiring and restoring some 3½ million acres of waterfowl habitat—and this in areas of greatest strategic importance. We need to expand this system. The Canadian Government, through its Prairie Farms Rehabilitation Administration, has built more than 5,500 dams, many of which are now important waterfowl areas; it has completed more than 20,000 water-restoration projects (inclusive of dug-outs). Ducks Unlimited on its 184 or so projects also has contributed toward improvement of nesting grounds. If our waterfowl are to survive the drought periods which are bound to come in the future, as they have in the past, it behooves us to do as much as we can toward stabilizing water levels in the more important breeding sections of the continent. All agencies concerned should take an active part in such a program. The losses from drought cannot be entirely curbed, but they can be minimized.

The enforcement of laws and regulations designed to give protection to waterfowl and to control the annual kill of these birds is highly important. While other factors play an essential part in keeping up the desired population of waterfowl, protection from excessive killing will always be one of the most important and practical means of maintaining this valuable resource. Experience with waterfowl clearly indicates that it is necessary to apply such restrictions on the taking of this game as will insure it a reasonable annual increase.

In addition to controlling the annual take of waterfowl by the law-abiding hunters, it is important to check illicit killing and traffic in these game species.

To be effective, the laws and regulations enacted to accomplish these purposes must be enforced. The only way that adequate observance of restrictions on the annual take of waterfowl can be brought about is, first, through their efficient enforcement, and second, through education of the public as to the desirability of refraining from destroying more than is warranted by the condition of the stock.

A larger force of Game Management Agents is needed than is now possible to employ with funds available to the Fish and Wildlife Service for this purpose. These agents enforce the waterfowl hunting regulations as well as do many other things in waterfowl management. The various state game departments render very valuable assistance, but at least twice as many more U. S. Game Management Agents are needed to properly take care of many situations that are not adequately handled by State Law Enforcement officers.

Most sportsmen are in favor of conservation—for the other fellows; the average nimrod, however, rarely is willing to accept curtailments affecting his own shooting. Too many states favor restrictions in other sections of the country and condemn vigorously those hitting close to home. But if America is to continue to reap the economic, social, and recreational benefits of wildfowling, we must support reasonable restrictions when they are necessary to insure adequate breeding stocks of birds; we must limit the annual harvest to the increment of increase. Perhaps this will entail a partial temporary closure of a state, section, or flyway, as was done for the honkers in the Mississippi flyway during the past season. In times of poor production and especially where there is a marked increase in hunting pressure, there must be curtailment.

We cannot predict what the regulations for the next season (1947) will be until next summer after the nesting season is largely past and those data have been analyzed in connection with the midwinter inventory, reports from our refuges, and facts and figures from all other sources of information. Then, after the recommendations of state game departments and conservation agencies have been received, and not before, the Service will submit its recommendations to the Secretary of the Interior and the President.

## CONCLUSIONS

The question has been asked, Is wildfowling on the way out? The answer is that while the sport is now headed precipitously downhill, *it need not* become a thing of the past if supported by intelligent, cooperative action of all persons, agencies, and states.

To insure that the sport of wildfowling may not vanish from the American way of life, the following steps are necessary:

1. Regulation of the annual kill to a carefully determined propor-

tion of the supply and distribution and in no case should this exceed the increment of increase.

2. Development of public support of sound conservation as opposed to selfish pressure groups that seek special privilege.

3. Greater effort to eliminate, so far as possible, the present excessive crippling loss, and losses from such other factors as lead poisoning and botulism.

4. Development of public recognition of the fact that our national wildlife resources may be increased only as we are willing to dedicate lands and waters for this purpose. This education may be effected by greater effort on the part of the states, clubs, and private capital interested in the establishment of more waterfowl habitat.

5. Amendment of the Duck Stamp Act to increase the cost of the stamp, the extra amount to be earmarked for better enforcement, for development, and for management of waterfowl areas and to help carry the load of fact-finding regarding the status and requirements of the birds. We believe also that the refuge program would meet fewer obstacles of public resistance, and would be on a sounder management basis, if the Migratory Bird Conservation Act were amended to permit a harvest on a portion of all federal refuges when—but only when—this is justified by conditions thereon.

## DISCUSSION

CHAIRMAN TITUS: I know just how earnestly Dr. Cottam has labored over this paper. He was handicapped by lack of final information and as a suggestion I am just going to ask Frank Bellrose to speak just a fraction of a minute on the item on which they do not agree.

MR. FRANK C. BELLROSE, JR. (Illinois): There is no doubt that the duck population is down. We all seem to agree on that. In Illinois, duck population dropped from 15 million in 1944 to 5 million in 1945. It was about the same this year as last year. Throughout the theme of the meeting, the general consensus has been to ascribe the decrease of the population to increased kill brought about by increase in number of waterfowl hunters. Figures obtained from the states by the Fish and Wildlife Service show an increase from 16 million to 26 million in the last 3 or 4 years.

Duck data does not indicate any such increase. I am wondering if our bookkeeping is not at fault, especially at the state conservation departments who rely on the hunting license card to obtain figures. We found in Illinois there is a tendency for the better hunters to report. When the system was first introduced, more hunters reported; as the years go by they see the information is not used extensively and cannot see the use for the information. So only a few hunters report.

The reports drop down. This, of course, would produce a great error by sampling only the better hunters who naturally kill more game per person. When this is multiplied to bring the total returns up to a hundred per cent, that could result in a great error. In Illinois, we have another system through duck clubs. We have found that the resulting kill figure is just half of the hunting license kill figure. Illinois is rated as one of the better hunting places in the nation, and the Illinois duck clubs are among the tops in the nation; yet the Illinois club hunter kills about 20 ducks per season. He hunts three or four times. He has a place to hunt. He kills an average of about six ducks per hunt.

Here among public shooting ground units, we find a kill of about one duck per hunter per day. A check made in Mississippi this year revealed the average kill was about one duck per hunter per day. We found from checking through that probably the average trips made per hunter was four. That would be about four ducks per day or a total of 6 million instead of 36 or 20 million.

The duck kill, of course, can be indicative if the returns were comparable from year to year but that might not have been true during the war years when not much effort was made to get the returns from the hunters. Many states dropped the license report system, and other states had a much lower percentage than the previous years. That might have brought a great deal of this increase from 16 to 26 million. Therefore, I believe it behooves us to perhaps look for hidden things in the population decrease, things we had not suspected because if management is to do its chore we need to know where the drain is going on, what we can do about it.

Mr. Baker struck a real note when he brought forth cycles repeatedly.

Are ducks cyclic? One would gather they could be because just 10 years ago we were in another duck depression and 15 years before that another one, so perhaps an increased number of hunters does not necessarily increase the kill to the same proportion the hunting pressure is increased.

We found on Illinois public shooting grounds, for example, there is a leveling off of the kill as the hunters increase. In fact, there can be so many hunters that the total kill drops rather than rises. In many states where excess marsh is no doubt increased, hunters increase the kill. But in other states there is no doubt that it brings about a decrease collectively as well as individually.

CHAIRMAN TITUS: Any questions?

MR. K. A. MCCASKILL (Colorado): I would like to ask two questions. Would you venture a guess that the duck population today is less than or more than it was during the low in 1937 or 1938?

DR. COTTAM: My opinion is that it is higher than it was then. I sincerely hope it is correct.

MR. MCCASKILL: Would you venture on opinion as to how much?

DR. COTTAM: We can do that in a couple of weeks when our data are in.

MR MCCASKILL: Does anybody want to buy a couple of old corn shelters?

MR. FORD (Alabama): I would like to ask a question on the part of the duck hunter. In our state, we have a restricted duck hunting area. We check with the opening day hunters. There were 1,300 of them, about 40 per cent of them paritcipated on opening day, killing an average of nine tenths of one duck per person. I would like to ask, in view of all the talk about overshooting and about the failure of adult ducks to return to the nesting grounds, why is this? Why is it that our Pittman-Robertson biologists report that instead of the usual ratio of 3 young ducks to 1 adult duck, the ratio dropped this year to 1.7 adult ducks to 1 young duck? Is that because few adults returned or fewer adults raised young birds?

DR. COTTAM: That is a sixty-four dollar question. I wish I knew the entire answer to it. We will have some information on that. Some data has already been gathered. It has not been analyzed and I am sorry to say I can't give you a full and complete answer on it. We do have some information but I think it is safer to defer that until the facts are in.

MR. W. C. GLAZENER (Texas): All of this talk on waterfowl has been in regard to the duck. May I ask Dr. Cottam about the situation of the geese? Have they shown a similar decrease?

DR. COTTAM: There are species of geese as there are species of ducks. The Canada group seems to go more or less into groups, restricted into sort of little clans, and you may have a tremendous decline in the Canada geese of one area and very little or no effect of the Canada geese of another area. In the Great

Basin region, I think the Canada geese are just as plentiful as a year ago. The Canada geese in the Mississippi Flyway, I believe, are a little up over what they were last year but they are still pathetically low in populations.

As to the snows and blues, if Bob Smith is in the audience I believe he can answer it better than I.

MR. ROBERT H. SMITH (Minnesota): We have never been able to determine whether or not blue goose populations fluctuated or not. The kill on those birds is restricted to two regions—James Bay and the Louisiana Coast. It doesn't seem to make any difference with the productions on the breeding grounds. Some years we have heavy production. Other years they come South with few or no young. Yet the hunting pressure on those birds is so slight there is very little fluctuation in the numbers of the geese.

MR. EDWARD K. LOVE (Missouri): We have been talking about the ducks and the geese; of course the personal element, the human element, the selfish element of the fellow shooting ducks that he shouldn't shoot at which causes a great many cripples and eventually affects the district in which he shoots. We have talked ducks and geese. What about the jacksnipe and the Wilson snipe? Have you any information on that?

DR. COTTAM: Yes, we do have information on that. The woodcock seems to be up just slightly over last year. The jacksnipe or the Wilson snipe throughout the country, as a whole, has shown but little recovery, possibly slightly better than it was before, but still it is down low, not high enough for an open season this year at least. There is one other point in answer to this, I sincerely hope that Frank is entirely correct. Bob Rutherford handed me a slip which I think will interest you and that is this: the amount of funds obtained for Pittman-Robertson work, which you know is a 10 per cent excise tax, is bearing on this question.

In 1943, the excise tax on guns and ammunition amounted to $1,149,000. In 1945, it was $3,000,000. In 1946, it was $5,000,000 for the entire year. He just received a letter in the last hour or so before this meeting started that for 6 months of this year, the excise amounted to $4,500,000. The question is: What did they spend that money for guns and ammunition for if there wasn't a hell of a kill?

MR. J. R. STURRE (Minnesota): There has been some mention made of duck banding. I have here the returns of duck banding by Ducks Unlimited, from 1939 through 1945. The 1946 data are not yet available. The return on ducks banded by Ducks Unlimited has run between 7 and 12 per cent. The best other figures I can get run up to 3 per cent, but to give you in short these figures, from 1939 including 1945, 41,810 ducks were banded by Ducks Unlimited. The United States returns during those years, 1939 through 1945, are 2,743; the total returns from all sources 3,800 ducks. All sources include all the provinces of Canada and the Northwest Territories, Alaska, Mexico, West Indies, Cuba, Central America and South America. We have been trying to get information.

I have the returns here by states, returns by provinces of Canada, and returns by foreign countries. We have been trying to get some data on the returns of banded birds, and it seems to me there is a tremendous loss of birds that have been banded that don't appear any place in the picture. They don't appear in the trapped birds that are x-rayed. They don't appear in the cripples picked up and don't appear in the report.

Have you anything to give us on that?

DR. COTTAM: There are one or two items that are a slight misinterpretation of the fact. I might say all the banding, like all other banding of ducks, is done by bands bearing U. S. Fish and Wildlife Service. Therefore, all the data that Mr. Sturre referred to, I believe, we submitted to Ducks Unlimited. We have that basic data.

One error, if I interpreted your statement correctly, that the average is 3 per cent. Three per cent was the average of nongame species. The average of game species throughout the country is about 10 to 12 per cent. Ducks Unlimited is somewhere near that figure with no great appreciable difference.

What happens to the banding on those to which you referred? The addition is between 88 and 90 per cent. What happens to the rest of them? I hope some of them died of old age. It is pure conjecture to say what happens to the rest, of course I don't know. I have in mind a discussion regarding the loss of birds. One exceedingly important factor which I believe is not taken into consideration which is well known is that there is a terrific mortality under normal conditions on the breeding grounds. The young birds are concerned in that mortality, and most of this banding was done on young birds. Therefore, you would expect a higher mortality than you would on the banding we do down here on adult birds. What happens to the rest—I could preach a sermon on that.

MR. STURRE: The ones that are banded and die in their juvenile stage from disease or from trying to migrate in drought are raked up and piled up and burned. That doesn't account for it, or any part of that unreported banded birds. I am merely asking you a question.

DR. COTTAM: I fully sympathize with your point of view. Frankly, I am in the same boat. I would like to know more than I do.

MR. C. RAY KNIGHT (California): I would like to inquire if the more liberal bag limit of Mexico is considered a major factor in the decrease of birds?

DR. COTTAM: My answer will be a personal opinion only. I have never done any duck shooting, nor witnessed duck shooting, in Mexico. My comments, therefore, if I would be more discreet, would probably be that I have no data on that; but from the stories I have received from sources which I think are quite reliable, I am afraid the large source of the loss down in that part is attributed to the same situation to which Al Hochbaum referred to in Canada, namely, American citizens go down away from home without restriction and they take an unlimited amount. There is a point of logic in that. The Mexican people, as a group, can't afford to buy even the shells. Therefore, plain logic tells me they are not killing as a group in any appreciable number. I can't help but feel that our own good citizens, who are not good sportsmen at times, are accountable for too much of that loss.

# GENERAL SESSION

## Tuesday Afternoon—February 4

*Chairman:* John W. Studebaker[1]
Commissioner, U. S. Office of Education, Washington, D. C.

*Vice-Chairman:* Douglas E. Wade
Naturalist, Dartmouth College, Hanover, New Hampshire

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## IS WILDLIFE EDUCATION GETTING RESULTS?

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## INTRODUCTORY REMARKS

Douglas E. Wade

John W. Studebaker who is listed as chairman unfortunately is unable to be here this afternoon. However, I think you ought to know a few things about Mr. Studebaker. He is an Iowan; and started out as a bricklayer. But he got acquainted with some of the architects and found out there were people who actually laid down the plans for building, so he advanced into the educational field via bricklaying, and now he is a factor in building our entire over-all national education picture.

It is indeed unfortunate that John Studebaker isn't here because I am sure that he could do a much better job of being chairman for this afternoon's session than the vice-chairman.

All through the sessions here at the Conference you have heard mentioned, human behavior. This question put before you this afternoon: "Is Wildlife Education Getting Results?" is based upon human behavior.

If you doubt that it is not based upon human behavior, you should examine the prospectus for the Inter-American Conference on Conservation of Renewable Resources to be held May 5 to 18, 1947, at Yosemite National Park. (And, incidentally this prospectus is worthy of examination and emulation by this Conference.) In the introduc-

[1]In the absence of Dr. Studebaker, Mr. Wade presided as chairman.

tion to the program it is stated: "The inter-relationships among the natural resources themselves are extremely complex and unstable; the day-to-day value of a given resource is, furthermore, lessened or enhanced by a larger number of factors such as historical trends, economic systems, cultural patterns, etc., which place within man's power the control of resources." The writer of this, who is, I suspect, William Vogt, Chief of the Conservation Section of the Pan American Union, has a view of efforts on two continents. He has been at pains (1) to establish "at least an elementary understanding of man's place in his environment as a part of our culture"; and (2) to impress upon all of us that *we live in this world in "an ecological sense, as well as, a political sense."* It should be obvious to the student of wildlife management that once this "ecological sense" has been more universally accepted, and if there is sufficient technical knowledge, it may be much easier for human beings to make the necessary social and physical adjustments which will enable them to live not only more harmoniously with the earth, but among themselves.

It should be of some encouragement to us at this Conference to realize that wildlife men have in a large way led the way in establishing many ecological concepts. At least, wildlife managers were aware early that consideration of wildlife resources alone, led to fallacious conclusions. In other words they learned how essential it is—whether farm game, hatchery trout, forest cover, soil, or wilderness area be the center of attention—*to use an ecological approach in appreciating and understanding the complex and dynamic biological web that has united water, soil, forests, and grasslands.*

This is no mean accomplishment, and makes this chairman feel that perhaps wildlife education is getting some results. Indeed, it is not too bold to predict that out of the concept that "we live in this world in an ecological sense" will come a new philosophy and improved education which will be not only dynamic and practical, but inspirational and fascinating.

In the meanwhile, though, time is fast running out on one wild species after another, and one wilderness biota after another. Indeed, it is a human behavior problem of first magnitude that we face in saving wild species and wilderness areas. After all, these, along with humans, are the supposed corecipients of the benefits of wildlife conservation education. Our efforts in wildlife education and research have been described to me by one irritated citizen as similar to someone dipping into a hogshead with a tiny thimble while at the same time the flow is running out unchecked at the bunghole.

We must recheck the bunghole and then use more modern implements to dip into the barrel of life. We have wonderful visual aids.

airplanes, radio, radar, infrared spotter scopes, thermocouples, and many other modern methods and tools that we have not yet applied in earnest to wildlife education and research. We also have an estimated 50 million people in this country who are enough interested in wildlife and wilderness to be glad to help—if we, who are supposed to be the leaders, can show them the way.

Facts, many more are needed; and money and effort are needed. Surely we can put 50 million brains and pairs of eyes to work, not to speak of 50 million pocketbooks, that could go far in a hurry to saving the remnants of wildlife and wilderness—if we will only develop our imagination and quit using thimbles.

For instance, look at the time and effort we waste at these annual conferences (and this chairman is just as guilty as anyone), when we should be working terribly hard measuring our progress, learning new methods, and vowing to triple our efforts. We have failed miserably at these conferences in exploring new ways, or showing signs of imagination.

The question of the session this afternoon is, therefore, much broader than that actually listed on the program. It is a question directed toward the entire educational picture rather than the restricted field of wildlife education. Hence, we are more or less this afternoon, putting the entire educational field into the searchlight. Nevertheless, I hope by the time the afternoon session is finished, that you will have a much clearer picture of whether or not wildlife education is getting results.

It's extremely difficult to get indicators or signposts that show clearly whether or not this educational effort is getting results. It is urgent, though, that we find out, for there are close to 19,500,000 persons who hunt and fish; at least there are 19,500,000 who buy fishing licenses, hunting licenses, and other licenses of that nature. There are also an estimated 25 million more, while not hunters and fishermen, are nevertheless interested in wildlife.

At this time, there are some states thinking seriously of license fee increases. It's my own personal conviction that if they do make increases, they ought to take a part that comes in from the increased fees and apply it to a very sound, modern, and carefully-thought-out educational program.

Some states have been bothered this year by an increase in law violation. One Midwest state has analyzed the situation rather thoroughly. This state pointed out that there was a parallel between other law violation and violation of game and fish laws, and that perhaps we shouldn't get too excited about the situation.

However, it stands to reason that when there is a large increase, an estimated 20 per cent increase, in our hunting and fishing population here in this country, that perhaps some of those "20 percenters" are the ones who will have great need of education. Perhaps some of the increase in law violation is within that 20 per cent. If these agencies that are collecting the license fees could use some of this money to hire competent educators, we might better be able to answer this question: "Is wildlife education getting results?"

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# MORE PUBLIC KNOWLEDGE—LESS HIGH DAMS

CHARLES E. JACKSON
*General Manager, National Fisheries Institute, Washington, D. C.*

My answer to our theme question: "Is Wildlife Education Getting Results?" is "yes," but unfortunately the "yes" must be qualified. We are not getting "results" fast enough to protect some of our most valuable natural resources. In fact some of these resources have already been needlessly destroyed and cannot be restored. Our principal hope is to save something of what is left. To do this we must immediately enlist the support of a large number of people; we must utilize every media of public education, every means of publicity in daily newspapers, magazines, radio, moving pictures, and public speakers. It is not too difficult to enlist these aids but those persons and agencies who would dam all our rivers, flood all our lands, sacrifice our fisheries and destroy our natural resources in their mad scramble for power —and more power—have been using these media so effectively so long, are so well entrenched and so strongly organized that we must be prepared to meet the keenest kind of competition. I am speaking, of course, about high and low dam projects on the rivers and streams of America. A great many of these cannot possibly be justified, if put to the test. Dams have already been constructed for flood control, where no flood control was necessary; for power where the power already available is far in excess of farseeable demands; for reclamation in areas where the present stored water supplies are more than adequate to meet current needs. Despite this, many more dams are projected by the War Department Corps of Engineers, the Interior Department, and Bureau of Reclamation. By means of public education through Chambers of Commerce, the press and radio, these agencies have sold the public on flood control, power irrigation and water transportation projects on almost every river in almost every valley in the Nation.

So successful have they been that Congress has authorized hundreds of projects in almost all of the 48 states. There is one notable exception—the State of Vermont. That state's rich farm valleys would have been flooded too had it not been that one of the new United States Senators was a member of the Senate Committee on Commerce, that both the United States Senators vigorously opposed the War Department Engineer plan. I was present at the hearing on the bill. Vermont state officials, farmers, witness after witness from every walk of life, appeared to protest against inclusion of Vermont projects in the bill. I remember how ridiculous it seemed that citizens of a state had to bear the expense of journeying to Washington to protest against the War Department's ambition to dam up the streams of their state, thus flooding a large part of their best farmlands and jeopardizing the tax revenues of the state.

Some 13 flood-control and power dams were projected for the beautiful and historic Potomac River and its tributaries. One of the proposed impoundments would have diverted all the water from the scenic "Great Falls" near the City of Washington. Recognizing that public opinion might thwart their plans, the Engineers ingeniously worked out a plan so that some water would be released during daylight hours in the tourist season and be permitted to flow over "Great Falls." Visitors to the Nation's Capital could, by properly timing their visit, be privileged to visit this historic site. Thus by day the waterfalls could be viewed (if the storage of water was sufficient) while at night the water would be impounded for power. It took the leadership of Congressman A. Willis Robertson, now United States Senator from Virginia, supported by hundreds of farmers and sportsmen from Virginia, West Virginia, Maryland, and the District of Columbia to divert the Engineer Corps from this scheming. Hundreds of farmers, sportsmen and other citizens overflowed the large auditorium in the Nation's Capitol to protest. But this does not mean the Corps of Engineers will give up the project. They will simply wait a more auspicious opportunity.

Through public education, through wildlife education the American people are gradually beginning to realize that Engineers' dreams do not always add up on the credit side of the ledger. It was not so long ago that the Engineer Corps could justify a project merely by showing benefits to be derived from cheap water transportation or by providing some flood control. But the few projects that could be justified solely on these grounds were soon constructed. It then became necessary to find other justifications to spend the taxpayer's money, so the "multiple-purpose" dam came into the picture. By their own standards the Engineers assess benefits of every kind. Valuations are placed on potential power, irrigated lands, flood control, transportation and all other benefits that can be imagined. But in fairness, I must say that the Engineers also consider the undesirable features of a proposed project. The seriousness with which these undesirable features are disposed of can best be illustrated by the District Army Engineer's report on the proposed Iron Canyon Dam on the Sacramento River, Central Valley, California. His report, in part, reads as follows:

"Certain local problems and detrimental effects will arise in connection with the proposed subjects. Although some of these problems are important locally they are minor in character when compared with over-all project benefits, they are not insurmountable, and more complicated problems of a similar nature have been satisfactorily taken care of in other similar projects. Accordingly they have not been evaluated herein since the unevaluated incidental benefits from the proposed project as a whole are considered to be more than sufficient to compensate for any incidental damages that might occur."

The Fish and Wildlife Service in cooperation with the California Fish and Game Commission had conducted a survey of the effect of the Iron Canyon project on fish and game, and submitted its report to the District Engineer. The District Engineer then placed his own interpretations on the Service report and welded his interpretations of the effect of the proposed project on fish and wildlife, etc., in his over-all report. The Fish and Wildlife report was added to the end of the report as an appendix. Needless to say when Fish and Wildlife Service reviewed the Engineer's report they were amazed. In a written comment they said:

"The Service finds that:

"1. The report presents an optimistic view of maintaining the salmon runs of the Sacramento River which is scarcely justified by the facts.

"2. Plans of construction in the Central Valley will not produce the benefits to fish and wildlife which are claimed in the report.

"3. The report creates the impression that the sequence of construction of the various units has been scheduled so as to derive maximum fish benefits. On the contrary, the report stresses the immediate construction of all authorized units including a low-level dam at Table Mountain for which the dam at Iron Canyon has been substituted. This dam will destroy the entire upper Sacramento River salmon run.

"4. In view of these apparent benefits of the tributary storage plan, the construction of Iron Canyon dam should be held in abeyance until the real merits of the two plans can be more thoroughly studied.''

Suffice it to say that even the mighty Engineer Corps have at least temporarily abandoned the Iron Canyon and Table Mountain dam projects. But only because the searchlight of publicity was beamed on the proposal. Wildlife education in the year 1944 had begun to show results.

Among the many public-spirited men who aided in ''educating'' the public on this issue was Dr. Robert Lorentz, Chairman, Conservation Committee, San Francisco Tyee Club, whose ''Analysis of Iron Canyon Dam and Table Mountain Dam'' was printed and widely distributed. There were no public funds to pay for this exposure of an unjustifiable federal project. The publication was sponsored and paid for by The California Salmon Conservation League, Northern California Fresh Fish Dealers Association, International Fishermen and Allied Workers, CIO, the Associated Sportsmen of California, Inc., The San Francisco Tyee Club, and the San Francisco Bay Area Chapter, Izaak Walton League of America, Inc.

Another publication was ''Table Mountain Dam, a Public Liability'' issued by the Salmon Conservation League of California, representing the Northern California Fish Industry and the International Fishermen and Allied Workers of America.

Congressman George Miller of California, formerly Executive Secretary of the California Fish and Game Commission, worked untiringly to beat the project and will be on the alert in Washington should efforts be made to renew the project.

The Army Engineers and the Bureau of Reclamation are experts on public relations. Two experienced newspaper men head up that Bureau as director and assistant director. This seems to indicate the importance reclamation places in public relations. The Army Engineers also have a staff of public relations men (they may be called engineers) who are always on the job. Let a group of citizens assemble to discuss the adverse effect of the Columbia and Snake River dam proposals on the valuable salmon runs and the next day there will be news articles emphasizing all the benefits of the proposal, not one article but a series, so that the report on salmon destruction will be minimized. Public relations activities in the field are backed by what is known as the Army Engineers drawing-room lobby in Washington.

I restate the effectiveness of these government public relations so as to reiterate the competition wildlife education or public education must be prepared to meet. And remember, the taxpayers pay the publicity bill of the Army Engineers and the Bureau of Reclamation, while those championing the cause of fish and wildlife must bear the cost themselves. This it not nearly so effective as a full-time, paid publicity staff, but it is getting results nevertheless from aroused citizens.

Why do we regard fish and salmon and wildlife so important? I made some studies on this recently and in coming to Texas, the great cotton state, I recall, and you do too, there was a day not so long ago that the United States enjoyed a monopoly on cotton, and cotton was our principal balance of trade for many, many years. And in a somewhat relative position, I believe it's true of salmon.

The Fish and Wildlife Service, the old Bureau of Fisheries, attempted many years ago—when they established a fish hatchery in Baird, California, the first federal fish hatchery in the United States—to introduce chinook salmon into various countries of the world and the report is there and it makes very interesting reading.

There was very little success that resulted from that attempt to plant salmon in other places in the world. Some success was had, however, in lower part of the South Island of New Zealand, and a little success was had in Chile.

I don't believe that any of them developed salmon in commercial quantities, with the possible exception of New Zealand, so that in North America, I believe, we have a monopoly of salmon.

The United States must have or almost has a world monopoly of salmon, and we speak in terms of canned salmon because that is the way it reaches the markets of the world.

I checked on the statistics and found that prior to the war, Russia and Japan produced a little less than one third which means that the United States and Canada always produced better than two thirds of the world production of salmon.

Now, that is one important thing that I think we conservationists should keep in mind. Why should we go on developing great dam projects particularly on the Columbia River, when we know there is a surplus of power in the Northwest, and destroy what is left of these salmon runs? When we have a world monopoly we can always sell all the canned salmon we can produce; and if we can't sell it in this country, we can sell it in the world market. It seems utter folly that we should not see to it that the Nation and people responsible understand that this is one single resource that is worth saving.

I cannot do any better than explain the importance of the Columbia River salmon fishery and it also applies to shad on the Atlantic Coast, and other species of fish that go up the river to spawn, which we must protect.

The Army Engineers have never understood why we are not willing just to dismiss with the wave of the hat their obstructions. I dared challenge their statements and they said they had solved that problem just by merely building a ladder and the salmon would go their way up the stream.

At the time we had just learned something new from developments at Hell Gate fishery. Dr. W. F. Thompson, director of that commission of which I had the privilege of being a member for years and Edward W. Allen still is a member and is in the room, found in 1942, I believe, that 1,000,000 salmon were lost at Hell Gate because of the terrific water pressure and because it was impossible for the salmon to combat that pressure in order to get through the stream.

The water pressure was so great that it was only possible two days in a given period of time for the salmon to pass on upstream and the salmon had waited there for a certain number of days and they were so exhausted that they could not go through and Dr. Thompson estimated that a million salmon died at the foot of what we might term an obstruction.

That is another convincing argument to show these engineers we cannot expect to pass salmon over any number of dams. True, they may have succeeded to a certain extent to go over the Bonneville Dam. There is already evidence of their having difficulty in getting over that ladder, and if they have to go on and climb ladder after ladder, the evidence all seems to indicate that they will die before they ever reach the spawning grounds.

Another publication, paid for by citizens and available for wide distribution, is "Wealth of the River" published by a large group of conservation organizations, including the Izaak Walton League in Oregon and Washington. Two editions of this booklet are already exhausted and the third is on the press. The facts contained therein are a perfect example of wildlife education. And it is full of facts. Facts supported by engineers, power experts, biologists and conservationists.

This "Wealth of the River" and the men behind it are responsible for the best illustration of the title of this address "More Public Knowledge—Less High Dams."

The proposal to erect a series of high dams in the Willamette River Basin, State of Oregon, has been abandoned by the Army Engineers and instead, a series of headwater dams will be constructed on tributaries. High dams would have utterly destroyed the rich salmon and steelhead runs. In time greater benefits will be derived from the dams on tributaries, and the fish that supply employment, food and recreation for thousands will have a chance of survival.

The authors of "Wealth of the River" were most discouraged in their fight to preserve the Willamette Basin from high dams and all the attendant evils. They knew that if the public undrestood what high dams would do to the Valley, the project would be defeated. What with the influence of misguided Chambers of Commerce and well-organized propaganda as to the supposed merits of the high dams, it was virtually impossible to get the facts to the public. Citizens dug down into their pockets—they inserted a paid advertisement in certain newspapers. The public read the advertisements. It was full of introconvertible facts. For the first time the people learned what was going on. Then "Wealth of the River" was printed. You know the answer. It was not long after that the plan for a series of high dams in the Willamette River Basin was abandoned.

If we have to get the people by paid advertisements, by printing pamphlets at the expense of conservationists, let us pursue that policy if thereby we can save some of America's natural resources. I quote a few truths from "Wealth of the River":

"It is not the intent or purpose of the fishery to obstruct the proper economic development of the Columbia basin area. This fishery has long been, however, and still is an important economic factor and it does intend to protest any development which will interfere with or deplete its resource, and which cannot justify itself by definitely providing benefits greater than the values which it will destroy.

"The benefits accruing from the construction of dams may be placed generally in five categories. They are: (1) Power; (2) Reclamation; (3) Water Transportation; (4) Flood Control; (5) Payrolls.

"Our contention in the case of this and other similar proposed structures on the Columbia River is that there does not exist at this time any economical justification for the construction of more power sources or the irrigation of more acres. We further contend that the building of an economical water transportation system on the Columbia River is entirely impractical, and that there is no need for flood control in the vicinity of any of the proposed dam structures on the Columbia River itself.

*"The Power Argument:* Examination of the conditions of the Northwest inter-connected power system as of March 1945, prior to the cessation of the war indicated that the peak load was 2,635,000 kilowatts. Of this load, BPA, with a peak capacity of 1,517,000 kilowatts, was furnishing 1,036,000 kilowatts having even then surplus capacity of 481,000 kilowatts. As of the same date, other systems inter-connected with BPA had a peak capacity of 2,005,000 kilowatts leaving them a surplus of 406,000 kilowatts. Thus, the total surplus

capacity of the inter-connected system prior to VE and/or VJ Day was 887,000 kilowatts.

"*Power Surplus:* Estimates based on the reduction on the power requirements all ready made since the ending of the war and others certain to be made, indicate that the requirements for elctrical current in the area will have been reduced approximately 400,000 kilowatts by March 1946. Thus by March 1946, including additional capacity installed by the city of Tacoma, it appears certain that this area will have a surplus capacity of providing electrical current of 1,352,000 kilowatts.

"At Grand Coulee there are at the present time in use six generators with a peaking capacity of 130,000 kilowatts each and two borrowed (from Shasta Dam) generators of 90,000 kilowatts each. Coulee is planned for the installation of eighteen generators developing 130,000 kilowatts each, thus, if this existing project is completed and its power potential fully utilized, present power capacity could be increased 1,380,000 kilowatts. In addition, at Rock Island six more generators with a potential of 20,000 kilowatts each can be installed. Thus we have definitely indicated that if no new dam structures were erected, but if the potential at existing structures were made available, there could exist a power surplus of 2,852,000 kilowatts, or more than the entire peak power load during the war boom period.

"*Reclamation:* When Coulee Dam was constructed, the reclamation project connected therewith proposed the irrigation and preparation for settlement of about one million acres. Today these acres are still a desert. In other words, the potential facilities for reclamation at Coulee Dam have not been touched.

"We wish further to point out that prior to the war existing acreage in this country produced a surplus of agricultural commodities to such an extent that it was necessary then to subsidize the agricultural producers of the country. During the war period the unit production of such acreage has been greatly increased by improved and intensive methods of agricultural operation. There exists no reason to presume that in the period immediately following the war that existing acreage will not again afford a surplus of agricultural products necessitating a continuance of agricultural subsidies.

"In view of the above, we cannot see how further dam construction of the Columbia River can be justified by conjectural benefits from reclamation features."

"Wealth of the River" goes on to show the fallacy about water transportation, freight rate reduction and payrolls. It concludes as follows:

"In conclusion we wish to reiterate that we sincerely believe that it would be height of folly to sacrifice a resource which has paid substantial dividends over a long period of years, and which has a chance for a long and continued existence, if not further damaged, merely to create huge structures at the expenditure of vast amounts of taxpayers' money, when there does not exist any sane or reasonable evidence that the functional purpose of such structures can be economically utilized in the foreseeable future."

I hope no one will imply from my remarks that conservationists are opposed to all power dams, to all irrigation projects, to all flood control projects, or even to inland waterway transportation schemes.

We recognize that the economic development of a fast-growing Nation like ours is necessary and desirable. As the Nation grows we will need more power, more reclaimed lands.

We maintain that up to the present time too much emphasis has been placed on the benefits that will accrue from damming our rivers and flooding our lands; that there has been too little consideration given to preserving the natural resources the Almighty has given us, such as the salmon, steelhead and shad fisheries of our rivers and the rich bottomlands of our valleys.

It is time to slow down, if we are to preserve valuable resources. It is almost too late now. Every one of the high-dam projects should be reconsidered. There should be a careful analysis of the losses as well as the gains that may be derived from river valley projects.

Now is the time for conservationists to become active. Heretofore, sponsors of power, reclamation and flood-control projects have had all the advantages, but the advantage is at last turning our way. These advantages may be only temporary, so it behooves us to move fast. I refer to our economy-minded Congress. I believe the President and Congress are determined to reduce the cost of government. There is no better way to save money than to withdraw appropriations from these numerous dam projects.

Now is the time for wildlife education to do its most effective work. The economy program gives us a breathing spell—appropriations will at least be reduced. But do not forget that many river valley projects that will be destructive to our fisheries have been *authorized* by Congress. As soon as the economy wave slackens, the War and Reclamation Engineers will be after appropriations. They are moving heaven and earth now to get every dollar they can before the ax falls.

Appropriations may be denied these projects, but unless conservationists can prove their case against construction of wasteful projects in the meantime, the authorization of Congress to build that project remains on the statute books. Our program of wildlife education or public education can be tied in with the economy wave. The combination *can get results.*

More public knowledge—less high dams means wildlife education of one kind is getting results.

## DISCUSSION

CHAIRMAN WADE: I am sure that Charlie Jackson has raised many, many questions in your minds, but before getting onto the floor, there is one person here in the audience that I think we have a right to hear. He has one educational angle which I am sure that should interest all of us throughout the country.

I would like right now to have Carl Noren, who is with the Missouri Conservation Commission, come up here to the front.

MR. CARL NOREN (Missouri): I don't know if I can talk on one angle on this subject or not as the chairman said. This subject of dams is very complex. I think a subject even more controversial and difficult than most game problems, and we all know how difficult they can be.

First, I might explain my own position, in order to more or less justify remarks that I might make. My sole job with the Missouri Conservation Commission is to keep a liaison with the Army Engineers and other organizations interested and connected with flood control.

Missouri is in a rather peculiar position, an unfortunate position in some respects, in that the state is divided by the Army Engineers into seven different districts. Each district is controlled by separate army offices, and their plans come from that office and necessarily that makes it more difficult for us to keep contacts with various plans developing.

In the past, 6 or 7 years ago, there was absolutely no cooperation between Army Engineers and our organization. However, at the present time there is a good bit of progress in the direction of cooperation. I think it should be explained that dealing with each army engineer district is essentially like dealing with separate people—they are all different. With different people in separate offices, the results you get are different, and from some of them we get practically no results. In others, we get fine cooperation; but unfortunately, sometimes the cooperation results in nothing because the problem is so difficult that we can accomplish nothing. When reservoirs are once constructed and we wish to put in wildlife improvement measures, it is often too late to do anything.

In other cases we have been able to do something. One difficulty has been not being able to get wildlife management, and other land use, into the army engineers' plans when they are first being made.

With the passing of Law 732, in the last Congress, I think a lot of the difficulties will be overcome, in that wildlife plans must be included at the start with the engineers' plans.

We have completed a license on one project in Missouri which I think is very encouraging. I think it's probably the outstanding license of its kind in the country, although, I don't know. I haven't had broad enough experience with the other states' developments in that respect, but it's a comprehensive license that has with it a plan of management for the entire watershed as well as for the fish and wildlife on the reservoir itself.

We have been attempting to get the Army Engineers to think more and more in terms of general land use. The results are encouraging. General Lewis A. Pick, I think, is probably coming around in that direction more all the time. You have heard him speak. He spoke before the International Association of Game, Fish, and Conservation Commissioners last fall; and while the thing isn't rosy by any means, I think it's looking better all the time. Speaking in terms of education, the engineers need education and we need education, too. We know very little about this subject.

Right here in the audience today I see a man from one of the district engineers offices and it happens to be one of the offices that gives us good cooperation. In fact, they have offered to do things, wanted to do things on some of the reservoirs in Missouri on which we could not give any concrete plans because, once they were built, there is little we know we can do to change them. On the other hand, there are some things we can do if we are in early enough to make management plans.

In Missouri, we try to evaluate each reservoir separately. It so happens that most of them turn out with a negative value for wildlife—resulting in wildlife loss. However, there are other states that might feel differently. We might hear from them—Oklahoma, for instance. They have practically no water, so they gain, no matter what type it is. But, we, in Missouri, are about to lose every good float-fishing stream we have.

This is a subject, on which, unless you speak at great length, you may add more confusion to an already confusing subject.

CHAIRMAN WADE: I am sure that this subject deserves more debate, so let's take our coats off and go into it.

MR. KENNETH A. REID (Illinois): You fellows know I couldn't stay out of this. I want to make a few general remarks that I think may tend to amplify or pin down some that have already been made. For instance, on this matter of economic justification. Frankly, the method used by the Army Engineers is all wrong. I propose to tell you why.

Economically justifiable to them simply means that if the number of dollars, dollar values of the new values, exceed the cost of the project according to their own figures, it is economically justified.

I contend that is all wrong because they lump in dollar benefits, lumped together, all kinds of values to everybody, anybody and everybody. Take the flood control, for instance, that is a known reimbursable public expenditure, it is entirely improper in my opinion to put into the economic justification column purely private benefits and that is the system that is used in a lot of these projects to make them economically justifiable.

Only things that are of benefit to the whole public should go into that column of benefits since public money pays for the thing, not private money. I think that's an important point.

The second thing that occured to me to jot down here is the multiple purpose dam. Of all the ingenious but morally disturbing things, this is the worst. It is a means of making things look good on paper, an economic monstrosity. It is wonderful for that.

I don't want to take the time here to go into all the amusing angles of the multiple purpose dams, but simply to quote roughly, not exactly, because I don't happen to have the written paper with me, the statement made at a national reclamation meeting a few years ago in which one of the officials said, Gentlemen, we must recognize the fact that all of the economically feasible irrigation projects have already been developed. Therefore, in order to continue our wonderful reclamation work, we must adopt the term of multiple purpose dam, and make power navigation, flood control and what-not carry some, and in many cases, the bulk of the cost.

In many of those irrigation projects where 30 per cent is charged to fancy navigation and fancy power and another 30 per cent to flood control, it makes it look good on paper, but it's still rotten. The fact remains that the irrigation projects of today are fantastic in the extreme.

If you don't believe it, look into that Gunnison-Arkansas-Trans-Mountain Diversion. The cost per acre on that, as far as I can figure out, is going to be in excess of $1,000 to put water on it. That isn't the way they will show it when the window dressing is taken off and you get down to it, and that is what it will be.

I think it's vitally important. I want to give one more existing case, that is the Colorado Big Thompson Trans-Mountain water project which is already underway. That was justified, or at least approved by Congress, on the basis of either 43 or 47 million dollars—I have forgotten exactly. It wasn't long until it was 66 million, then 88 million and the latest report is 128 million.

I want to say to you that it makes a whale of a difference whether a thing is sensibly and economically justified—on a 40 odd million or 128 million basis, one thing that might be justified on the first would be utterly ridiculous on the second. I want to put out this question to both the Bureau of Reclamation and the Army Engineers: Are you poor at arithmetic, poor at engineering or merely do you want to get the foot in the door, the camel's nose in the tent? Bad news comes in later.

I have here in my pocket three different bills in the hopper of this Congress for the relief of this or that irrigation district from the past, old projects which the whole public pays for.

Now, if those irrigation projects, started 20 or 30 years ago, are proving economically unsound, what in the devil will the present ones be? It's only natural that the most reasonable, feasible, and most sound projects were developed first, and that applies to power first, and it applies to navigation.

You know what we need to do is to revise some of our basic water laws. It could be that Congress would if they were given the green light. The only means of transportation over the country, this so-called cheap water transportation today, if you actually put in the cost, the whole cost, and spread that over the tonnage carried—brother, it would prove to be the most expensive form of transportation known to man as well as the slowest.

I would like to publish an account of the tonnage carried on the Mississippi from Rock Island to St. Paul on that basis and see what its cheap transportation amounted to.

You want to watch yourselves because irrigation is now realizing they are about at the end of the rope with fancy bookkeeping. They are going to try to get through Congress legislation that will make irrigation nonreimbursable. At the present time the irrigation is paid for. Actually we all pay for most of it. They want to get it on the same basis as navigation and flood control where they won't be expected to pay any back.

The thing we need more than anything else is public knowledge of what this is all about, and the best way to get it is to declare a moratorium on these high dams for a while because no man knows how many of them have been authorized or what they will all cost.

Last year one of the milestones of conservation occurred on passage of Public Law 732. Briefly, prior to authorization of any large river development projects, there would be a comprehensive biological survey made by the official wildlife service with appropriate state agencies, on a par with, and at the same time as, the engineering service. Secondly, that appropriation for further engineering service was contingent on this survey. The final, full reports of both surveys constitute the report to Congress, giving Congress for the first time in the history of this Nation, a full and complete balance sheet of all values on which it could at least be possible to make an intelligent determination as to whether or not the proposal was or was not in the public interest.

We have not had that heretofore. What they have done, they have let the engineers go ahead and build the developments and then allowed the biologists to come in as a post mortem on the dead body of a river.

That is no good. I have been trying to get some data on what Congress has already committed. Some of you may have read the item by the Chairman of the House Public Works Committee, saying he gave a figure of three million four hundred some thousand dollars that had been authorized. I saw Dondero last Thursday. He told me he was utterly astounded at the total. So far he wasn't sure he had it all. In excess of 6½ billion dollars already has been authorized. Considering the fact that it always costs more than they estimate on, you can be darn sure if they go on with those it will mean the taxpayers of this Nation are going to put out from 12 to 15 billion dollars to build these things that are are already authorized in excess of $6,500,000,000. When Congress is talking about economy there is no more fertile field for economy in tax money and in sound conservation of natural resources than to call a moratorium not only on new ones, but let's bring out some of these previous authorizations and dust them off and look them over and see whether they are worth-while.

Public Law 732 is going to do a real lot of good, but down underneath there is the fundamental fault that we have had two bureaus who have been built up beyond all reason. We shouldn't criticize them. It is the congressional people that you should get after, members of Congress, because with the large personnel they now have—I checked up during the war some 3 or 4 years ago, and found that there were 34,635 employees in the Army Engineer Corps on civilian river projects alone—unless it might be considered diversion of man power and material from the war effort, and at the same time the Bureau of Reclamation has 12,800. Both of them have increased a great deal since then. I was delighted that President Truman cut the Engineer Corps in half. I understand a lot of them have been shifted elsewhere.

As long as they have that tremendous personnel they have no other choice but to scour the country like a horde of locusts seeking out every conceivable dam site in order to justify themselves. These are harsh words. I am not criticizing the Engineer Corps or the Bureau of Reclamation, but Congress. It's only human nature. You would do it; I would do it.

The simple way for Congress to do in thinking about economy, is to cut down the personnel to that actually needed, so they won't have to have sales and promotion forces out. We won't have to spend our time going to hearings trying to protect our rivers from ruination by our own Government. (Applause)

CHAIRMAN WADE: I can see where the Wildlife Management Institute made a grave mistake and that was in not putting in this Conference program, the theme, "Wealth of the River."

MR. JACKSON: There is one thing I would like to leave with you. I hope you don't think I am running away after throwing a bomb into the audience. Every one knew I had to catch a plane. There is still a little time. I don't want to make charges and desert them. I don't know whether I can answer some if they are raised. I believe in giving credit where credit is due. I was happy this morning when I saw in the paper where Secretary Patterson announced the War Secretary rejects 22 flood-control jobs.

It is still a little dubious. The article says Secretary of War Patterson submitted adverse reports to Congress on the premise for 22 flood-control and river and harbor projects in 17 states and in each instance the Secretary reported that the Chief of Army Engineers had found the construction of the projects would be inadvisable at this time.

Boy, what publicity! They are wonderful on education. And that's our weakness, and that is the purpose and the theme of this Conference. We must hand credit to both of them. They are wonderful when it comes to public relations. This is a weakness of the other side. They also state they are not in accordance with the President's program. Well, I just have a hunch that this may be partly the result of the surveys.

CHAIRMAN WADE: You have to push these "dam" people right off the platform. Thanks a lot Charlie Jackson, and I hope that the Institute will put this thing on strong next year and that in the meantime we can get that moratorium on *dams*.

# PROFESSIONAL OPPORTUNITIES IN THE FISH AND WILDLIFE FIELD[1]

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*The investigation and its pursuit.*— For some time prior to the end of the war in 1945, and in the months immediately following, thousands of inquiries about possibilities of employment in the conservation field were received by federal, state or provincial, and private agencies from those contemplating a career in such work. The universities were similarly flooded with letters from those anxious to take training preparatory to professional work in wildlife and other conservation occupations. Those who wrote, mainly men in the services, wished to know three things in general:

1. What training is recommended as the best preparation for careers in the specific phases of fishery and wildlife work.

2. What institutions in the United States and Canada give professional training in conservation work, and what facilities are possessed by the institutions in question.

3. Upon completion of training, what are the opportunities and conditions of employment.

The information concerning education and employment in the fish and wildlife field was too meager to be satisfactory to the senders of the letters or to those to whom the inquiries were directed. Employers and educators could each furnish specific information about their individual agency or institution with regard to one, or perhaps, two of the points listed above but it was impossible to furnish a complete picture because of lack of data. Since for obvious reasons the need for a picture of education and employment in the fish and wildlife field was imperative, it was determined that an investigation would be conducted to secure the required information.

The survey was carried out and a final report was typed during November 1946. This address presents a summary of the findings of this practical, timely and recent educational research.

The Wildlife Management Institute, the American Nature Association, and Cornell University cooperated to make the survey possible. The first two agencies provided the funds, and Cornell Uni-

[1]This report gives a summary of the conclusions arising from the study "Education and Employment in the Fish and Wildlife Field" outlined at the Eleventh North American Wildlife Conference and printed in the Transactions for 1946, and provides background reference for this report.

versity, through a committee composed of Professors E. L. Palmer, A. A. Allen, and C. H. Guise, directed the investigations. The speaker conducted the study.

The purposes of the investigation were:

1. To determine the opportunities for employment in the fish and wildlife field

2. To provide information to employers with respect to institutional facilities for the training of fishery and wildlife workers

3. To provide information to educators with respect to personnel needs of employers, and inform them of trends in employment

4. To obtain and present to employers, educators, and those citizens intending a career in fishery or wildlife management, the opinions of experienced professional leaders in those fields, with respect to adequate academic and nonacademic preparation for practice.

5. To evolve a pattern of desirable developments in the professional field of fish and wildlife conservation

The procedures adopted in the prosecution of the investigation were use of (1) personal interviews where and when possible, (2) institutional questionnaires, (3) state or provincial questionnaires, and (4) individual questionnaires. The personal interview was productive of the highest results and was used in connection with federal and state or provincial agencies and with most of the major universities, in 33 of the 48 states, and in 8 of the 9 provinces in Canada.

The individual questionnaire devised to obtain the opinion of professionally-trained men with respect to suitable preparation for the specific phases of fish and wildlife work in which they were engaged, was delivered or mailed to more than 2,000 biologists in government agencies, universities, and in other practices.

*Limitations of the survey.*—Some of the reasons why this survey should be thought of as a preliminary study are indicated below.

1. The need for sufficient data to indicate the relationship between education and employment as it exists today in the United States and Canada was urgent. Returning service men, as well as employers and educators, needed the information at the earliest possible moment. The matter resolved itself into a rehabilitation problem of immediate and practical importance. Consequently, while the investigation was far from superficial, there was not time to explore all the implications that arose from consideration of the data that were obtained.

2. While the employment situation with respect to governmental agencies was examined quite thoroughly it was impossible, in the allotted time, to canvass employment possibilities in the private field. Due to the scarcity of data and the difficulty of ferreting it out, the

possibilities of employment in private capacities is still largely unknown.

3. While visits were made to a large majority of the employing agencies and universities concerned, neither time nor funds permitted on-the-spot conferences with the agencies and institutions of 15 states. The results, obtained in these cases by correspondence, while often excellent as such, could not match those that were obtained through personal inspection and discussion.

4. The fish and wildlife field has expanded at an accelerated rate in the past 30 years but the publication of information that would inform those interested in conservation careers has not kept pace. To dig out all the data that have accumulated at the original sources was an impossible job for one individual, and the report is incomplete in that respect. The Forest Education Report by Graves and Guise for example, took 2 years to prepare, was done by two investigators with adequate stenographic assistance and at a cost of $30,000. This report, on the other hand, was prepared by one man, with limited secretarial help, in less time, and at a cost of approximately $2,500.

5. The specific phases of fish and wildlife work were not examined in detail. The purpose of the investigation was to provide a preliminary overview, not an exhaustive analysis. It was believed that the loss that is registered from anything less than an intensive study would be compensated for by the general conclusions that the geographical cross-section and broad investigation would provide. This aim, it is thought, has been realized, and reliable direction in so far as training recommendations, university facilities, employment possibilities and other vital matters has been secured.

## DISCUSSIONS AND CONCLUSIONS

The main sections of the report deal with individual training, training institutions, and employment possibilities. Little more than the major findings can be given in the time at my disposal, and discussion must necessarily be limited. If the full import of the investigation is to be realized, the data from which the conclusions are derived, and which are included in the full report, must be examined. It is expected that the report will soon be in print and available.

The conclusions are given by sections.

*Individual training.*—1. There is near-unanimity of opinion among practicing fishery and wildlife professionials that training is essential or desirable in the following fields of knowledge: elementary botany, elementary chemistry, ecology, English composition, elementary geology, algebra, statistics, public speaking, conservation principles, conservation techniques, elementary zoology, comparative anatomy, entomology, physiology, and systematic zoology.

2. The value of the broad training is emphasized by the selection of subjects that ran second to the group mentioned in No. 1 above. This group includes ecologic botany, systematic botany, genetics, physics, soil conservation, wildlife administration, ichthyology, invertebrate zoology, mammalogy, ornithology and parasitology.

3. After the 26 subjects found in the two groups above, the professional fishery men placed emphasis on bacteriology, biochemistry, organic chemistry, qualitative chemistry, German, calculus, trigonometry, oceanography, fish culture, embryology, and limnology.

The professional wildlife men strongly recommended studies in general forestry, photography, range management, economics, nature and properties of soils, surveys and maps, game management, herpetology, and limnology.

4. The 26 subjects, with adjustments made for fisheries or wildlife as may be deemed advisable, constitute the curriculum core in the ideal biological training for fishery and wildlife work.

5. The 4-year course is not adequate to prepare a fishery or wildlife student for professional practice. Exploration of the 26 subject fields noted in Nos. 1 and 2 above, certain university course requirements and the experience with cultural courses that professional workers recommend indicate that 1 or 2 years' graduate work is obligatory.

6. In most phases of fishery and wildlife work, the need for training in foreign languages is of minor importance. The same can be said for bacteriology, except in a few phases of work, mostly fisheries.

7. The later academic years are preferable for the assignment of individual problems. Third and fourth years was easily the first choice for such activity, with the immediate post-graduate years a rather poor second.

8. Assignment of individual problems should be made after the student's background has been investigated. The size of the problem, its nature, time of starting and duration should largely depend on the past experience and interests of the student.

9. The individual problem should carry the equivalent of 3 to 6 semester hours.

10. The summer period between semesters should be made an integral part of student preparation for positions in the fishery and wildlife field.

11. Activities most directly related to the intended career and which afford ample practice with techniques and involve the shouldering of responsiblities are recommended.

12. In order of preference, the field experiences likely to make the

greatest contribution to individual training are, in order of importance, those of research assistant, assistant at a biological station, stream survey assistant or biological aide in fishery and wildlife projects.

13. Based on the consensus as exprèssed in nearly 700 individual questionnaires, qualifications for positions are as follows:

Ph.D. degree for university faculty positions when research is involved

M.S. degree, and preferably the Ph.D., for research in fisherics and wildlife

M.S. degree strongly preferred over the B.S. degree for management phases which involve any research

B.S. and even the M.S., for refuge management and game management

14. Based on at least 100 personal opinions expressed in interviews or in correspondence, the trend is towards higher training for fishery and wildlife management. The greatest emphasis is in the shift from the B.S. to the M.S. degree.

15. The 2-year M.S. degree is much more desirable than the 1-year M.S., as expressed in a striking approval of the former.

16. In precollege years, out-of-door activities which call into play initiative, resourcefulness and skill should be encouraged. In general, fishing, hunting, natural history hobbies and boy scout activities are best. Farming, trapping, camping and club work have merit.

17. Physical, public relations and outdoor-living demands of fishery and wildlife jobs vary from moderate to heavy.

18. Outdoor-living knowledge is required in some measure by practically all fishery and wildlife biologists. Unless adequate precollege experience has been gained in that capacity, the student should plan to take a course in that field.

19. The ability to meet people and create a favorable impression is indispensable in the equipment of the professional in fishery and wildlife work, second only to his scientific training, and often more important than a higher degree.

*Training institutions.*—1. Some 33 institutions in the United States and 3 in Canada offer professional training in fishery and wildilfe management, and it is expected that a total of 50 will be reached by the year 1950.

2. The importance of the conservation field has been recognized by nearly all universities, and courses have given way to curricula, curricula to increased programs, and in many cases, programs have led to the creation of departments of conservation. Facilities of the universities should show still greater increase in the next 5 years.

3. Many institutions today are unable to meet the demand, largely from ex-service men, for training in the fishery and wildlife field. There is much planning for additional staff members and accommodation to meet this persistent demand.

4. When the excessive enrollment due to the unusual situation which exists today subsides, the numbers of students applying for undergraduate and graduate training in fishery and wildlife work will not decrease in proportion. In the schools laying the foundations for conservation training, long-term programs are proposed, based on the belief that needs in conservation are fundamental and permanent in the philosophy of this century.

5. The majority of the institutions giving professional training in fishery and wildlife management offer science degrees, not degrees in conservation as such. The instruction given, and the men who give it, mean more to the employer of graduates than does the names of the degree.

6. There is no lowering of standards among institutions that have led in the excellence of biological training, in deference to demand for fishery and wildlife graduates. If anything, the time and thoroughness of training have been increased.

7. Some of the schools offering the 4-year course in fishery and wildlife management emphasize vocational aspects of the training, preparing the students for subprofessional categories such as refuge managers and conservation officers. Others that give undergraduate training recommend that graduate work be taken as necessary preparation for professional work.

8. Institutions that concentrate on the 4-year course have been criticized by employers of the graduates that the training is superficial to some extent and inadequate for jobs that involve research. The best of the graduates do satisfactory work in management and educational phases but would have benefited from 1 or 2 years of graduate training.

9. The name and credit given are not the important things about a course. What are fundamental are, in order of importance, the man who gives it, the bias of the course, and the content.

10. The rating of an institution cannot be established by a consideration of courses, except perhaps that it be done exhaustively. Ecology, for example, may permeate many courses at an institution and the name never, or rarely, appear in course names of discussions. At Wisconsin, advanced work in wildlife management is given without fixed courses.

11. Until accrediting of schools can be accomplished by a professional committee that can measure the "intangibles," such as the

ability of the staff, and the success of the graduates, only a general estimate of the professional excellence of the various institutions giving training in fishery and wildlife management can be made. This estimate will be based in large part upon an evaluation of the tangible facilities that are recorded in a study such as this.

12. Since the boundaries of the fishery and wildlife fields are difficult to define, the data giving the facilities of an institution similarly are difficult to determine. While in most cases, the information is correct, it must be recognized that there are discrepancies due to misinterpretation or misjudgment.

*Employment possibilities: United States—federal.*—1. There are approximately 400 trained fishery and wildlife biologists in professional positions with the U. S. Fish and Wildlife Service. About 165 of them are fishery and the remainder wildlife personnel.

With the normal estimated turnover of 5 per cent there should be about 20 positions in professional categories available each year in the U. S. Fish and Wildlife Service.

2. In subprofessional categories there are about 325 culturists and 103 refuge managers whose ranks contain a considerable number of technically-trained men.

Since positions in these and other subprofessional categories now require higher qualifications and offer higher salaries than formerly, it can be expected that the college-trained man will compete for preferred positions in these classes of personnel.

With a minimum of 400 positions and the 5 per cent turnover, a further 20 openings should occur each year in these categories. The calculation is conservative since changes occur more rapidly in these classes of positions through promotion and a larger number of resignations.

3. There exists a limited demand for additional personnel at present (October 1946). Six aquatic biologists, 19 wildlife biologists, 4 fishery biologists for game fish and hatchery work, and 9 subprofessional wildlife research men are needed for present projects. When these positions are filled the complement of personnel will be adequate under the reorganization of the Service which took place in 1946.

4. Training requirements set by the U. S. Fish and Wildlife Service are rigorous and selective and only the ablest of the applicants can win a position. Promotions are not usually rapid, since this is a career service where competition is keen and resignation is uncommon.

5. The recent graduate who enters the Fish and Wildlife Service will ordinarily do so in a junior research or a refuge or fish culture position.

6. In 1945, the total force of U. S. Forest Service wildlife specialists serving the 160 national forests was 5, while there were more than 40 such personnel before the war, in categories P1 to P3. Some of this loss will be repaired as adequately-trained men become available.

7. The District Ranger category offers the chief avenue of entry for fishery and wildlife graduates. There are 735 forest districts, of which those in the West, numbering 446, have range and wildlife as their greatest resources. The graduate with the combination training of forestry and wildlife management is preferred for district ranger work.

With the increased use of the forest by the general public, more intensive land and wildlife practice will be required. There should be 25 or more openings per year in this work for professionally-trained men, with occasional opportunities for men in higher positions.

8. Students with a career in the U. S. Forest Service in mind, and who are registered at a school of forestry, should plan to obtain summer employment and field experience with the Service and special training in the fishery and wildlife field.

9. In 1946, there were 10 biologists in the Division of Biology of the U. S. Soil Conservation Service. There is a possibility that, where the biological work is heavy in any of the seven regions, assistant regional biologists will be appointed. It can be concluded that at no time will there be need for more than a small staff of highly-trained biologists.

10. Of the 2,941 P1 and P2 soil conservationists in the employ of the Service in 1946, about 5 per cent, or nearly 150, were believed to be biologically trained. These men start at the P1 salary scale of $2,645–3,397 and can, by promotion, reach the regional biologist P5 salary range of $5,905–6,863.

There seems no reason to doubt that the present force of 2,941 soil conservationists will reach 5,000 in the next few years. If the present rate of 5 per cent for biology graduates prevails, openings for up to 100 additional soil conservationists with a biology background should occur by the year 1950, or about 25 each year. Turnover in present personnel should provide from 5 to 10 further opportunities each year.

As the youngest and fastest growing of the federal conservation agencies, the Soil Conservation Service offers a large number of employment opportunities for the technically-trained fishery and wildlife biologist.

11. The National Park Service, by interbureau arrangement with the Fish and Wildlife Service, receives from its fishery and wildlife

research and management assistance whenever required. While this arrangement exists the need for biological personnel by the National Park Service will be limited. At present there are 6 biologists on the staff of the National Park Service, and a few of the 40 park naturalists are biologically trained.

Positions available to fishery and wildlife graduate will be less than 12 per year, and will be mostly in the subprofessional category of park ranger.

While it is true that park naturalists, park executives and Service leaders may have started their careers as rangers, it is not to be expected that promotion will be rapid for those who start their career in the park ranger category.

12. The Tennessee Valley Authority, as an independent corporate agency of the United States Government, has its own technical staff. The Biological Readjustment Division is directly concerned with the restoration and development of fish and wildlife resources. There are 11 biologists in the division, all but one or two in fishery work.

As of 1946, the fishery and wildlife staff is reasonably adequate. Further additions of personnel will occur only when replacements are necessary, though it would appear that more wildlife management men would be necessary to reduce the seemingly unusual disparity between fishery and wildlife personnel.

13. By agreement, the U. S. Fish and Wildlife Service and the state departments of fish and game concerned manage the biological programs in the reservoir areas under the administration of the U. S. Army Engineers. Opportunities for employment in fishery and wildlife categories with the Army Engineers then, it is concluded, will be relatively few.

*Canada—federal.*—14. There are only seven positions in the Wildlife Division, National Parks Bureau, Lands, Parks and Forests Branch of the Department of Mines and Resources which require technical training in biology. Planned expansion will provide openings for 2 or more mammalogists, about 35 biologists of various flavors, 4 to 7 Dominion wildlife officers (Chief Federal Migratory Bird Officers), 7 or 8 wildlife management biologists, and a corresponding number of fishery management biologists to staff the major national parks and groups of smaller parks. At least three limnologists and one research ornithologist are wanted for special problems. Up to 10 research biologists will be required for the three permanent biological research stations which are contemplated for the Arctic and sub-Arctic.

The above positions, it is expected, will be filled as quickly as the professional personnel become available. It is probable that further openings will occur in the Wildlife Division before Canadian universities have been able to furnish graduates for the positions now available.

The National Museum will employ up to five curators and assistants, technically trained in specific categories such as mammalogy, ornithology and ichthyology as soon as competent men can be obtained.

Demand for professionally-trained fishery and wildlife personnel, it is concluded, will exceed the available supply for some years to come.

15. The Fisheries Research Board of Canada is an independent agency engaged in fishery research largely for the Dominion Department of Fisheries. About 30 research men form the biologically-trained staff of this Board.

In the next 5 years the staff number of the Fisheries Research Board of Canada will probably double. The additional personnel might reach 30 junior biologists and 6 research assistants.

The demand for professional fishery biologists can probably be met much more quickly than can that for wildlife graduates since Canadian universities have always given emphasis, in professional training, to fishery work.

16. A few further openings for professional fishery men will likely occur in the next 5 years with the international fisheries commissions on the Pacific Coast. It is probable that personnel can be readily obtained from the University of Washington in Seattle and the University of British Columbia in Vancouver.

*States.*—1. The fish and game departments of the individual states have more funds at their disposal than at any previous time in their history. Sources responsible for the high revenues are game restoration funds, current high license revenues, state surplus fund appropriations, and increased federal aid grants.

Expansion in technically-trained personnel is included in postwar plans. Some states have filled their needs in this respect but the majority have not.

Though employment opportunities for professional fishery and wildlife workers was never greater than at present, the field is nevertheless limited. Many states will be able to absorb up to the year 1950 the graduates from their own colleges, but it is possible that the saturation point may have been reached before then, in the strictly technical positions of research and management of fish and game. State fish and game departments will not be able to employ the numbers of graduates that the colleges will produce after 1950, nor, it is expected, even more than a few of them as replacements are necessary.

2. The trend to emphasize management phases of fishery and wildlife work, while research maintains about its present position, will mean that the graduate who has specialized in management work will have the greater opportunity for employment in the years to come.

3. The strictly technical field will not absorb many more professional workers after immediate needs, which are estimated at 150, are satisfied. The states, according to their present predictions, might have openings available for approximately 100 biologists each year if revenues continue as anticipated. On the average this means two openings per state per year which will be much less than the annual production of graduates.

In the light of this situation and the competition it involves, the student would be wise to consider carefully before embarking on a program with a view to become a research or management biologist in state service.

4. Opportunities for future employment in state and other service, seem greater in a relatively new field, that of education and extension. There are sufficient indications that herein lies the next great expansion in personnel needs. In the years that lie ahead, this class of worker may well exceed in numbers the total of those required for the research and management phases of fishery and wildlife work.

It must not be assumed that this field should be a haven for the misfits of the professional fish and wildlife field. The man to do education and extension work must be well qualified, with a thorough academic training, a wide professional preparation and experience in both teaching and in fishery and wildlife practice.

5. With specifications and salaries for the positions of conservation officers rising, it should not be many years before the college graduate invades this type of work. In some states this situation has already occurred and the development is far advanced in many of the others. With this circumstance becoming usual, the possibility of having many unemployed graduates in fisheries and wildlife management in the years after 1950 is much reduced, since this is by far the largest field of employment for work in fisheries and game managment.

*Provinces.*—1. From questionnaire returns, it would seem that demand for technically-trained fishery and wildlife personnel is limited in the provinces of Canada. Most of the provinces have arrangements with their respective universities to handle biological problems that arise.

In the next 5 years there are less than 30 trained men required.

Most of the opportunities are reported from Ontario, Quebec, and Saskatchewan. In spite of obvious need there is no immediate demand for conservation education leaders.

*Institutions.*—1. The universities in both the United States and Canada offer teaching and research positions in fishery and wildlife management. Nearly all the institutions giving instruction in this work plan to increase their staff on the average of from one to two. The men who will fill these openings, which may reach a total of 100, will be highly trained, with not less than the M.S. degree and preferably with the Ph.D. and with practical experience.

*Private agencies.*—1. Conservation societies and organzations such as the Audubon Society, the Wildlife Management Institute, the Izaak Walton League and Ducks Unlimited have a few professional leaders in fishery and wildlife management in their service. There may be a total of 50 or more biologists working in such capacities. Opportunities for employment with such groups are few but an occasional opening does occur for the technically-trained man who possesses the desired qualifications.

*Private.*—1. An effort was made to obtain an approximate idea of the private fishery and wildlife positions occupied over the United States and Canada. The number actually reported to the writer through individual questionnaires and in interviews, where the subject was most discussed, was not large but seems to be increasing. Because the individual is more likely to escape attention than employees of an agency, it is suspected that the number of graduates engaged in private practice is larger than is generally supposed.

Among the kinds of positions that were mentioned were fishery and wildlife farms of several kinds, chiefly fur and trout. Other specialists were engaged in shellfish operations, game bird propagation and management, and wildlife management for individuals or corporations on large tracts of land such as the King Ranch in Texas and Anticosti Island in Canada. Reports were received of biologists in the employ of clubs, particularly those interested in waterfowling, and in research for companies like the Hudson's Bay Company in Canada.

The field of private practice, it is felt, holds considerable possibility of employment for the trained fishery and wildlife man. When large land-holding corporations such as banks, railroads and insurance companies become convinced, and many today are on the point of being so, that it is to their financial advantage to develop the wildlife potentialities on the blocks of land which they control, the field of opportunities for professional fishery and wildlife biologists will be noticeably increased.

2. "There is undoubtedly opportunity for the game school graduate in the Southeast," states Herbert L. Stoddard, speaking of opportunities for private employment, "but his success or failure will depend largely upon his practical knowledge rather than on his diploma. The field is largely unexplored and possibilities cannot even be guessed by me during these troubled times. Right now the Southeast is in the midst of an agricultural revolution, and the past is little guide to the future."

## RECOMMENDATIONS

While reasonably satisfactory answers were obtained to the main questions being studied in this comprehensive investigation, it was impossible to more than touch some fundamental problems. So that greater light and knowledge might be shed on the picture of the fishery and wildlife field, it is recommended that studies be undertaken on the following issues:

1. *Extent and boundaries of fish and wildlife work.* Until the scope of the fishery and wildlife field is more rigorously defined, it will be difficult to obtain a perspective of the problems and the personnel that are associated with it.

2. *Accrediting of institutions.* Before students can make the wisest judgment, before employers can exercise the best selection, and before trained workers can enjoy the benefits associated with a recognized profession, some uniformity of training and standards must be set up for the universities that prepare students for practice in the fishery and wildlife field.

There is urgent need for the appointment of a committee of professional men to spend full-time in a 2-year study of the colleges in the United States and Canada that offer fishery and wildlife conservation and conservation education training. An investigation such as this led to the accrediting of forestry schools some years ago. Forestry as a profession was established on a firm basis. The same should be done for fisheries and wildlife.

3. *Evolution of the conservation officer.* The rise in qualifications demanded and status and salary accorded the conservation officer, once the "catfish cop" of heavy hand and wooden head, is an intriguing and significant story. In every state and province visited, the conservation officer, or to use older terms, the fish patrol officer or game warden, is rapidly acquiring a position of responsibility and trust, charged as the official representative of his department with promoting understanding and cooperation between all sections of the public and the agency he represents.

The evolution of this type of fishery and wildlife worker is leading to a demand for the highly-trained man. Just how quickly and how completely the college graduate is moving into this class of semi-technical work is a worth-while subject for investigation.

4. *Conservation education.*—Marked trends in the sphere of conservation public relations promise the need for a large number of men trained in fishery and wildlife management, with sound knowledge of educational methods and procedure, and with practical experience in both teaching and in fishery and wildlife management. The employment scope, in universities, in federal, state and provincial agencies, and in private organizations and societies have been glimpsed by only a few men who have the foresight and imagination to analyze the currents of popular and scientific thinking. The future in this kind of educational development is not seen as a vision but as the logical outcome of the growing understanding by the farmer, the lawyer, the teacher, the school children and most other groups of citizens of the practical importance of fisheries and wildlife and conservation generally in their everyday life and welfare.

Graduates trained in conservation education will bridge the gap between technical theory and findings and public understanding and application of conservation principles. There will be an ever-increasing number of these bridges to build in the years to come. What kind and how many specialists will be required to do this building should be estimated, if they are to be adequately prepared to assume the important responsibilities that are theirs. This can be done if the possibilities inherent in this new work which is on the threshold of development is investigated.

5. *Private employment.* No one knows what the future holds for preserves where fish and game is the primary crop. No one knows how far the purchase of lands and waterways for combined farm, forestry and wildlife programs will go. No one knows how soon the great landowning corporations will decide to start realizing on the biological richnesses they possess in their vast acreages. How many men and what kind of men will get the main fishery and wildlife jobs involved in the developments hinted at above are unsolved and unconsidered questions.

It is not too early to take a preliminary inventory of the possibilities involved in the field of private employment. It is never too early to put our resources, whether they be trained brains or wild land, to optimum use. The time is propitious for an examination of the possibilities of employment for fishery and wildlife professionals in private programs that are concerned with wildlife restoration.

# TEXAS EXTENSION WILDLIFE PROGRAM AND SOME RESULTS

R. E. CALLENDER

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It is my purpose here to give you a few of the high points and some of the accomplishments under the Texas Extension Service wildlife conservation program in answering our part of the question: "Is wildlife education getting results?"

It is a fact well known that the wildlife resources of this country and the European demand for furs, particularly beaver and the fur seal, hastened the colonization of North America. Our early history seems to be rich in the romance of furs and the stories of wildlife in abundance. From then until now, the wildlife of this country has had a place in our society, and it is evident that this resource will fit well into the future of a freedom-loving people.

During the years that have come and gone, we have cleared forests and we have plowed up vast areas of virgin grasslands on the prairies and upon the open plains in making new fields to grow crops. We have changed the face of the earth as we have produced field crops and livestock to maintain homes and for the markets of the world. Our population has increased and manufacturing centers have been built. We have lived and we have prospered as we have used up much of our natural resources.

That day is here and we now see the need of conservation and we are engaged in that very serious business of conserving the soils, waters, forests and the desirable wildlife that makes its home upon the land. I think of wildlife as a renewable resource and as a crop of the land. A resource that is interwoven into the fabric of agriculture, industry, finance, labor, and our homes.

As I recall, it was in 1936 that President Franklin D. Roosevelt was instrumental in calling the first of this series of North American Wildlife Conferences in Washington. It was my pleasure to attend the second conference which was held in St. Louis, the next year. So after 10 years it is again my pleasure to be with you in the general session of this, the 12th North American Wildlife Conference, with a similar message, though perhaps seasoned with more observation and a little more experience. A program of education was recommended as the number one factor in wildlife conservation then and a program of education is still factor number one as I see it today. There has been a sort of crusade during the past few years and wildlife conservation has been heralded, even from the housetops. All of this served a good purpose for it helped wake us up and helped create a desire to do something about it in a practical way.

The Agricultural and Mechanical College of Texas, a Land Grant Institution as you know, has recognized the value and the need of the conservation of Texas wildlife in the following steps:

First—The Cooperative Wildlife Research Unit was established in 1935 with Dr. Walter P. Taylor as Leader. Other cooperating parties to this Memorandum of Agreement being the Texas Game, Fish and Oyster Commission, the U. S. Fish and Wildlife Service and the American Wildlife Institute.

Second—The Division of Wildlife Research was added to the Texas Agricultural Experiment Station, July 1, 1936.

Third—Wildlife conservation was given a place on our Extension Service program of educational demonstrations out in the counties and a Specialist in Wildlife Conservation was added to the staff, September 16, 1936.

Fourth—The Department of Wild Game and Fish was added by the A. and M. College, September 1, 1937, with Dr. W. B. Davis in charge.

The Extension Service mission is one of education, and the demonstration method is fundamental with the Service. The county agricultural agents use this method to take the findings of research and the knowledge gained from experience to the operators of the land, who in turn, make further demonstration tests on the final proving grounds, the farms and ranches over the state. On January 1, 1947, there were 12 district agents, 240 county agents and 36 assistant county agents serving 247 of the 254 counties of Texas.

The county agricultural agents are the local county leaders of the over-all Extension farm program. There are 29 Extension Staff Specialists who are assistants-at-large to all county agents on a subject matter basis, but without administrative authority.

I am concerned here with only one phase of the county agents' program, the wildlife conservation and game management demonstration. Under this demonstration, all wildlife values are recognized but emphasis is given to game, fur bearers and fish as a crop. The program involves land, people and wildlife and the relations existing between all three. There are a few things which I would like to mention in connection with this demonstration:

*Who owns the land?*—The land may be publicly owned as in the case of national forests, state forests, or state and national parks, as well as some of our wildlife refuge areas. However, most of the land in this country is owned by individuals, groups, or corporations and is classified as privately-owned land. Somewhere there is an owner who is responsible for the management of the land either for himself or for society in general. We must keep in mind the fact that there are certain rights, titles, privileges, and responsibilities incident to the ownership of land.

*Landowners are key men.*—The landowners control the land and they are regarded as key men since wildlife is but another crop of the land. The production of game is here regarded as similar to the production of all other live crops such as poultry, cattle, sheep or swine. It is the landowner who finally decides which crops he will raise and the manner in which they are produced. He may sow and reap as he chooses with state and federal laws as his only limitations. In most instances the landowner is very close to his property from day to day and throughout the year and he has much to do with the crops that are produced on his land.

*Who owns wild game?*—Wildlife is considered as belonging to all the people and as the property of the state or commonwealth. Wild game and fur bearers can be regarded as possessed only when properly taken in compliance with all regulations. The farmer or ranchman, who produces game, is not the sole owner, but he is regarded as joint custodian. Thus we have a crop of the land, produced by the operator on his own land, that becomes the property of the state when it is produced. Game may be produced on one farm today and harvested on the lands of another tomorrow. Waterfowl raised in Canada may be taken on the Texas coast during the open season. The landowner may produce 1,000 deer on his property but is legally permitted to take only 2 himself. Wild game cannot be legally sold, but the landowner can sell permits in the form of hunting and fishing leases to others for a consideration. Texas landowners received approximately $875,000 for such leases during 1945. The trespass law in Texas is the principal authority under which the property owner may control hunting and fishing on his premises. This law provides that whoever fishes or hunts or attempts to do so on the lands of another without permission of the owner is trespassing in violation of the law and subject to prosecution.

*The land area required.*—The area may involve one farm (regardless of size) or a group of farms banded together as a unit. A large area of several thousand acres is to be preferred. Unless the individual holdings are large it is best to form a cooperative unit. Such a unit might involve an entire community or precinct. In our case, the county may be considered as a working unit in some of the ranching sections of the western part of Texas where no distinct community lines exist. Quail, squirrels, and some of the other small game may be managed very well on small individual farms. Even so, these could be better managed on larger blocks of land. Since deer and wild turkey require more space, areas ranging from 25,000 to 50,000 acres are considered necessary for best results.

*The cooperative land unit.*—The cooperative unit provides an excellent stage for performance and action on the land. A stage where the research worker can work, and where all agricultural leadership can join with those who operate the land. It offers an excellent opportunity for enabling landowners to work together in a cooperative way in producing a crop that cannot be practically controlled on land.

The formation of a cooperative unit may be outlined by steps as follows:

First—The land is pooled by agreement among the individual landowners and the area thereby definitely established.

Second—An association of participating members is formed to operate the area as a unit.

Third—The erection of suitable protective markers, on and around the area, thereby inviting the cooperation and assistance of every one.

Fourth—The members of the association make their own program under the leadership of their county agricultural agent.

Fifth—They proceed to execute the program, as planned from time to time, over a period of years.

*The pooling agreement.*—The agreement which follows has been signed by thousands of landowners in Texas during the past few years in pooling millions of acres of land for their wildlife conservation program:

The State of Texas }
County of } KNOW ALL MEN BY THESE PRESENTS

That I, John Doe, of the county and state aforesaid, desire to join my neighbors to protect, conserve and increase the desirable wildlife species of game birds, non-game birds, game animals, fur-bearing animals, adapted fishes, etc., do hereby bind myself together with my neighbors in consideration of said purposes, and such purposes only, agreeing to combine my lands and act as a unit with them. The following tracts of land are designated by me to become a part of said unit:

(The land is here described)

I hereby make application for membership in ________________ Wildlife Conservation Association. It is my desire that this agreement and application be attached to the Articles of Association to which I hereby subscribe.

I pledge myself to properly respect the game laws of this state and I will help others to do likewise.

Signed____________________________

Address____________________________

*The program of work.*—The landowners plan the details of the over-all program for the entire area, as well as for their individual farms and ranches. Good farming and ranching practices otherwise, and those which are also favorable to the increase of desirable wildlife are considered. The plan of work includes all wildlife adapted to the area with emphasis on those species of most interest such as deer, antelope, quail, or wild turkey. The control of certain undesirable species may be considered necessary and control plans are included for these.

The program of work may be divided under four heads:

1. The protection of all desirable wildlife
2. Improvement of the habitat—food and cover
3. Control of predators and maintenance of predator balance
4. A regulated harvest of game, furs and fish

An adequate program of protection is needed, but a program of protection alone is not regarded as sufficient. Since the wildlife population is largely dependent on the available food and shelter, closed seasons mean little where food and cover are lacking. A regulated harvest of game, harvesting the surplus over and above needed seed stock, is regarded as preferable to closed seasons, for long closed seasons sometimes reflect adversely on the interest of the people in the conservation program, and are to be encouraged only as a last resort in protecting seed stock which approaches the vanishing point.

*Period of time required under the program.*—Five years or more are needed. Programs should continue for several years, or as long as the group desires to continue. They may start when they please and quit when they are ready. An individual may withdraw at his own discretion at any time. The improvement of the wildlife status is regarded as a slow process and that a number of years are required for best results.

*The protective marker.*—It is not necessary to post lands or otherwise mark the area in order to take advantage of the trespass law in Texas. Posted signs are sometimes used, however, indicating that the owner will take advantage of the trespass law if trespassed upon without his permission. A protective marker has been used under the demonstration program which reads as follows: GAME PRESERVE DEMONSTRATION, COOPERATING WITH THE EXTENSION SERVICE, A. AND M. COLLEGE OF TEXAS. The use of such markers is optional and they are provided by the owners themselves. Even so, more than a 100,000 of these markers have been erected under the program since 1937 at a cost of approximately $40,000 to the cooperating landowners. The word "posted" with its implied threat of prosecution does not appear on this marker. It seems to be regarded more as an invitation to help and it has been respected by the public in a remarkable degree.

*The long-time objectives.* (1) To bring back and more evenly distribute the desirable species on their lands; to restore desirable species, once native to the area, but now gone; (2) to raise such as a crop for food, for sport, and for their otherwise economic value; for the natural color they afford on the land; (3) to use nature's processes of hatching and brooding in the wild; (4) to maintain and increase them by providing better food and cover, in other words, improved habitats out on their land; (5) to provide an added source of income through an increased game supply; (6) to control undesirable predators; (7) to regulate the "take" of game on their lands, harvesting only the surplus over and above needed seed stock.

*Some things regarded as fundamental.*—In order to reach these objectives, certain things are taken into account which are regarded as fundamental:

That wildlife and game management is little more than good land management otherwise.

That the cooperation of the public at large is needed if desirable wildlife is to be maintained and increased.

That fortunately wildlife is a renewable resource and the wise use of it appears to be one of the best conservators.

That a regulated "take" of game is to be preferred over long-time closed seasons.

That the producer of game may grow the crop on his land today and it may be harvested on the lands of a neighbor tomorrow; and, therefore, the cooperation of neighbors is necessary.

That landowners make better producers by taking part in the harvesting of game on their land.

That progress depends a great deal on the degree of farmer-sportsman cooperation in effect in the community.

That a planned wildlife program must include all species of desirable wildlife.

*Who controls the cooperative area?*—The landowners themselves as individuals and as an association. They own the land. The members are silent game wardens and work as their neighboring brother's keeper. The game warden is on their team and he can serve well on such a field of play.

*Organization status of the cooperative wildlife unit.*—It is a simple federation of independent landowners banded together for the purpose of unified action in the interest of wildlife conservation. The cooperative unit is owned, operated and controlled by the people themselves. It is not necessarily affiliated with any other organization.

*Hunting privileges on the area.*—No rights, titles or privileges are automatically surrendered by the individuals or by the group to any man, not even to one another. All details pertaining to such are entirely in their own hands. These details are cared for in the Articles of Association and in the minutes of the meetings from time to time. The consideration involved for hunting on the area ranges all the way from that of just friendship to that of all cash and no friendship. It is sometimes a combination of the two. In all cases, it is evident that when a man obtains permission to hunt on the lands of another that a consideration should and does pass between them.

The county agricultural agents work with both adults and 4-H Club boys, and conservation activities are also carried by farm and ranch boys on a statewide basis with conservation activities made available under the 4-H Club program. There are 41,000 4-H Club boys in Texas and those conducting conservation activities take the following pledge:

"Upon my honor as a 4-H Club member, I pledge my head, my heart and my hand to conserve our wildlife. I will guard and protect it as a sportsman should, and I will lead others to do likewise in order that it shall not pass but be saved and enjoyed by this and future generations."

*Some results under the program for 1946.*—Reports from 241 of the 254 counties of the state show: 6,156 4-H boys participated under the program; 90 counties held conservation camps with 6,004 in attendance; 72 counties held 4-H Rifle Marksmanship programs with 3,638 boys taking part; the 12 district teams competed for the state honors with state champion team selected at the state 4-H Roundup. Some combined statistics for adults and juniors showed: There were 2,026 wildlife conservation demonstration areas with 17,248 farmers and 4-H Club members taking part on the combined holdings aggregating 12,432,000 acres; 6,060 new farm ponds were constructed and 3,455 ponds were fertilized or otherwise improved; 5,855 ponds were stocked with fish by the cooperators which were furnished mainly from our state and federal hatcheries. There were 483 deer and 120 antelope received by cooperators through the State Game, Fish and Oyster Commission; 9,063 cooperators permitted regulated hunting with 3,792 issuing no hunting permits for the year; $698,792.00 in revenue was received for hunting and fishing and trapping leases and $321,-

000 was derived from the sale of furs by the cooperators. Predator damage to livestock and poultry was estimated at well over $1,000,-000 with coyotes, wolves and bobcats receiving most of the credit. There were 26,750 coyotes, 1,514 wolves and 4,011 bobcats reported as being trapped or otherwise taken during the year; 2,988 cooperators with 15,600 domestic breeding rabbits produced 84,000 rabbits for meat for home use and for market.

I have given a few of the high points under the Texas Extension program of education with some of the measurable results the county agents have witnessed in working with Texas landowners and their families. All educational processes seem to work slowly and rightfully and so far as we are thus permitted to prove all things and to hold fast to the good.

There are results from any educational approach that cannot be measured by a bushel basket, a yardstick or the dollar symbol. I think that the greatest results under wildlife education up to now have been of this type. I am thinking of that change in heart and the growing trend among the masses to conserve and maintain the wildlife of this continent. Education, I think, is responsible for the changing attitude of our people.

Lots of teamwork on the part of all of us is needed for the future if we are to properly do the job of conservation. Most of us have seen some good football games during the past season. I like to see a football team as it clicks with precision and where brain and brawn are tuned in perfect harmony. I like to think of another great team that is playing the game of conservation of wildlife and the other natural resources. I see the landowners of a continent holding hard and fast in the line with the determination that "they shall not pass." On that team I see research and trained leadership calling signals. There are some hard running backfield men on that team representing the sportsmen, the patrol service, our public schools and our colleges. The Izaak Walton League, the National Audubon Society, the Wildlife Management Institute, the U. S. Fish and Wildlife Service, the Soil Conservation Service, the Forest Service, the Wildlife Society, the Wilderness Society, the American Fisheries Society, and the Friends of the Land, and others are out there on the field of play. The outdoor writers of America are in the press box recording the game play by play.

The grandstand is filled with the public at large. To me, the grandstand is the 12th man on this team, the most valuable player of all. They are leaning toward the goal line yelling for that winning touchdown. The score stands in favor of the opponents for the moment, and they have been winning for 150 years. They have not yet known a general defeat. In that opposing line we see destruction of forests, overgrazing, and the destruction of grasslands, pollution of waters, and erosion by wind and water. There are barren wastes with rich farms eroded and scarred by sinful use, and wildlife habitats are being destroyed by the violation of natural laws.

Can we break this "jinx" and win this game? I believe we can win through education, through teamwork in action and with the cooperation of an enlightened people.

## SIGNPOSTS OF SUCCESS

ROBERTS MANN
*Superintendent of Conservation, Forest Preserve District of Cook County, Chicago, Illinois*

How successful is the teaching of wildlife education? Where and why is it successful? Where and why has it failed? Any attempt to evaluate must consider wildlife management as one field of resource-use; and wildlife education as one area of education in resource-use and conservation which must be implemented into general education.

First, let's straighten out a couple of definitions. I know the word "conservation" is a good, convenient term. It's a good word. The public have gotten used to it and we might as well accept it, but personally, I prefer, and here, I will use rather than that, the term "resource-use and conservation." Further, when I talk about education, I am talking not only about child education, but adult education. Education at all age levels. Some of us are inclined to neglect the factors in child education, the necessity for it. Others of us neglect adult education.

In the October number of *The American Biology Teacher* there were four articles significant to us here. In one of them, "What Wildlife Information Should Be Taught in the Schools," Walter P. Taylor, leader of the Texas Cooperative Wildlife Research Unit, developed the thesis that it is not so important to teach comprehensive wildlife facts in the school as it is to inspire in each pupil a sympathetic interest in nature and an appreciation of it. He stressed the fact that we live in One World; that we cannot remain isolationists in nature any more than we can as a nation among nations. Some of us have been guilty of that isolationism.

A major obstacle in the progress of education in resource-use and conservation has been the single-track mind of the specialist insisting upon unilateral consideration of *his* field. They remind me of a high school band in early September. It is folly for the specialist—the forester, the soil conservationist, the fish man, the waterfowl man, the upland-game man, the bird lover, or the big-game man—to toot, toot, toot on his own horn, deaf to the other instruments in the band.

Wildlife programs have been directed toward the preservation of vanishing species and toward increasing the diversity and density of wildlife populations for the people to use and enjoy. But the emphasis has been upon management to provide good hunting and fishing. Formal education has been directed toward the development of technicians. Parenthetically, I am told that a serious defect in this education is its failure to teach enough mathematics to enable the technician to handle variables and interpret data statistically. My own gripe is that wildlife men are not taught how to meet the public nor how to translate their knowledge for consumption by the sportsmen and the general public.

In the past two decades, especially in the last decade, the management of fish and game has been put upon sound bases with established techniques. With the help of the outdoor writers, some of whom are well informed and courageous, some of whom still pander to the old misproven beliefs, the sportsmen are gradually becoming oriented away from blind insistence on propagation and restocking. Public education has been directed largely toward that end.

There is the larger problem of bringing people into the out-of-doors and making them feel at home there; of bringing people *to* the wildlife—not bringing wildlife to the people—and teaching them to be friendly with all living things; of demonstrating what *fun* they can have without destroying. To a degree, it is a problem in showmanship, but it deals primarily with intangibles and we should join forces with the educator, the sociologist and the nature study people, all of whom habitually deal with intangibles.

If it were possible to issue licenses for looking at a sunset mirrored in a lake, or for watching a marsh alive with ducks, shorebirds, turtles and muskrats, perhaps we would be farther ahead with this larger problem. Our Cook County Forest Preserve District comprises 37,000 acres, 80 per cent of it wild land, in a county of 4,000,000 people which includes Chicago. Charles G. Sauers, general superintendent, in an effort to *entice* people to look at nature, directed the establishment of 86 lakes, ponds and marshes, varying from 1 to 325 acres in area, in our Palos region of 10,000 acres. One of these is Longjohn Slough, a shallow 35-acre lake bounded on two sides by paved highways. You can pull your car off on the highway shoulder and watch wild ducks feeding near the shore, secure in their protection. In July and August, American egrets are there on reverse migration from the lower Mississippi Valley. I recall one man and woman who stopped and asked what those white birds were. I told them. Passing by the following Sunday, I saw them there with a little pair of opera glasses. The next summer I met them again, this time with expensive binoculars and a bird guide. Those people, two of many I could name, became nature students and true conservationists—"good customers," I call them.

According to the 1940 census, 56.5 per cent of our population is urban and 85 per cent of that urban population lives in 140 metropolitan centers like New York City, Chicago and San Francisco. Those people vote —they vote as instructed by their precinct captains or according to what they read in the newspapers. The bulk of them are plumb strangers out-of-doors. They have no kinship with the land which provides their food, shelter and clothing. What little knowledge they have about things in nature is colored by misinformation and fear.

Last summer one of the Jewish community centers in Chicago sent one of their 6-day-camp groups to one of our picnic centers, 1 day each week for 8 weeks. Our 165 picnic centers are heavily used on 17 Sundays and holidays from Memorial Day to Labor Day, by hundreds of thousands to whom the out-of-doors means only a place to picnic. On week days these areas stand virtually empty. We have been urging youth organizations and welfare centers to utilize them for day camps. Just outside the mowed picnic grounds are the wild, unspoiled woodlands, meadows and stream banks for hiking and nature study. Healthful, enjoyable and educational experience could be provided for thousands of youngsters who will not get it otherwise.

We were asked to provide naturalist service for this group. Each Wednesday, Dr. David H. Thompson, our Senior Naturalist, and an assistant spent the day taking successive groups of 25 on 45-minute field trips along a temporary labelled nature trail, concluding with a "council ring" general session where he related a segment of a connected story of the Chicago region from the early geologic ages until now.

On the first day, most of those 125 children and some of the adult counselors were afraid to sit on the ground *because of ants!* They asked what those things were, hanging on a tree, that "look like pumpkins"—they had never seen a hickory nut, or an acorn. The trail led through a patch of giant ragweed in the river bottom and they thought they were in the jungles.

During lunch period on the last day, those kids came running up to us in a continual stream, with insects, frogs, snakes, mice, leaves, weeds and even mushrooms, with questions tumbling out of their mouths. They knew all the common trees. They had lost all fear and they jealously regarded that area as *their preserve.* If all the 4,000,000 people in Cook County could be made to feel the same way, my job and yours would be simplified and more pleasant.

As a result of that experiment, the day camp movement alone would give employment to a score of naturalists in the Chicago region—naturalists with specific training in the psychology and the techniques of conducting field trips, plus the peculiar knack of handling kids. The Boy Scouts, all over the country, are forsaking the crafts and lore associated with Daniel Boone, and substituting absorbing interests in nature study and conservation—which require no handax. They require naturalists to train area executives, Scoutmasters and Scout leaders. The training of school teachers and of juvenile leaders offers further employment for naturalists. I know of at least three places where such training has been given with notable success and far-reaching implications: The National Capital Parks in Washington, D.C., under Raymond Gregg, park naturalist; at Morton Arboretum, Lisle, Illinois, under May Theilgaard Watts; and in our Forest Preserve District by Dr. Thompson.

In that number of *The American Biology Teacher* to which I referred, there was an article by Robert L. Luse of Elizabeth, New Jersey, "Making Field Trips Worthy." In it he stressed what some of us have been preaching—you can teach biology in a city vacant lot. The biology on the student's own doorstep can stimulate socially valuable thinking. Some of the questions he proposed are:

What kinds of organisms survive here? How are they fitted to live under these conditions?

What conditions here prevent other organisms from making this their home?

Why are some organisms more abundant than others?

Can you find a case where one of the organisms living here has made possible the life of another in the same area?

Further questions were directed at bringing out man's relationship to his environment and his social responsibility for that vacant lot, that block, that city.

There has been, in the past, emphasis placed on the acquisition and management of important wilderness areas. Emphasis must now be shifted to the acquisition of land that is merely wild or reasonably wild, and accessible to huge masses of urban people. This introduces new problems of wildlife management and sociology. It introduces new problems of interpretation. Now it becomes our problem to improve the quality of public use—*to entice the public to use its own* *property and use it wisely.* I refer you again to that instance of the Jewish day camp.

We've simply got to get people out-of-doors and open their eyes. Then we've got to bring them to a realization of the interrelationships and interdependencies of all things in nature; of the unity of nature in terms of man's existence in relation to soil, water, vegetation, minerals and animal life; teach them to be humble and tolerant and remember that man is only an animal which remembers. Then people will arrive at a conception of conservation of *all* our national resources as a prerequisite for our national welfare.

Our basic problems of land use are involved. Most of our ills are problems of improper land use. Misuse, destruction and waste stem from intolerance. Intolerance stems from ignorance. The cure is education.

There are a number of outstanding school radio programs. The Chicago Board of Education has a Radio Council with its own station, which puts on excellent nature programs. Ranger Bill Scott broadcasts to the New York City public schools with the U.S. Forest Service cooperating. Dr. E. Laurence Palmer, Professor of Rural Education at Cornell University, for several years has had an outstanding program for the rural schools in New York. The Wisconsin School of the Air is now entering upon its 14th year. Wakelin McNeel (Ranger Mac) broadcasts every Monday morning from 9:30 to 9:50 for grades 5 to 8. The preface to the 1946-47 program is worth your attention:

"These broadcasts are given to help children understand and enjoy the plants and animals about them; to know their names that they may use them in conversation; to learn how well Nature has equipped her creatures for the business of living. If there is one thread running through the entire list of broadcasts, it is that the soil is the basic resource, that our welfare and the future of this Nation are based on the soil. If we hold to this thread, we'll find that the glory of the fox's tail, the mechanism of the feather, the falling of leaves, and the decay of plants all relate in some way to the soil. . . . Good conservationists are made by love and understanding, rather than by fear."

There are, too, an amazing lot of visual aids. The Educational Film Guide devotes 26 pages to listings of natural history science movies, both sound and silent, with 7 pages devoted to animals, 5½ to birds and 3 to physiologic botany. Some of these are excellent, some are mediocre, but the quality steadily improves each year. In the Chicago area, the Chicago city schools and most of the suburban school districts stress these visual aid programs.

There is a wealth of valuable published material available and being used in the schools. A catalogue of it would require more time than we have here today. Most of the states have issued, or have in course of preparation, bulletins of resource material and program material for use by the teacher in the several areas of resource-use and conservation. There are numerous magazines, attractively illustrated, such as *Nature, Audubon, Natural History, Canadian Nature.*

Dr. Palmer issues his Cornell Rural School Leaflets; Audubon issues their School Nature League Bulletin. Dr. Thompson and I issue a weekly nature bulletin which goes to every school in the Chicago region, both elementary and secondary, both public and parochial, in quantities which allow one copy per teacher in most schools. School districts in Illinois outside of Cook County, and in other states, are now reproducing these bulletins for their own distribution. In addition, they are sent to 135 newspapers in the Chicago area, including 48 foreign language papers, most of whom reproduce them. Our weekly distribution now is 6,300 copies.

Another encouraging indicator of success is the number of children's organizations which, while extra-curricular, are based upon the schools. The Audubon Junior Club enrollment on December 31, 1946, was 123,483 in 4,566 clubs; 114,132 of that in the United States and 9,274 in Canada. In the Middle Western States of which I have knowledge, Junior Academy of Science chapters are peculiarly active and effective in the high schools. In Illinois we have a third organization—the Junior Conservation Clubs—sponsored by member clubs of the Illinois Federation of Sportsmen's Clubs, or Women's Clubs, or Garden Clubs, in cooperation with the Illinois Department of Conservation.

There is a fourth youth organization which, like the Boy Scouts of America, the Girl Scouts and the Camp Fire Girls, should receive the attention of your group, namely, the 4-H Clubs, primarily a rural organization, with more than a million members. In Illinois and some other states, there are summer conservation camps for 4-H club members. In others, conservation work is an extra-curricular activity. In some, wildlife conservation is a definite project; in others it is ignored. The potentials of this group are tremendous and it is an exceptionally appropriate group with which to carry on a wildlife conservation program.

There is more conservation education, including wildlife education, being taught than most of us realize. The quantity of it still leaves much to be desired. The quality of some of it leaves much more to be desired. The principal bottleneck is the teacher.

Most of us now are agreed that nation-wide progress in education in resource-use and conservation can be achieved only by:

1. Devising means of implementing such education into the existing curricula—not by law nor as a separate course of study.
2. Convincing educators and school administrators that this is not only desirable but feasible.
3. Providing and requiring adequate pre-service and in-service training for teachers.

Between things as they exist in nature, and natural history science or the biological sciences as they are taught in the classrooms of most elementary schools and high schools, there is a wide gap which should and can be bridged. Dr. Thompson has demonstrated that in the experimental field trips we have been conducting for two years. Too frequently, the teaching is from books and specimens by teachers with little intimate knowledge of nature lore or of the land itself. In the rare cases where there are field trips, there usually is so much carry-over of classroom attitudes and techniques that nature study becomes markedly unpopular. *Children can learn and have fun doing it.* Biology can and must be taught as a fundamental all-important cultural subject—a fascinating dramatic story of all life, accompanied by rich emotional experiences out-of-doors; not as an elective; not as a terrifying maze of scientific names and anatomical structures. We have found that nature appreciation engendered by nature lore first-hand is the key to the door opening upon a concept of the broad field of conservation and its several phases. An intangible by-product for the individual will be a fuller, richer life.

One of the "signposts of success" is the number of summer conservation camps, laboratories, or workshops for teachers being given in various states: notably Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, New Jersey, Pennsylvania, Virginia, Ohio, Indiana, and Michigan. My own state, Illinois, will initiate one such camp in 1947, and probably another in the Chicago region in 1948. Those camps conspicuously successful—by whatever name—not only gave the teachers college credit (which is all important) but had an integrated program in which the enrollees received instruction and field work in six areas: geology, soils, plant ecology, animal ecology, social economics, and teaching methods and materials; with emphasis upon the dynamic aspects of biology and upon the interrelationships of the entire biota of the given area.

Workshops during the school year, however, appear to be the most potential medium of teacher training. In a workshop, teachers and leaders learn by doing; they learn about available pertinent materials, and they learn how to vividly weave that material into instructional activities. They will not be successful, however, unless substantial college credits, or credits toward the improvement of teachers' certificates, are given. We offered to conduct field trips to train elementary school teachers of the Chicago region in nature lore and field trip techniques, and ran into a stone wall. Now we have proposed to the University of Illinois and the five state normals that we conduct, each spring and fall, two or more series of field trips for which each participant would receive one hour of college credit.

However, I read in "Resource-use Education," the news letter issued by Dr. John Ivey, executive secretary of the Committee on Southern Regional Studies and Education, that summer workshops and study conferences on resource-use education reached more than 5,000 public school teachers and administrators in the South last summer. Off-campus studies were major features of many programs. Teaching through direct experience was thus important.

In 1945, the Izaak Walton League of America organized a committee on conservation education with two primary objectives: a group of educators and conservationists was asked to formulate the objectives of a national policy of conservation education and to devise ways and means by which this policy could be put into effect to become a vital part of the school program.

At our meeting in Buffalo on June 28-29, 1946, the title was changed to "The National Committee on Policies in Conservation Education," a cooperative activity of conservation, civic, scientific and educational organizations. A national conference is projected in 1947. One hundred and fifty organizations, including yours, will be invited to participate.

As a coordinating policy-making body that committee is important and should be supported. Concurrently, however, I believe there should be established other regional committees on education in resource-use and education. The success of the Southern Regional Committee demonstrates the desirability of such coordinating bodies in other regions. True, the South has peculiar racial and economic problems, is intensely sectional, and has the TVA for a pivot. But I can visualize similar success for regional committees in the New England States, the Middle Atlantic States, the Middle Western States, the Great Plains States, the Rocky Mountain States, and the Pacific Coast. I have just been informed that a preliminary conference to establish such a committee for the Rocky Mountain States will be held at Laramie, Wyoming, this coming summer.

There is too much groping. Each state in my part of the country is fumbling around with programs of education in resource-use and conservation. Some of the fumbling is pitiful. Yet each has some ideas of genuine merit. Together we could work out a complete, well-rounded, coordinated program enlisting all agencies in any way involved, as they have done in the South. The strength of the Southern Regional Committee lies largely in the fact that it has the sociological approach. We need to sit down with the sociologists and join forces with them. They not only know how to meet and interest people, they know how to get all the related groups and agencies together and put them to work; and they have an approach to education in land use that we need.

In the final analysis, what we're all working toward is the conservation of our human resources. When the biologists and the sociologists, brothers under the skin, sit down together and go to work upon this problem—that is a signpost of success.

## DISCUSSION

CHAIRMAN WADE: Now, we have a lot of time for discussion. I think we can just stay here if you wish until we drop. I would like—before many of these people get out of the room, to find out how many teachers of San Antonio are here this afternoon. May we see the hands of the teachers of San Antonio. (Count taken—two)

We have fallen down on the job. We should have had this room crowded with these teachers from San Antonio, and let them get a little taste of conservation education. Perhaps they could have helped us.

MR. HOWARD ZAHNISER (Maryland): I was very much interested and inspired by Roberts Mann's paper that we just heard. I was particularly interested in the reference to natural areas near centers of population in contrast with wilderness areas. I want to say a very hearty amen to what was proposed there, and I see it as a necessity in the preservation of the wilderness areas themselves.

We must meet all the public demands for outdoor recreation in the country. We can't select from them. We must be prepared to meet all of them and the demand is increasing.

If we are going to save our wilderness areas from the irresistible pressure a generation or so from now, we must also begin now to develop areas near at hand to take care of the demand for outdoor recreation with convenience.

Also, if I may, I would like to make a comment on the "multiple-use" remarks that were made in regard to dams. I want to underline as it were, Ken Reid's report on Public Law 732. I have heard a number of statements about that law in reporting it that disturbed me a little bit. I have heard a number of people speaking of it as though it were an instruction to the biologists of the government to participate in the planning of dams so as to get the most out of wildlife possibilities of the dams.

Now, that is certainly a purpose of the law if the dam is to be built; but as Ken Reid made it plain, and I am trying to emphasize it, the purpose of the law is to see that the biologists participate in the preliminary survey to determine whether the dam is going to be built at all or not, and the answer of the biologist may be "no" to the whole dam. I hope the biologists who are making the study go into it first of all wondering whether the dam should be built at all or not, rather than in an attempt to see how much they could get out of a dam if it were built.

The existing recreational wildlife, and other values that are familiar with, of areas that are proposed for dams, will very often outweigh the theoretical new advantages, I am sure they are finding.

DR. THOMAS LANGLOIS (Ohio): I will bet you that in the list of requirements that David Turner summarized, he didn't specify that a man should have gone through Cornell University and studied engineering 20 years ago. That, of course, is a background about Ken Reid and I mention that simply because a good teacher is wherever you find him, not simply the product of some particular curriculum. It seems to me that part of our concern in this conservational business is a matter of picking the teachers who may have a little fiare for showmanship, but there is something else involved also.

We learn that about 47 per cent of the students who enter our colleges at all, drop out by the end of their second year. Somehow or other we have to reach that group during those first 2 years with the fundamentals so they will be the good citizens in the use of resources that we want them to be even if they do drop out at the end of 1 year and 2 years.

It's also true that in the training of professional conservation workers we need to be aware of the same sort of error that the engineers have made. As a member of the Graduate Council of the Ohio State University last year, I heard the Engineering College requested authorization to lengthen their course to 5 years and the immediate remarks of the entire Council were, "What for? So you can give them another year of concentrated engineering?"

There was no support for that at all. If the engineers were minded to have another extra year in order to give cultural subjects, by all means, fine; but not giving an increased preparation for engineers.

In our training of conservation workers, I think that we ought to stress a little more the general cultural subjects during the first couple of years of training rather than throwing them into a series of courses that will make them better technicians at the end of 4 or 5 or 6 or 7 years.

CHAIRMAN WADE: I will certainly add to Dr. Langlois' remarks. I am sure we aren't getting a liberally educated group of wildlife technicians. It takes a long time to get the feel of this world; and it takes a long time to get the feel of your own specialty. If you don't have the first, I personally don't see how you can operate well in the second.

MR. B. F. STILES (Iowa): I would like to ask Bob Mann this question. Outside of the interest in hunting and fishing that we are told has been increasing, is it your opinion that the general interest in the outdoors and general knowledge of the outdoors has been decreasing especially in urban areas?

MR. MANN: I take it's on the increase, sir. I think the general knowledge of the outdoors is increasing. I think the general interest is increasing. It is made every time they turn around. In each woman's club they have a conservation chairman, and there is a conservation chairman for each district, and a general conservation chairman for the state; and too, for the garden clubs they have a conservation chairman. That is also true in the Rotary Club and the Lion's Club and what-not. Every time they turn around they run into an interest, maybe not of fishing and hunting, but of the outdoor generally and in conservation generally.

MR. STILES: Then is it your thought we are behind in our abiilty to supply the demand?

MR. MANN: Yes, because I think this: We have got to get to the kids, get them in the very first grade and carry right on through, and carry it on through the high school, and carry it into the college, and carry adult education along at the same time.

You have got to remember that those people in the clubs I was talking about, that I just enumerated, are the cream off the top; whereas, in a city like Chicago, there you have 400,000 people who have never had an automobile and never will. They will never get to a state park or a national park. If they didn't have in the Chicago area 37,000 acres that they could get to inside of a half hour or less, they would never get out of doors at all.

I had one Negro boy 15 years old that came from 39th and Prairie—the high school took a bunch of Negro boys and girls out—this one Negro boy confessed the only animals he had ever known were the dog, the cat and the English sparrow.

CHAIRMAN WADE: There was one point Bob Mann made in his paper that I think ought to be re-emphasized, that is the utility of sociology, or of working with the sociologists.

We have been stuck in our own specialty of wildlife work so long that we have forgotten, or didn't know how these other outfits are operating. The modern sociologist has a 'lot on the ball.' Here is something that happened. I don't know if the story is accurate or how correctly I give it. Down in the Piedmont section of South Carolina, a stretch of land running down through Virginia and the Carolinas, where the cotton and tobacco land and huge gullies exist, the soil conservation fellows said, "Lets put this land into grass."

A big plan was evolved apparently to turn the region into a cattle and milk cow economy. But, the sociologists said, "You can't do that to us down here," and the soil conservationists said, "Why not?" The sociologists replied, "Just take a look at the people." So they took a look at the people. They were working about 8 months of the year, and loafing the rest of the time.

You know what they will have to do with a grass economy, they will have to work 365 days of the year. So establishing a grass economy in the Piedmont section is going to be a rather tough job; and it's an educational job that will probably take another 15 years in order to change the pattern of life of the people in that section. Without the sociologists, trained in modern methods, the soil technicians would have been licked at the start. We in the wildlife field would do well to ask the help of sociologists in solving many of our problems. They have some know-how that we are in great need of right now.

MR. MANN: A gentleman from San Antonio has just asked me to define "conservation."

Well, I would like to use the definition that was given by the late Dr. Henry B. Ward who was chairman of that educational committee appointed by the National Wildlife Federation. His definition was: Conservation is the wise use of all our natural resources for the permanent good of all the people. That is about as simple as you can make it.

MR. M. E. KING (Maryland): I am very much interested in what Mr. Mann learned by doing. In Maryland we have one county school sponsoring a small sanctuary area where the little tots in the first grade right up through high school can go in the field and learn things by doing.

We furnish wildlife technicians to plan this area where the kids can go out and do the planting on the area and learn the growth of plants.

Little tots set up bird feeding stations to feed the birds. In one higher school we have a mapping and engineering class which is going out and surveying areas and making plans for the development of farms which the Board of Education has sponsored.

Things like that, I think, is what we need in this phase of education. Learn by doing. I certainly like that.

MR. OLLIE E. FINK (Ohio): I think in view of the comments that Bob Mann made relative to the interest and need of these city people to understand conservation, that one little phase might be expressd here which may at first seem rather contradictory to his point of view, that is, that conservation in the long run is a city problem. When Ben Franklin lived it took 19 people working with the soil to produce food for 20. At the time of the Civil War we had the steel plow, a new implement, so it was possible for 8 people to produce enough food for 20. The other 12 were free to go to town. Today we have the tractor combining all transportation facilities for the farm, and 80 per cent of all work done on the farm has to do with transportation, so it's possible now for 1½ people to produce food and fiber for 18½ of the rest of us.

A good farm today which has fertile soil produces the food and fiber for the farm family first and then the surplus goes to town. That's the part upon which you and I live, but there are farms that were once fertile that no longer are. Perhaps there is enough food for the farm family and maybe one or two city families, there is that much of a surplus.

Then out of 6,000,000 odd farms in America there are hundreds of thousands that no longer produce any surplus and if there is no surplus, there is no city. In other words, the farmer himself can still scratch out a living for himself after all the city people have starved.

Now, if you think this idea of starvation is something that shouldn't be brought up in a meeting like this, I just call your attention to the fact for instance that India alone—with birth rate and death rate comparable to the United States, which they don't have—in one century could populate not one, but five earths as full of people as we are today. In other words, the population of the world is going up and up—twice as many mouths to feed as 100 years ago; and the acres of the world are going down.

So, we think conservation is primarily in the long run a city problem and we [Friends of the Land] are trying to reach those people.

MR. ZAHNISER: Our problem of providing recreational areas in the outdoors is also a city problem. It's the congested, complicated, nerve-racking life of the city that makes it so essential to establish and maintain these natural areas in the country. So where they were speaking of basic things as Ollie Fink is, or recreational problems, it certainly is a city problem.

MR. FRED J. POYNEER (Iowa): I think we all agree in this discussion with Mr. Mann's remarks that it's also a matter of appreciation. That's what we are trying to develop, and I like the part of his paper that referred to the developing an appreciation among the children.

I just want to pass on a little idea we have in Iowa. It might be of use to you.

We have very wonderful cooperation in our state between the conservation commission and the sportsmen group—the Izaak Walton League or fish-game clubs, whatever you call them, and their constant request is: What can we do?

Fortunately they have gotten a little beyond the stage where they all think they ought to raise game and all have a fish pond and improve the fishing. They have found we can raise fish better than they can in each county. They are still anxious for something to do; and we feel it's our obligation to help them.

In the last two or three years, we have had 8 or 10 Nature Schools, in cooperation with the state sportsmen. They select boys from over the county. We don't have large cities, but we have an even distribution of the boys from small towns and fair-sized cities and the township schools. There will be 60 or 70 of them selected from the boys. The boys are 13 to 16 years old. The boys pay $1 or $1.50; and the Club carries the rest of the expense.

They have an evening program. The staff is furnished mostly from our state personnel. We have a fur man, a bird man, a fish man, a firearms instructor, and there are conservation soil men usually gotten from the county. Bird experts are gotten from the local colleges and these boys are taken out on a bird hike the first thing in the morning, and they might make a marsh study—looking at all kinds of aquatic life. They will go on to the river where the fish leader will make the boys want to help to identify the fish. A man is along with a bird dog; and he shows them how a bird dog works. A man with a coon dog shows the live coon carried along.

That evening they drop into headquarters and our bird specialist gives them some movies, slides, on birds. The next morning they head up various other trips. At about 11 o'clock the family will drive in with a picnic lunch. There are services at noon.

This thing has become so popular that our big trouble is trying to keep all the "adult" members of the conservation clubs and the Izaak Walton League from attending.

We know it works. It's going to be a great aid to conservation groups.

CHAIRMAN WADE: This Iowa program sounds very fine; many of us will follow it with keen interest. It shows that Iowa is awake throughout, from commissioners down through to the sportsmen and children.

It does, by contrast, make one wonder what is happening in some other states; and brings up a phase of this wildlife conservation education that we have rather neglected in all of these education sessions to date. It is a terribly touchy subject; and my remarks on it are not directed against any one I see in this room or at this Conference.

In some states it is fairly well known that the wildlife policies are largely controlled by the decisions of commissioners, who in turn may be controlled by a few "powerful" individuals within the state. This is not at all a healthy condition, especially if and when the powers-that-be show they have not kept up to date on wildlife management ideas. No, if some of these commissioners haven't had a new, constructive idea in 20 or so years, isn't it about time they either got out, or got educated? And, I don't mean educated "politically," either (they'll get that); but education in fundamental ecological concepts and sound, long-term conservation. The same should be applied to the "powers-that-be."

MR. JOHN ANDERSON (Ohio): A few minutes ago you asked for a show of hands of the teachers who were here from San Antonio. If you haven't already done so, you should also ask for a show of hands for the outdoor writers. They are meeting here in conjunction with the North American Wildlife Conference.

Last night the first speaker on the program was an outdoor writer. One of his points was the need for public education. He stated that the hunter did not read the stuff which we write in the *Journal of Wildlife Management.*

There was a corps of outdoor writers sitting right beside the speakers' table. I would predict that the second paper, which was Al Hochbaum's accurate analysis of the duck picture, will not appear in any of the hunting and fishing magazines in the next month; and that I will go back to my state and read the outdoor writer's column that appears daily, and it will continue to give story after story about how Fred Smith got the rabbits over on the old Jones' place. There just won't be any mention of Hochbaum's paper; and as far as I can see, Hochbaum's paper could be published word for word. The outdoor writers don't have to change it either, and put it in duck hunters' language, because Al used plain, simple, logical, personal, ethical appeal. It's language just as good as that of the outdoor writer. If the outdoor writers are going to continue to ignore the things that men like Al Hochbaum put out, perhaps it's up to us as biologists to pay a little more attention to them and their various magazines.

I asked one outdoor writer about this, and he said, "Well, if you don't like the stuff we write, why don't you write to our boss and tell him you don't like it. Then the boss will know that there is at least one customer who reads my column, and, therefore, he will pay more attention to the stuff I am writing and I can afford to put out better stuff."

I think that is something the biologist should think about.

Chemists come on the radio every week—better things for better living, new chemistry, and DuPont will be with you again next week at this time. Do you tell the pheasant hunters and rabbit hunters and duck hunters that we can possibly have better duck hunting through biology, and 'step it up' just the same way the chemist does? He sells his profession. Why can't we sell ours?

CHAIRMAN WADE: You are exactly right in asking these questions, which are extremely timely and important. In New Hampshire I have questioned many hunters and fishermen, asking them where they get their information on wildlife. They read it in the sporting and outdoor magazines; and if they are reading a high-class brand magazine, and getting correct knowledge, information, then those magazines are doing a good job. I would suggest, if we wouldn't be accused of getting a commercial taint, or whatever it is, that we ought once a year to pin on a rose, right at this meeting, for the sporting or outdoor magazine that has shown the most improvement in forwarding "sound" conservation during the year; and then watch the writers.

I know which one I read. I will plug for it because its writers are largely on the job. They are at least trying honestly to find out what's going on. They even join organizations that are supplying the technical information and they are really 'stepping' in there. Some of the others haven't caught up yet with the fundamentals.

# GENERAL SESSION

## Wednesday Afternoon—February 5

*Chairman:* EDWARD W. ALLEN
Chairman, International Pacific Fisheries Commission, Seattle, Washington

*Vice-Chairman:* J. L. BAUGHMAN
Marine Biologist, Game, Fish and Oyster Commission, Rockport, Texas

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## WILDLIFE AND BUSINESS

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## CONSERVATION DAY PLEDGE CEREMONY

CARL D. SHOEMAKER
*National Wildlife Federation, Washington, D. C.*

This is a day for every American to face the truth about our natural resources. The truth is that due to past misuse and the war's terrific toll, our God-given riches have dwindled to an alarming stage but today, Conservation Pledge Day, is also a day of hope because its purpose is to enlist every man, woman and child in America in the fight to save our natural resources which are the life blood of the nation.

Here is how this all came about. Last year, one of the national outdoor magazines, *Outdoor Life,* and its editor Raymond J. Brown, decided to do something to awaken all Americans to the dangers which menace our national wealth. For one thing, its editor knew from the lessons of the First World War that these important war years would see a tremendous increase in the number of anglers and hunters. He also knew that without sharply stepping up conservation measures such an overwhelming demand would result in the destruction of our treasured wildlife. That would mean the end of sport.

You know all too well that right now our game and fish are facing the greatest crisis in history. To help meet this emergency, Mr. Brown conceived the idea of a conservation pledge, one which would inspire every American to save not only our wildlife but all our natural resources. He enlisted the support of an advisory board of distinguished American conservationists, scientists, and educators. Then the magazine sponsored and financed a free and open nation-wide competition to develop a Conservation Pledge. In other words, Americans were invited to write their own pledge—with $5,000 in cash awards as an incentive.

Thousands upon thousands of entries poured in from every corner of the land. From these a committee of judges, consisting of the advisory board and the editors of the magazine, agreed upon one pledge as best suited to serve as America's Conservation Pledge—simple, inspiring, easy to learn and remember.

In Washington, last December, this pledge was formally presented to America. It was accepted for the American people by Secretary of the Interior Krug, head of the department which is one of the custodians of our natural resources. At that time, Secretary Krug and other government leaders indorsed the idea of designating today as Conservation Pledge Day. And so today America's Conservation Pledge is being adopted and recited in schools and by many civic and patriotic bodies all over the nation.

We, of course, are particularly concerned with America's wildlife. We are scientists and technicians. Quite likely the general public does not understand many of the terms and practices we employ. On the other hand, it may be that we, ourselves, do not have an adequate conception of the tremendous value of gaining public understanding and support for our efforts, devoted as we are to our highly-specialized procedures.

Thanks to America's Conservation Pledge, we will have that support. For, the people of America are now being aroused to the critical need for conservation—not only of wildlife but of all our priceless natural treasures. The Conservation Pledge will enlist the men, women and children of the country in the fight when we and other conservationists are carrying on. We will have behind us the full power and influence of public support.

There, Ladies and Gentlemen, is America's Conservation Pledge. (The Pledge was unveiled on the stage.)

Let us, every one of us, adopt it today and uphold it ourselves. More than that, let all of us do everything in his power to have this Pledge adopted and recited regularly in the schools and at all patriotic assemblies in our home communities. We can perform a vitally important service for conservation education by encouraging widespread use of this Pledge.

And now, let us all join in reciting America's Conservation Pledge. Will you all please rise and repeat the words after me.

> I give my pledge as an American to save and faithfully to defend from waste the natural resources of my country—its soil and minerals, its forests, waters, and wildlife.

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## ECONOMIC IMPORTANCE OF THE FUR INDUSTRY

G. DONALD GIBBONS
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It is rather interesting to recall that whereas furs were used by primitive man as a body covering and for a protection against the elements, incorporating the first major style change—from fig leaf to furs, civilized society up to recent years considered furs an item of luxury for the privileged few. Now, at least in America, furs are again used by great masses of people as necessary apparel. There are two possible reasons for this change: first, habits and customs of American home life have developed a need for warmer outer garments—the American home with its central heating system makes necessary the use of light forms of clothing inside and greater need for warmth and protection of fur garments in the outdoors. Secondly, the automobile has made fur garments more of a necessity than formerly.

In answer to recent inquiries regarding the magnitude and importance of the fur industry a top executive of one of the fur associations said, "Don't you know that the fur industry is famous for not having any statistics, reliable or otherwise?" There is more truth than poetry in this statement.

First of all there are no reliable records of the total annual domestic catch of furs. Secondly, the value of a pelt is not readily defined, for the texture, density, color and condition are matters of individual appraisal, therefore, there are few recognized standards of value. Thirdly, processing of furs does not lend itself to blueprints and specifications, for the methods used are mostly refinements of very ancient techniques and are zealously guarded as trade secrets. In the fourth place, the manufacturing of a fur coat represents the effort of an individual artisan and, therefore, is a product of craftsmanship and design rather than a product of the machine. Lastly, when the fur coat is ready for market and offered at retail the customer finds few standard brands or other means of identifying quality.

Judge Rosenman who just recently left the quiet and peace of the

White House to become the counsel for the American Fur Manufacturers' Association said that it took him 2 years to realize that a let-out muskrat was not a rejected animal and that a broadtail, as you probably know, is a very young lamb of the Persian variety. Judge Rosenman said he found after 2 years that it was not an uncomplimentary description of the human anatomy.

Because of these variables and the lack of blueprints and standardization throughout the entire industry from trapper to consumer, the layman is confronted with what appears a veil of mystery. However, a peep under the veil would show an industry of great magnitude and major importance from the reaches of the deep forest to Park Avenue.

The industry is divided into three main branches—raw furs, processing, manufacturing and retailing. An examination of each will show gradual development, a definite urge on the part of its members to adopt modern methods, and a desire of a substantial group of the trade to educate the public in order to gain confidence in and prestige for the industry.

Let's take a look at the magnitude of the raw fur branch. Furbearing animals are collected by millions of fur trappers and farmers over widely-distributed areas of the globe. Prior to World War I, Leipzig and London were the two principal markets for raw furs. The United States raw trade up to that time was a primary source for these two European markets. Daily during the season the American receiving houses, after collecting raw furs from trappers regrouped them, and fur dealers purchased them under sealed bids. The dealers after collecting sizable quantities of each type of fur shipped to the European market, where, after further grading and lotting, furs were offered to the world trade gathered at auction.

There were of course some raw furs like Alaska sealskins that were shipped direct from the source to the London fur auctions. After sale and processing 80 per cent were returned to the American market, on which the American consumer paid 30 per cent ad valorem duty. Just prior to World War I the sale of raw Alaska sealskins was transferred to the United States and shortly thereafter the processing was established here. Also about that time there occurred the first public auction of raw furs in the United States. The auction business in America developed with amazing rapidity, and by 1920 it is conservatively estimated that about three quarters of the world's supply of furs was in the United States. London and Leipzig lost their position as leading raw fur markets, but London regained part of it between World War I and World War II. At the present time New York is definitely the world center for furs. It should remain so in spite of recent evidence of activities on the part of the British interests to recapture the raw fur industry for London.

From information available the approximate value of the annual take of furs in the United States is 100 million dollars. The value of undressed furs imported was $139,500,000 in 1945, but has risen to $207,500,000 during the first 11 months of 1946. It is interesting to note that of the $76,000,000 total imports from Russia between January and September 1946 $54,000,000 comprised furs.

America has been the world's chief source of furs. As the states were settled with gradually increasing population, inroads were made upon the annual fur supply because of the lack of game laws and regulations for the protection of the fur-bearing animals. The depletion of fur resources resulted partly from overtrapping and partly from disappearance of the natural habitat of fur animals. The state and Federal Government through the Fish and Wildlife Service, however, are now doing much to develop controls in conserving our fur resources. But some credit for this I claim for the industry, for many of its members took the initiative in the field of conservation. As far back as 1899 Colonel Philip B. Fouke wrote the governor of each state and the president of every legislature urging the passage of game laws to regulate the seasons of trapping.

Fur farming has offset to a degree the depletion of some fur resources, and is growing considerably. It is estimated 20 per cent of the total annual value of raw furs comprise the farm- or ranch-raised furs, such as mink and fox. These farms have many million dollars invested in breeding stock and equipment, and their economic contribution to the industry is most significant. It has its hazards, though, as I was explaining at luncheon today. The mink raisers have followed the advice of the trades which developed very dark mink for milady's fashion. They exercised their prerogatives, changed their ideas. Now they want light muskrat and it takes 5 years in the ranch raising them to change their color.

Studies are being made in the quality and primeness of furs, both wild and farmed, and in improved methods of trapping and pelting. Whereas the method of skinning, stretching, and drying of raw furs is comparatively simple and has not changed basically since biblical days, it has shown gradual refinement. The real intrinsic value of any given fur pelt is in the quality, color, and texture, but this value can be quickly affected unless decomposition and deterioration are immediately arrested. I was amazed to find a few days before I left St. Louis that there were literally thousands of packages of furs coming in from the trappers containing furs of all description and all different grades of decomposition, a terrific economic loss. There is now closer cooperative effort between the fur merchant and the trapper, as evidenced by the fact that one auction company employes a number of fieldmen at all times, educating the ranches and trappers, who of course are mostly farmers and farm boys, in the best methods of pelting. Also between 30 and 40 skilled men are sent each year to the Pribilof Islands in connection with the blubbering, skinning, and improved curing methods on Alaska fur seals. Such close cooperation enhances the value of furs and is, therefore, of great importance both to trapper, processor, and manufacturer. The general level of the industry is raised through better control of quality and standards.

Processing of furs is the second major division and is an extremely important factor in the fur picture. Having been closely connected all my business life with the processing end, I can perhaps be allowed a little prejudice in this respect. To the processor is entrusted the intrinsic value of the skins to preserve their beauty and wearing quality. At all times furs in the hands of the processor are in a perishable condition and, therefore, every 24 hours of the day and night there is need for great vigilance. In many ways the processor is the hub of the industry, for to him more than any other person is entrusted the decision of what constitutes prime condition in fur and pelt, proper trapping and pelting. Also what methods of dressing and dyeing are particularly suited for each kind of fur and will to the greatest degree fit in with the designs and needs of the manufacturer.

Fur processing has not made the advances that have been made in other kindred products like leather. The leather trade has its research laboratories in cooperation with at least two large American universities and great progress has been made towards laboratory control, and the development of new and improved tanning methods. However, it must be taken into consideration that the leather processor is interested only in the flesh side of the skin, whereas the fur processor is interested in both the fur and the flesh side. The fur dresser is aiming for soft, pliable, stretchable leather, reduced in thinness to the utmost degree consistent with proper tensile strength, whereas the leather tanner is primarily interested in leather of minimum stretch and maximum wearing qualities. Therefore, the development in leather manufacture has little application for the fur processor.

Formerly fur coats were utility garments, the pelts of which were comparatively stiff. Modern fur manufacture requires pelts with the drape ability of cloth and the fur processors have made great strides in this respect. In the more crude methods of fur dressing there was a gradual deterioration in the tensile strength of pelts. Even the natural animal oils in the pelt breakdown and adversely affect their strength. Better dressing methods and better controls are now producing pelts of increased tensile strength and less deterioration sets in. During the last 10 years, for instance, we have been able to increase the tensile strength of the fur pelts over 25 per cent, adding substantially to their market value.

The dyeing of furs has mostly changed from vegetable products to aniline, making possible a larger degree of laboratory control and enabling furs of little market value to be dyed to imitate the more costly ones, greatly increasing the value of large groups of pelts. Plastics have come into the fur picture in recent years in the form of Mouton. In developing Mouton, modern methods of chrome leather are used and plastic-like materials are employed to de-kink the curl and develop luster on sheep shearlings. Less than 20 per cent of shearlings are suitable for such process, but each pelt used increases in value greatly over its original value for leather. Approximately two million shearlings formerly used for leather are now being processed for Mouton.

Formerly Leipzig was the seat of the fur processing trade. Now it has shifted to the States. The annual United States fur trade bill for dressing and dyeing all types of fur is approximately $45,000,000, but this is insignificant to the actual contribution made, for most furs are enhanced in market value many times the processing fee.

The third major branch of the fur industry is manufacturing and retailing. Up to the turn of the century little was expected of a fur coat other than it be a piece of apparel to keep the wearer warm, and comparatively few classes of furs were used. Through the ingenuity of the processor and manufacturer quantities of fur-bearing animals not formerly used have been made available for the market, thereby enormously increasing the economic importance of the industry.

The manufacturing of fur garments comprising matching, cutting, designing, requires great skill and craftsmanship, and has developed in America to a greater degree than in any other fur-consuming country. The American fur manufacturer has adapted his design to the comfort and tastes of American women. Fur garments here are better made than in any other country. There are more women wearing fur garments in America than in any other country, and American women are better informed on fur values.

Fashion and promotion play a continually increasing important part in the economics of the industry. The fashion rightness of furs is receiving the attention of the trade as never before, and fur consumers have become style conscious, and fashion has taken on a growing significance. This style consciousness is also recognized in the demand for new colors in dyed furs and new effects in natural furs such as mutations. It was not too many years ago when the mutation fur was an oddity, thrown under the bench of the fur grader to be collected by the glue maker. Quantities of platinum and white mink were so discarded at the St. Louis fur dealing houses.

Since the imposition of 20 per cent excise tax on furs, it is possible to gain an accurate estimate of the value of fur garments at retail. For the fiscal year ending June 30, 1944, approximately $58,750,000 was collected from excise taxes; in 1945, approximately $79,400,000; and in 1946, approximately $91,706,000. This suggests that the present annual value of the fur garments sold at retail is over $500,000,000. Perhaps a good perspective of the fur industry can be gained by a comparison with other industries where statistics are available through the amount of excise taxes collected. Over the fiscal periods from 1942 through 1946, fur taxes exceeded the amount collected for toilet preparations. Collections from jewelry in the same period amount to about double that of furs.

So far we have discussed the individuality of the industry and shown, in spite of the many variables, it has developed in its many functions. This has been accomplished without the benefit of mechanization and streamlining that other industries have enjoyed. As to the future, the fur trade looks for effective means for the greater stability and controls that some other industries enjoy. Fluctuations in prices are more severe than in most industries, due in the main to overspeculation, undercapitalization and excessive use of credit facilities by some sections. The fur trade has been the first to feel the effects of approaching business recession. Faced with increased prices for essentials, and many essentials being available for the first time since the war, the consuming public has less to spend on furs.

This season in addition to consumer resistance to all inflated prices, there have been other factors that contributed to the severe drop in fur prices. First, the advance publicity about the reduction or removal of federal tax on furs, next the unseasonable weather, the possible change in dress styles, and also the adverse publicity on radio and in the press about the fur market weakness. Whereas each major branch of the industry has its trade associations, there is no voice that speaks for the fur trade as a whole. There is definite need for a public relations bureau or some centralized bureau for the dissemination of reliable information about the fur trade. One recognizes a feeling of great need on a substantial part of the industry for greater cooperative effort within its own associations and with other trades.

There is growing interest on the part of the trade in the conservation work of the states, the government, and the Wildlife Management Institute. The benefit of close cooperation between the fur industry and the government can be judged by the splendid results in the consrvation and marketing of the United States Government Alaska sealskins. The herd that originally held 4 or 5 million animals was reduced by needless slaughter to 120,000 animals by 1911. Since that time the herd has been built back again to over 3 million and well over 1,000,000 pelts have been taken for market. During 1946 nearly $3,000,000 was turned into the United States Treasury from the sale of processed Alaska sealskins. The rebuilding of the Alaska seal herd is generally considered the greatest piece of animal conservation in history. An excellent job done by the U.S. Fish and Wildlife Service has been one item to conserve the seal herd. The South African Government, Uruguayan Government, and other governments have taken up in other parts of the world the conservation of whole families of animals like chinchilla and nutria.

There are other valuable fur animals badly needing the cooperation of industry and government in the interest of conservation. The setting aside of more restricted areas and preserves for fur animals is imperative to increase the production and to build up this great natural resource. On the other hand, the value of animals such as beaver and muskrats to the propagation of wildlife should be recognized. It is becoming more and more apparent that the marshes credited to and maintained by muskrats and beaver have a great deal to do with the increase of fish, ducks, and geese.

Most significant is a suggestion contained in the annual report of The American Fur Merchants Association—that the raw fur trade might consider the advisability of setting up a cooperative research unit to cover fur-bearing animals under the auspices of the Wildlife Management Institute, similar to the research units backed by other trades now in operation in 10 states. The major part of the present research naturally deals with game rather than fur animals because money is contributed from the arms and ammunition companies and the state fish and game commissions. We understand that there exists an excellent opportunity to interest research on fur animals in some of these institutions if the fur trade would be willing to contribute with the understanding that money be specially earmarked for fur-animal studies.

Other sections of the industry, such as the dressers and dyers would well afford to consider cooperative research under similar auspices. The benefits would be twofold, for it would not only bring capable young men of college education into the field of fur research, but it would bring members of the fur trade into closer contact with colleges and universities. The present generation of fur men are coming into the industry with a background of college education, and these men would naturally have a very sympathetic attitude towards scientific research. I have been quite impressed with the young fellows who are now coming into the fur industry. In many cases, they are sons of foreigners but they are receiving college education and in the main they are very sympathetic towards the more constructive practices and features of their industry and are anxious to have it less highly speculative and be on more solid ground.

The major benefits of cooperative research projects to the trade would not be direct. But the indirect benefits in the way of public education to develop a more comprehensive understanding of the value of furs as a natural resource and the need for perpetuating this resource would be very real. Some of us in the industry feel that the fur trade is of such importance economically to the welfare of the United States that cooperation with the Wildlife Management Institute in research and conservation is imperative. We also feel that such a program would raise the general level of the whole industry in the eyes of the public.

# ECONOMICS AND HUMAN PSYCHOLOGY IN WATER POLLUTION

KENNETH A. REID
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Water pollution is a changing thing and what I might talk about today is largely dependent on recent developments, the last one being last Thursday in Washington. Economics and human psychology in water pollution, I think, are two of the biggest factors that have prevented its solution up to date.

Twenty-five years ago my organization, the Izaak Walton League of America, made its first objective control of water pollution and I think it is fair to say that it has worked conscientiously, continually, and hard on that job. Through its local chapters and in local communities, it has caused many civic improvements to be put in, and through the state divisions it has been either directly or indirectly responsible for much of the state legislation now on the books, but when we took inventory about 11 or 12 years ago, after working some 14 years on those two channels or through those two channels of local education and party prodding and state legislation and guiding, we came to the rather discouraging conclusion that the sum total of water pollution was greater than when we started.

As fast as we would bat one down over there, a new source would pop up over here, so it was then that we inaugurated the movement for federal control of pollution. The first bill was the Lonergan Bill in January 1936, and it wasn't long until there were a number of others purporting to be pollution-control bills, but not one of them giving one iota of any authority to any agency to control any pollution; and the people who supported those bills claimed that state authority was adequate.

It seems to me that that is a silly statement because it was self-evident that it wasn't. The states had the authority or had the opporunity to give themselves the authority to control pollution all these years, and the job was farther from being done than it was when we started. In other words, pollution was increasing, and when you find state hospitals under state health dapartments pouring their raw sewage into public water and particularly find state health departments getting up and saying, "We don't want any big bad federal government in here, we are entirely able to take care of our own." I say go back and wash your own hands before you open your mouth.

We are in a most embarrassing position to deal with polluters when the health department of the state is itself a prime offender. If you will check up you will find that is very common. In fact, the states where that does not pertain are the exception rather than the rule. Some of the people who opposed federal control of pollution back in 1936 said, "You are precipitant. Give the states a little time, 5 years, 10 years at the outside. They will have the job done and you won't need any federal control."

All right, 11 years have elapsed and again a check-up will show there is more pollution today rampant in these United States than there was 11 years ago and there was more 11 years ago than there was 25 years ago. So let's quit kidding ourselves! Let's be realists. Sure, a lot of good has been done but it has been like trying to build a new roof on a house to keep it from leaking while a whole flock of termites are eating at the foundation without anybody trying to stop them. We have got to get the realists in this thing, look at the economics of it and look at the human psychology. I want to touch on the human psychology first.

Why has the state control of pollution not been effective? Just look in a mirror. Be honest with yourself on human nature and you will get the answer. People are not altruistic en masse or in corporate bodies when it comes to digging down into their pockets and spending money for the benefit of the other fellow and that is what pollution control amounts to.

Unfortunately, pollution flows by gravity along with the water and the upstream state isn't one bit interested in benefiting the downstream state, if it is going to cost them any money. Sure, we read in storybooks about this fine altruism and there is some fine altruism in the conservation circles, but outside of that I think it is doggone scarce.

Why aren't states effective beyond that? There is an old moss-grown argument that is rather plausible and it is eminently effective and all these years it has done more to prevent correction of water pollution than any other thing. Briefly, it is this, that to pass such a law to control pollution in my state would penalize the industries of my state, put them at a competitive disadvantage with the industries of the adjoining state and drive them out of the state. Look at all the employment and all the payroll you lose.

I don't suppose any of you have ever heard that. I want to tell you it is just as effective against the enforcement of state laws as it is against their passage. I have seen it time and again absolutely nullify well-drawn legislation. In my state of Pennsylvania, a bill I helped write and pass in 1927 was an absolute dead letter simply because the group in power didn't want any interference with industrialism in the state.

If you have a federal law in the background, it eliminates this competitive disadvantage and puts all industries on a level, competitive basis eliminating such inequalities as may now exist by reason of one industry out of the goodness of its heart or because some good conservation organization was out there prodding a little bit to do something about it. It eliminates the competitive disadvantage that that industry may have been placed in and that is the form of legislation that we are now seeking, giving full recognition to the primary responsibility and authority of the states to control their own water pollution, but in the background having the big stick waving there for cases when the state or an interstate compact, as the case may be, has demonstrated either its unwillingness or inability to do its own job. I don't see how any state that honestly wanted to do a job could object to that kind of legislation.

Sure, I could see how some of them could object to it who wanted no one on the job and had no intention of doing such a thing. There are some states in that class. The other essential we have always maintained for pollution-control legislation was a ban on new sources of pollution. I am not talking about one initial house put on a sewer system, but I am talking about a big industry put on an unpolluted stream. Certainly we can't get anywhere in correcting the present pollution unless we draw a line and say "Pollution shall not cross that line."

All we are doing in advocating that basic fundamental is just what the medical profession always does with the contagious disease. The first thing it does, it quarantines a disease before it attempts to cure that disease, and certainly pollution is a contagious disease water-born.

To get down to current status, for 10 years there has been a cat-and-dog fight in the National Congress between the conservation organizations, on one side, that said, "Better no bill than a dishonest subterfuge that would kid the public into believing that a pollution-control bill had been passed," when no control was in the bill, and certain other agencies spearheaded in the background by some polluters and unfortunately supported by many state health departments advocating spending a lot of money for study and investigation, but providing no control.

For 10 years, that cat-and-dog fight has gone on. I have become very tired of it. Probably a lot of you people have, and last October the Council of State Governments invited me to sit in on their conference with a number of these agencies, or whatever you want to call them, that previously had opposed every vestige of control in water pollution. I knew it was going to be me against the field, but I went anyway.

I managed to drag Dr. Gabrielson in. I don't mean he was reluctant, but they didn't invite anybody else in the conservation department except the Izaak Walton League, and I didn't want to be absolutely alone in that thing. I found out after that conference that some of these people in the engineering profession and public health profession and interstate compacts and what not, had an idea that the Izaak Walton League was radical and unreasonable and that I personally had horns on me, but before we got through with that meeting some of them were pretty good friends.

When we had our second conference in New York, instead of being me against the field it was on a test vote—on one side eight and three on the other, and the eight were on my side, so we are making progress.

What we have been trying to do is to get the two divergent views together on a common ground and have one draft in this Congress, and we came very close to doing it. At the conference in New York late in November, all these conferees—I won't take time to name them except the National Association of State Health Officers and the National Association of Sanitary Engineers and various interstate compacts—you know these compacts are becoming quite active recently to avert federal control and a lot of states have become very busy in passing additional state legislation fearing federal control will come in.

At any rate, after having the New York meeting, we agreed pretty well on basic principles. Then Arthur Weston of Massachusetts proceeded to whip into shape all these notes in a draft of a bill, hoping we could all get behind one draft. I didn't see it for a week after it arrived because I was away and Hudson Berry of Cincinnati apparently liked it and turned it over to Spence to introduce. When I saw it, I saw a few things that had been overlooked that we agreed at that conference, and when Carl Mundt came through he found some more. We worked up a draft of that bill with some slight changes and he took it to Washington, compared it with Spence, and had a conference with him.

The idea was to try to get the two of them to introduce identical bills. Because of this 10-year fight, we would have a terrible time explaining to you people that the Spence bill was a good bill and those of you who supported Spence in the past would have a terrible time explaining to your people that the Mundt bill was a good bill.

Therefore, we wanted two identical bills. We didn't quite achieve that. After Spence and Mundt got together, some of Spence's supporters tried to make it appear that I was welching. We didn't agree to any draft in New York. We didn't have any draft before us. We were taking notes and discussing the thing which Weston wrote up afterwards, and human errors will naturally creep in. All we ever insisted upon was a ban on new sources of pollution and federal authority in the background to be invoked when the state fails to do the job. That represented our statement to this group. I said, "Write your own bill."

He did a pretty good job and for the first time these bills are all the bills introduced in Congress to date and they have some pretty effective control in them. There are just minor differences that I think can be ironed out. I have had shipped from Chicago mimeographed copies of this composite bill so that you could see at a glance what little difference there was in the Spence bill and the Mundt bill.

The Austin bill is exactly the same as the Spence bill, and I just saw a copy yesterday of another bill in the Senate from Barclay and Taft together, which again is an exact duplicate of the Spence bill, so that we have in the Congress today actually only two bills although in number there are four.

The bill that we favor is H.R. 123—that is an easy number to remember. The Spence bill is H.R. 315. Unlike previous comparisons, the Spence bill is a fairly good bill. There are just a few things in it that were overlooked and that ought to be in to clarify and make it what it was intended to be at that conference so that the latest plans—I talked with Spence and Weston and Mundt in Washington last week, and I have talked with most of these conferees over long distance telephone—they are all agreeable to going to the hearing in Washington. In fact, the Congressman will invite them and suggest they come to the hearing one day in advance and get together amongst themselves and iron out these little differences. I think those little differences can be ironed out and we can all be behind one draft, so I am going to make a prediction this year that I have never done before, that the United States Congress this year will pass a pollution-control bill that will be effective and that we can end this 10-year cat-and-dog fight.

Lord knows, we have plenty of other big jobs to do and we would be delighted to have this pollution thing out of the way. The state agencies that were formerly opposed to the conservation agencies—I mean state health departments—are all in on this thing. Now, with your help, we can do this.

There are just slight differences in these two drafts and I think they can be ironed out and we can all be behind one draft. The state conservation departments will be kept advised of developments, and we will be glad to send them copies of this composite bill so that they can see at a glance just what the difference is.

I can't help but remark just briefly on a few other things that are vital.

Somebody in the hall here asked me to make a few remarks on certain things. I made a few the other day in connection with Charlie Jackson's talk. I just want to say to you that the American public is stuck for 6½ billion dollars according to the figure given me by Congressman Dondero of the House Public Works Committee last Thursday. No man knows what all has been authorized or what it will do. It is high time that we call a moratorium on these grandiose engineering projects, bring them out and look them over, and give the biological surveys provided for in Public Law 732 a chance to become operative, a chance to begin to catch up with the engineering surveys.

I refer both to the Bureau of Reclamation and the Army Engineers Corps in that respect. It has become the most dangerous thing in this Nation today with the possible exception of the public land grant. Perhaps they are on a par, but it is high time we call a moratorium on those things. When Congress is talking about the major economy, there is no more fertile field in this land than to curtail the blind engineering developments on our rivers. Some of them are all right, yes, but we don't know whether they are all right and the engineers don't know whether they are all right, and the biologists certainly don't know. Let's find out before we do it. Instead of going blindly ahead on building more dams for power where in many cases we have a surplus of power, building enormous dams for irrigation of land where according to some economic trends I have heard lately we will be paying farmers not to raise more food long before these irrigation dams are done. And as for inland water navigation, I just invite an opening of the books to show the record of what the actual cost is on some of these fantastic river projects that we have now.

If we do that, I wonder if we want any of it. It is time to go slow, time to look into those things, take stock, see what we have and not go hog-wild. I don't know but what atomic power may revolutionize a lot of things. Maybe by the time we get a lot of these big hydro-power plants built, they will be out of date.

And as I said just briefly yesterday, I don't want to be critical of the Army Engineers or the Bureau of Reclamation. They are just human. Fellows, you ought to criticize your Congressmen and your Senators for permitting bureaus to grow to such size as those with the large forces of salesmen and promoters out. They have ample funds. Lord knows how much. They are feeding stories out to the public all the time in favor of building more dams everywhere all over the country.

We have pennies where they have thousands and they are spending our money to do it. A lot of these dams are perfectly all right. I want it distinctly understood that we are not opposed to dams per se. A lot of the dams down in this part of the country and in Texas and Oklahoma are creating a lot of good which never existed before, but such fantastic things as the hundred odd dams proposed all over the Columbia River which will absolutely exterminate the salmon and steelhead and that monstrous scheme to dam up the Colorado River and pump it through the Continental Divide to run down the Arkansas to raise more sugar beets so we can pay sugar beet growers not to raise so many a few years hence are just nonsense.

It is high time we got down to sound economics and made these things stand on their own feet. You will find many of these irrigation projects will cost $500 to $1,000 an acre. I wouldn't be surprised if the Gunnison, Arkansas, would figure out about $1,500 an acre to work it out on the land, and that is utter nonsense.

# CONSERVATION OF PACIFIC COAST COMMERCIAL FISHERIES

W. F. THOMPSON
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We have heard for many years that true conservation is the utilization of our resources in such a manner as to secure the greatest possible permanent yield. It is my purpose to tell you today of what I believe is a very encouraging recognition of this fact, in fisheries on the Northwest Coast.

Business concerns have, of course, long acknowledged the merit of conservation of resources, as an ethical principle. In fisheries, they have been content to leave regulatory measures to the government. It has not seemed to be of enough vital concern to lead them to make their own inquiries as to the facts upon which these measures must be based. But in the spring of 1945 the Bristol Bay packers of the Alaska Salmon Industry undertook to invest their own funds in an attempt to increase the knowledge necessary in framing these regulations. In 1946, the Southeastern Alaska branch of the Alaska Salmon Industry, Inc. took initial steps to the same end. These decisions are very important because they mark the passing of an old attitude of mind, the passive acceptance of conservation regulations by men interested solely in carrying exploitation as far as the law will allow, to one of seeing to it themselves that the job is done as efficiently as possible.

Back of these moves there are at least two recent experiences which have led these men to believe it possible to devise systems of conservation which will more than repay their cost. They have not been persuaded by mere assertions that conservation has saved them from disaster, but by good evidence that it has remedied damage done. There has been a vagueness about whether or not regulation has been actually needed, as to what overfishing actually was, and at what stage it has occurred, if it has. Now with the progress of fishery science, something definite has been substituted for mere assertion. It happens that I am familiar with two outstanding cases in which this has occurred and this personal acquaintance will be my apology for dealing with them rather than others equally worthy of comment. I am sure they will be of interest to you.

It is natural that these examples of conservation should be found on our West Coast, because conditions there are favorable for them. There, men of middle age have seen with their own eyes, fisheries in both salt and fresh water which have progressed from virgin untouched abundance to maximum production and then to depletion. The contrast, because of the short lapse of time, is far more vivid than in older countries. Furthermore, the West, even more than our Nation as a whole, has a high standard of life, and our fishermen are not driven by a desperate struggle for existence to a point where thought for the future is blotted out in the consciousness of needs of today, as they are for men in Asia or Europe.

So our western governments reflect a well-developed and vigorous philosophy of conservation. Here again we have been fortunate in the Pacific Northwest, for these governments are few and able to work together, which they have not been able to do in Europe.

Our halibut fishery is found outside the 3-mile limit in large part, and along Canadian and American shores. Its fishermen are of both nationalities. The fish they take are not only on the continental shelf outside territorial limits, but migrate from banks fished by one nation to those fished by the other. To control it, an international agreement was necessary. After long agitation by the industry and the fleet, a treaty was signed in 1924. It could have been signed and made really effective only by two nations similar in ideals, economic standards and legal systems. In this, the Northwest has indeed been fortunate.

This first treaty merely provided for investigation by an international commission, and a closed season during the winter months. It provided joint international control of a section of the high seas, and was definitely an assertion of interest in, and of jurisdiction over, the halibut resources there. As a result of the investigations, carried on by a joint staff and reported on in 1928, a new treaty was signed in 1930. (The Commissioners shortly thereafter included Mr. Allen, the Chairman of this meeting.) This treaty was later replaced, in order that the legal powers given could be extended.

The treaty of 1930 was remarkable in that it contained what was really a modification of the usually inviolate sovereign powers of the signatory countries. To the International Fisheries Commission, composed of two Canadians and two Americans, was given power to investigate, and to recommend laws which limited the catch of halibut by area, closed certain grounds, and established a closed season. While technically speaking the regulations were subject to approval of the two governments, this has been a formality, and the Commission is actually a regulatory body in which Americans write regulations controlling Canadians and vice versa. Later, an enabling act by the United States provided definite legislative action against vessels of any nationality not conforming to the treaty. The precedent should not be forgotten.

To me as director of scientific work, the political significance of the treaty was overshadowed by the opportunity it gave for a comprehensive study of the halibut over wide areas of the sea. Few people realize what this has meant as an accomplishment in itself. A system of statistics has been established, comprehensive and adequate because it could count complete units of the stock of fish. The past history of the banks has been united to that of the present to give a uniquely complete story. At the same time, far-reaching investigations of the life history have been made.

The essential steps made were in sequence: the determination of the areas within which the stock of halibut was an independent unit, for practical purposes; the obtaining of statistics which showed the total yield, the amount of fishing and the relative abundance for each such stock; the analysis of these data to show the fundamental laws of population behavior; and the setting of a limit to the amount as determined by what could be taken from each such independent area, in accord with these laws.

It should be particularly noted that from the statistics, the laws governing the population of fish were discovered and used as a basis for determining this amount. Some of the theory had been advanced before in an obscure paper. In this case, for the first time, the theoretical principles were developed to show how a fishery would actually affect the supply of fish and a vast mass of detailed fact was collected to show that they did so in the expected way. It was shown that the abundance of the stock of fish could be controlled by varying the intensity of the fishery.

It is possible to increase the stock without permanently decreasing the yield by lessening the rate of capture, which is a very large component of the death rate, and one that can be controlled by man himself. The larger the stock the greater the catch per unit of gear, and the fewer the units of gear which have to be employed. In other words reduction of the amount of fishing does not reduce the yield, unless it happens that during the longer life, the losses by death outweigh the gains by growth. That has proved to be true in the halibut fishery. The stock on the banks has increased greatly because the amount of fishing has been decreased. The annual yield has not lessened. The result is a demonstration that it is possible to control and increase the number of fish on the banks, without loss of poundage in the catch, and to fish it much more economically. Whereas in 1930 the stock had been depleted, in one major area, it is now 2½ times as large, while fishing has been reduced 43 per cent, in the other area, the corresponding figures are 2 times and 43 per cent.

The annual take has been increased until the fishery has retraced the path of decline by many years. The biological significance of this greater yield in terms of egg production is yet to be determined. For our present purposes it will suffice to say that the industry has been given a clear demonstration of the power of scientific research to alter the stock of fish and to provide the facts which men wish when they want to deal intelligently with their industry. It has shown in the account books and bank balances. It has made a difference in the attitude of businessmen.

The second instance of which I wish to speak is the work of another international commission, officially known by the long title, International Pacific Salmon Fisheries Commission. (Of this our Chairman is also a member.) This regulates the fishery for Fraser River sockeye salmon. The mature sockeye, usually 4 years old, passes through American and Canadian waters, enroute from sea to fresh water to spawn in gravel beds far up the river. Formerly, the United States took over half of the fish, now Canada does. It was inevitable that this joint interest should require a treaty. The treaty establishing this commission was under discussion for many years, and was actually signed in 1930. It was not until 1937 that it was made effective by Senate ratification after addition of several safeguarding understandings. We like to think that the success of the International Fisheries Commission in the halibut had something to do with the final willingness of the fishermen, canners, dealers, etc., to accept the salmon treaty.

Here, too, there is in principle a mutual surrender of sovereignty between two nations. There is a joint staff of research men, and joint jurisdiction over the whole area of the Fraser sockeye fishery. The work began in 1938 and was immediately focused on a practical and urgent problem. Positive results have been attained. The tremendous run into the Fraser had been lost during construction of a railway through the Fraser Canyon. It was a cyclic run. That is, it returned every 4 years. At present prices it would be worth about 45 millions of dollars each year, with three lesser runs on intermediate years. An attempt was made to remove the dumped rock which caused the damage, and although this was thought to be complete, the runs did not rebuild themselves, except for certain *late season* runs which passed at water levels not affected by the obstruction. The stage of depletion of the various races through the Fraser was shown to be explainable only by the presence in the canyon of this obstruction, blocking the river the particular levels at which these various races passed. The races showing a maintained run or improvement were those which did not pass through the canyon or which passed through when the river was at levels which were open.

The history of the declining catch was examined; an index to its success of reproduction was designed; and its fluctuations were explained from the beginning of the fishery. The damage was shown to have continued to occur after the year 1914, when the rock was supposed to have been removed. Damage began in 1911, and was most noticeable during the large run of 1913. This large run was affected again in 1917, so that these big catch years had not become stabilized until 1920. At that time a distinct correlation between varying water levels at Hell's Gate and the variations in the success of reproduction appeared.

The declines in 1913, 1917 and 1921 were proved to have occurred or recurred not only in the runs to the river as a whole, but to the several spawning districts, such as Lake Quesnel. The damage has recurred at intervals since.

Large tagging experiments were carried out at Hell's Gate. These experiments showed that fish passed at certain levels and did not at others; that the damage was graduated according to the duration of the block and that it recurred each year for varying periods of time, as the river fell through certain levels.

The index to success of reproduction has shown that the history of the fishery from 1880 to 1911 was explainable, and that its major fluctuations were due to two periods when obstructions were existent. It was concluded, from all this evidence, that the obstruction was still present and in 1943 fish passes were begun at Hell's Gate.

By 1945 a fish pass had been built along one side of the obstructed narrows. The resultant escapement to the upriver areas which had been depleted showed an increase of 400 per cent over that in the parent year 1941. Since the catch in 1945 was about half that in 1941, the escapement must be considered an increase of nearly 800 per cent or eightfold the proportion to the available run it had in 1941. This result confirms the studies which had been made as to the reality and effectiveness of the blockade and is especially significant in that the regulation of the fishery by the Commission had not begun.

Further increase were shown in the 1946 run. In this year regulation had begun and fishways on both sides of the river were operating.

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"... From counts of the numbers of spawners found in the various areas the protected races have shown increases beyond anticipation. It was a pleasant surprise when our preliminary estimates showed that the 1946 escapement to the *up-river* spawning areas was two to five times greater than that found in 1942. Here are some typical examples: compared with 1942, Bowron River increased from 1,800 to 7,300; Raft River from 450 to 2,200; Seymour River from 1,950 to 3,500; Chilko River from 33,000 to 70,000; Stellako River from 48,000 to 250,000. Even the Quesnel River, where no fish were found in 1942, had at least 56 fish in 1946.

"Only the runs to the Stuart Lake area failed to show an increase. The reason is now known. This run passes through Hell's Gate between June 15 and July 15—at a time this year of exceptionally high water. We have found in our studies evidence of a blockade at these high levels but it was not until this year that the levels remained at a high stage and significant damage was actually found. The fish showed the effects of difficulty at Hell's Gate. The commission will install auxiliary high-level fishways this winter to eliminate this difficulty for all time."

A. L. HAGER, *Chairman*
International Pacific Salmon Fisheries Commission

As the loss of fish since the original catastrophe could be valued at half a billion dollars, these results in two successive years contributing toward a restoration of a great run were of obviously great financial value. In this case as in that of the halibut, positive results have been obtained, and these results mean money returns to the industry.

The effect has been very great on the attitude of the industry toward conservation. In these two instances of halibut and salmon, and in others I have neither time nor sufficient exact knowledge to review, it has been very plain that conservation can be made what it has been said so often to mean: rehabilitation of a fishery and its perpetuation at the most productive level. In some cases at least, it can be done by scientific studies which the canner or fisherman can see for himself are valuable.

The increased sense of responsibility for their own sources of supply, which the fishing industry has shown, has brought them to realize very keenly the importance of control of this supply wherever it may be tapped by fishing fleets. In the halibut, extensive studies have been made of the drift of eggs and larvae and of the migration of adults. It has been shown that great areas lying outside the 3-mile limit on long sections of the coast have stocks of fish in common, and that these can possibly be reduced by foreign vessels fishing far at sea. In the salmon, migrating schools approaching the coast can be threatened the same way. In both salmon and halibut, the supply is maintained by conserving action of our governments and industries. These are resources belonging to and cared for by the American and Canadian people. The feeling is very strong that our rights in our fishery resources must be protected against foreign encroachment, however far this protection must be extended to sea. This increased interest in conservation studies has naturally come to a head first in the great salmon industry.

To care for various joint activities, such as these, the salmon industry is organized. The group operating in Bristol Bay and that in southeastern Alaska acting through the Alaska Salmon Industry, Inc. have assessed themselves an amount depending on the number of cases packed. Arrangements have been made to conduct this ncessary research through the University of Washington, so that it will be of the highest possible caliber. It will, of course, be conducted in as close cooperation with the Fish and Wildlife Service as possible.

The salmon industry is also taking an active and continued interest in our international activities as far as they pertain to fisheries.

My reason for telling you of these developments is to point out that if this move is successful and spreads, fishery conservation will have taken a great step forward. As in forestry, where the progressive logging companies have recognized that reforestation is a desirable activity for themselves, so in fisheries the recognition that conservation is good business should change the attitude from unwilling acquiescence to active participation and support. The feeling that more intense scientific study will help to develop more efficient methods of conservation is no reflection on what has been done. It is rather a recognition of the magnitude of the tasks to be undertaken, and the very real profit in them, to industry and nation alike.

## DISCUSSION

MR. H. B. HICKMAN (Louisiana): I didn't understand just exactly what caused that block in the Fraser River. Was it the change in the course of the river making rapids or shooting off the side of the mountain?

DR. THOMPSON: Two railroads are built through the Canadian Rockies and through the Coast and Cascade ranges of British Columbia. The great Fraser Canyon is one of the great river canyons of the West and the only means whereby the transcontinental railroads can reach that part of the Coast. In building through the mountains, the two railroads chose the Fraser River and they dumped rocks along the river. When salmon go up the stream, they must use the eddies to allow them to get from one point to another. The changes in the river caused fast currents in excess of the rapidity at which the salmon could make this ascent.

They had to dynamite these slides out of the way in part and build fish ladders where the river was too great to change. It was 1910 to 1914 that the last railroad was built, the one that caused the greatest damage.

CHAIRMAN ALLEN: Does that answer your question?

MR. HICKMAN: Yes, sir.

CHAIRMAN ALLEN: Dr. Thompson mentioned the International Fisheries Commission, and I shall like to call your attention to the fact that the Assistant Director of the Fish and Wildlife Service, Mr. Milton C. James, is also a member of that commission and is entitled to credit for the work that Commission is accomplishing.

# THIS WILDLIFE BUSINESS[1]

NEWTON B. DRURY
*Director, National Park Service, Washington, D. C.*

Wildlife business in postwar America will amount to between three and four billion dollars annually, according to best recent surveys. This is a lot of money. It is ''big business.''

The surveys, however, touch lightly, if at all, upon the intangible values derived from our store of wildlife. They measure with reasonable accuracy the expenditures by hunters and fishermen, based upon the licensing system by states throughout the Nation, checks on hunters' kills and creel counts along the streams, and similar measurements.

Yet photographers and observers, as well as sportsmen, provide a big share of the wildlife business. The man with a 5-dollar to 400-dollar camera, with attachments, accessories, and film, the man with binoculars and hiking and other outdoor equipment seeking purely esthetic adventures in wildlife, are customers not to be overlooked. So is the man who travels hundreds of miles by rail, plane, bus or boat or automobile, just to get a look at nature's wild creatures, such as, for instance, the mountain sheep of Alaska, the bears and bison of Yellowstone, the amazing bird colonies of the Everglades in Florida.

A visitor to one of our western national parks this past summer, after traveling a round-trip distance of 2,500 miles from his home in Kalamazoo, Michigan, took the trouble to write us: ''We had wanted to see old *Ovis canadensis* (or Rocky Moutain bighorn) more than any other animal in the park—sure enough, we found one—majestic and poised and beautiful, as if on a magazine cover. Few experiences in a lifetime of enjoying wildlife have ever been as thrilling.''

During the 1946 travel year, through September 30, a total of 21,682,782 people visited the 160 area of the National Park System. Undoubtedly, there would have been hundreds of thousands more if transportation, housing and eating facilities had been adequate throughout the country. It is significant that a large portion of this travel was recorded in those great wilderness parks and the larger national monuments, which abound in a cross-section of American native wildlife. The national forests and the wildlife refuges similarly attracted many visitors. While fishing is permitted in the national park areas (in fact, they contain some of the famous fishing waters of the world), the killing of any wild terrestrial animal therein is

[1]Read by Victor Cahalane.

prohibited. Thus while it is impossible to estimate how many persons visited these regions to see, study, or photograph native wild animals and birds, we know from talks with visitors at our entrance checking stations and information centers, as well as from correspondence, that to thousands of visitors this is a major consideration. A large proportion have been more intrigued by the sight of strange or unusual creatures of the wild, living in natural adaptation to their environment and to each other, than they are by the superlative, but inanimate, manifestations of nature for which the national parks and monuments are world-famous. Scientists, teachers, students, and just plain citizens write or ask for specific information regarding opportunities for seeing, studying, and photographing wildlife in general and particularly the rare species such as the American bison, the trumpeter swan, the ptarmigan, the mountain goat, and the bighorn.

There is no formula for evaluating the enjoyment of scenery. The same is true of the observation of wildlife. The value of game as food, and the expenditures for hunting and fishing, can be estimated in dollars and cents; but the thrill of seeing the animals alive in their native haunts cannot be evaluated in monetary terms. All we know is that the amount involved commercially is large. We are sure that the intangible values in contributing to the richness of travel experience are larger still.

Thus, while we do not have figures to indicate exactly how many American people are vitally interested in live wild animals and birds, our experience and that of other agencies leads us to hazard a guess that the figure is at least as large as the number in the hunters' and fishermen's groups. Arthur Hawthorne Carhart, publishing an article in the *Nation's Business* of April 1945, estimates that these latter groups comprised 20 million hunters and fishermen and that their activities represented a national annual business of nearly two billion dollars. He estimated that in postwar times this may be upped to a three-billion-dollar business. A survey by *Outdoor Life* magazine indicates that in the next few years 26 million Americans will go hunting and fishing and that their annual expenditures will exceed four billion dollars! Polling returning veterans, the *American Legion* magazine concluded that 70 out of every 100 want to go hunting and that 62 out of every 100 listed fishing next to hunting as their favorite form of recreation. If, as seems probable, we will have 26 million hunters and fishermen throughout the country in these postwar years, you may reasonably double that number to include all of the people who will travel and spend their dollars for endless necessities and special equipment while seeking various values from our wealth of wildlife resources. A six- to eight-billion-dollar business!

American businessmen, as well as conservationists, can be depended upon to take note of this continuing national asset.

Our realization of wildlife as a local and national resource of the first order is of comparatively recent origin. Like the abundance of forest and forage in the early days of our national history, wildlife was long considered an inexhaustible source of food and clothing. Birds and animals of the wild provided necessaries of life in the rugged process of pushing westward and settling the wilderness. They were taken for granted, and were hunted and taken without regulation or restraint. One of the western railroads advertised and conducted popular excursions into the buffalo country, introducing hundreds of people of that day to the thrill of shooting down these monarchs of the plains. You didn't have to leave your car to do it. Hide and head hunters ran rampant through the West. Countless numbers of the once abundant trumpeter swan were shot for their breast feathers. Such ordinary animals as elk, deer, and antelope were free booty to anyone who wanted to target his rifle or grab an easy piece of meat, a head, or a hide.

Because of such utter disregard for ultimate consequences to wildlife down almost to the turn of the century, once plentiful species such as the passenger pigeon and the heath hen wholly disappeared. The buffalo, once numbering millions, was entirely wiped from the plains. By 1894, only a pitiful few remained on private ranches and in the wilderness protection of Yellowstone National Park. By 1901, poaching had reduced the wild Yellowstone herd to a mere 25 animals. The tragedy of the bison is well known. Some 50 million wild buffalo in about 1870. Only 25 in 1901! The great trumpeter swan by the early 1900's was believed by many to have vanished altogether. Later it was discovered that hunters had overlooked a small remnant of former thousands in the solitary fastness of Yellowstone Park. Elk, deer, antelope, and bighorn were exterminated from most of their native ranges through advance of settlement and, in many localties, either precariously reduced in numbers or wiped out entirely. Traditional prejudices associated with the American black and grizzly bears might well have eliminated these interesting animals from the American scene long ago were it not for their ability to persist in wilderness retreats against great odds.

Early in the present century, some attention was given here and there in local communities to the problem of restoring wild animals to ranges where the original stock had vanished by reason of advance of development. Requests for certain animals have been received by the National Park Service during the past 30 years, and a considerable number of several species, but principally elk, have been supplied from these wildlife reservoirs for restocking purposes throughout the nation. From the refuges of the Fish and Wildlife Service similar contributions to wildlife restoration have been made.

To a group like the North American Wildlife Conference, the recent trends toward increased national interest in wildlife are more or less familiar. Likewise, it may be assumed that all in this group have a general knowledge of wildlife preservation and restoration work which has already been accomplished in this country. The National Park Service is proud of its part in all this. How the last remnant of buffalo in the United States was saved from the very real threat of extinction, how the trumpeter swan was assisted in restaging its successful fight for survival, and how wildlife is now afforded sanctuary in many preserves and special areas not only on national park lands but in lands administered by other federal or state agencies—are rather familiar stories to all of us.

Business enterprise may be expected to cater to the needs and whims of the outdoorsman, to get him to the wild places, to feed him, shelter him, clothe him, equip him, and entertain him. But in order to sustain this tremendous business, it is obvious that the resource upon which it depends must be conserved and not depleted. Our wildlife, like any of our other natural resources, is not inexhaustible. Man has laid a heavy hand on nature in the past, sometimes most wastefully. In many cases through ingenuity, he has been able to recoup his mistakes before it was too late by invoking the aid of science. Science, however, cannot create wildlife. We are, therefore, obligated to take stock of what we have right now and from that point lay our plans for the future, with care and circumspection.

The National Park concept of wildlife preservation, we feel, has much to commend it. The fact that the animals and birds therein are held inviolate gives them special recreational, inspirational, scientific, and educational meaning. They serve their purpose continuously without depletion or destruction. For example, the ungainly but majestic moose browsing among the willows in one of our western national parks on most any summer day may be closely observed, studied, and photographed by 10 thousand persons who have never before seen this animal living naturally in his wild surroundings. The next day 10 to 15 thousand others may derive the same esthetic experience from this same specimen. Through the season even one animal may have afforded unique pleasure, of great though undetermined value, to perhaps hundreds of thousands. The same applies to the mountain goat, bighorn, bear, caribou, antelope, trumpeter swan and to the wide variety of other mammals and birds preserved in the various areas. The more hard-won the observation of these creatures, the greater the thrill.

There is another contribution by the national parks. A by-product of surplus animals normally results in these areas where hunting, killing, or other disturbances by man are prohibited. Surpluses often build up, and these surpluses in many cases are the continuous source of supply to areas adjoining national park areas where hunting or trapping is permitted under state regulation. Surplus animals which become abundant in our national preserves and migrate or drift to outside areas where they provide a continuing resource for the legitimate hunter and trapper include, among others, such important fur bearers as the marten, mink, otter, coyote, and fox, and such esteemed game mammals as the deer, bighorn, bear, and elk. Adjacent to one of our larger western parks more than 25,000 elk alone have been taken by hunters during the past 10 years. These relatively small areas in Montana are among the most famous big-game hunting sections in the United States, due solely to preservation of basic stock which the national preserve affords.

Mention has already been made of fishing in national park areas. This is provided under regulations similar to those of the states. Up to the present time fish have been considered as a renewable or replaceable resource. Through artificial propagation we have succeeded in maintaining fish in the streams and lakes in spite of heavy takes by anglers. It is hoped that through scientific management these fishing resources will supply the legitimate demands which fishermen will make upon park waters in coming years, because this popular outdoor sport has not damaged or destroyed natural features and because fishermen as a group, perhaps above all others, appreciate and derive untold enjoyment and healthful recreation from the wild places, and what they bring home is not measured by the number of fish alone.

The point has been reached in protection of wildlife in the national park areas where we can give quite general assurances that normal numbers of most species will be preserved for generations of the future. Other conservation agencies, groups and individuals well may have a more difficult task than ours where preservation is more definitely coupled with regulated end-use of wildlife resources, or where the outdoorsman must be permitted to take away something which cannot be replaced. But, be that as it may, if we are to continue enjoyment of not only the tangible but the intangible values of "This Business of Wildlife" we must recognize that it must be managed as methodically and scientifically as any large industry in the nation. We must have the best specialists we can muster to guide our efforts and wholehearted publc support in the programs formulated. If wildlife is to remain big business, it must be managed as big business.

DISCUSSION

DR. HARRISON F. LEWIS (Ontario): Mr. Drury's remarks about the minimum reached by vital populations of trumpeter swans and buffalo or bison in the early part of this century must be taken not as applying to those species as a whole but only to those parts of species in the United States. There have never been less than several hundreds of each of these species in Canada and careful protection has been given to them for many years past with the result that in Canada they are also increasing in number.

MR. CAHALANE: That is correct and that distinction should be made clear—that our Canadian neighbors have been much more, shall we say, fortunate and perhaps much more far-sighted than we have.

# THE CONTEST FOR WESTERN PUBLIC GAME FIELDS

J. V. K. WAGAR

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This contest contains all ingredients necessary for intense partisanship, bitterness, and violence. It is genuine, not a show. The principals are: (1) Members of the livestock industry who graze cattle and sheep under permit upon public lands; (2) agencies created to administer these public lands; (3) the public itself, and (4) traditional, legal, and professional policies governing public land use.

Livelihoods are concerned. Pride in toil well done plays a part. The vigorous independence of men at home among wild lands adds leaven to the mixture. Emotions intertwined with American traditions of pioneering, settlement, hunting, herding, and guarding a nation's properties tug madly at orderly reason. Yet we dare not be partisan. We like and admire all factions involved, though we cannot always agree with them. We must analyze this contest, understand it, and as citizens inform others of it, that we may act with the fair intelligence which should characterize democracy.

Western public lands involved are not game fields alone, but they are primarily that to this audience and to hunters, fishermen, and naturalists we serve. They are principally national forest and national grazing lands, and in lesser acreage, national parks.

These lands first belonged to the East. They were bought from other nations by eastern money, claimed by eastern explorers, or paid for with blood spent by sons of the East. Yet in 1862 we began giving these lands to those who wanted to build homes upon them;

first upon the basis of 160 acres for 5 years of "proving up." Later, and always in an effort to be fair, the 5 years were cut to 3, and the 160 acres increased to 320 and even 640 acres. Following World War I, veterans were permitted to shorten the 3-year "proving up" period by the time of their military service.

This generous plan for giving away lands lasted for nearly 30 years. To be sure Yellowstone National Park was established in 1872 and three more parks were created in 1890. School sections and railroad grants were exempt from homesteading. But in a large sense the best lands were free for the asking. Actual looting of the public domain occurred under some laws and practices, but was condoned rather than deprive honest citizens of new lands through restrictive regulations. Read the record of our land dispensation (Hibbard, 1924). Then ask who can accuse this Nation of miserly land policies.

Every national park has been created by an Act of Congress, following hearings in which local people often were the most insistent for the creation of parks from Yellowstone on. You people of Texas have recently created the newest and one of the greatest national parks, through your gifts and your own decisions.

Western national forests were chiefly set aside by Presidents of the United States in office from 1891 to 1906. This action was recommended by the nation's scientists other than foresters and sanctioned by general approval. National grazing lands withdrawn from homesteading in 1934 and placed under orderly management beginning that year were lands which settlers could have had prior to that time, but which no one wanted. Still other grazing lands, placed under land-use projects administered by the Soil Conservation Service, were lands upon which settlers had gone broke, and which then reverted through tax delinquency or resettlement.

The U. S. Forest Service was not created until 1905, 14 years after the first national forest area was designated. The National Park Service was created in 1916, 44 years after the first of 26 existing national parks was established. The Grazing Service was established when the national range was set aside following suitable hearings. The people of the Nation decided that these lands should remain public, set them aside, and only then created agencies to administer them.

Since these were conservation measures, local opposition arose. Some local harvester loses maximum immediate gain when *any* resource is spared for his tomorrow or for that of the Nation—be it a tree, a blade of grass, the last bird in a covey, or a real estate deal.

Homesteaders eyed hungrily the stream bottoms within the national forests, upon which little mountain ranches could be placed, and under the Act of June 11, 1906, were permitted to homestead lands chiefly valuable for agriculture. These were the most fertile, the most productive of all national forest lands, and yet a high percentage of these forest homesteads became tax delinquent and reverted to public ownership.

Counties embracing national forests complained of revenue losses from large areas of public lands paying no taxes. These claims were just. Beginning in 1906, provisions were made granting counties 25 per cent of gross forest revenues, and another 10 per cent for roads and trails benefiting both counties and the forests. National game refuges yield 25 per cent of their gross income to the counties, lessened only by direct costs involved when disposing of products sold. Taylor grazing lands pay 50 per cent of grazing receipts to local states. Another 25 per cent is spent within the area concerned for range improvements. It has been suggested that a portion of national park entrance receipts be paid contiguous counties, though clearly recognized increases in the valuation of resort properties related to park attractions lessen pressures for such demands.

Thus the less productive public lands of the West were placed under management. Men desiring to found new homes were permitted a trial. Tax claims of local counties were met. State ownership of wildlife is recognized on all but national parks, where complete jurisdiction is ceded to the Nation. Regulated timber cutting by private operators under permit occurs with increasing satisfaction upon the national forests. Summer homes may be leased within some public forests. Recreationists of all kinds turn with mounting appreciation to these extensive wild lands of their own. The only major differences of opinion are to be found between stockmen and those who administer our public grazing lands.

Excepting Yellowstone National Park, the cattlemen were there first, and at first there was plenty of room. Later there seemed not to be enough room for both cattle and sheep, but eventually that contest was composed. Still later, nomadic herdsmen and established local ranchers competed for each season's forage in a race that impaired the range and prohibited orderly use.

When the national forests and, much later, the Taylor Grazing Lands were placed under management, the herds of nomadic cattle and sheep men were excluded, and the livestock of responsible residents was assigned to definite areas upon an allotment basis. This met general approval. It was the first step towards solving the eternal three-cornered riddle of land management; determining how much of land income should (1) contribute to the livelihood of the owner or leaser, (2) contribute to the cost of its own protection, and (3) contribute to the support of government.

The next step, that of charging local users grazing fees, met with opposition in early Forest Service days. Stockmen had long grazed their animals free of charge on what they considered wild lands. They carried their protest to the Supreme Court, which declared such fees legal. But we still argue over whether permittees who graze their stock upon public lands should pay commercial rates prevailing upon adjacent private lands, or whether they should be charged only the cost of administration.

The stockman contends that he should pay only the cost of administration. He is thus accorded a federal subsidy not granted those who own their lands. Subsidies are common among agricultural industries; to favor one essential crop against others, or to encourage farmers to place more land under cultivation. But this subsidy is different. The stockman upon public ranges has no alternate crop save dude ranching, and it is scarcely competitive. He already desires to maintain highest possible herd numbers. This subsidy serves only to increase his income and to maintain the resale value of his ranch.

On the national parks and monuments, grazing was gradually excluded, even from former national forest lands on which grazing had been permitted, but areas concerned were relatively small, and no great opposition resulted.

Both stockmen and public land administrators have been interested in the following problems:

1. What is the present carrying capacity of the range?

2. What is the capacity of the range for maintaining this productivity or to increase it?

3. What practices can be inaugurated to increase carrying capacity without damage to the area or other important uses?

They both recognize that carrying capacity depends upon (1) the volume of annual forage production, (2) its palatability and nutritive value, (3) the forage consumption of each unit of stock, and (4) the amount and nature of competition from rodents and game.

These problems dominate range research conducted by both federal and state agencies, but except to the scientist they do not indicate all factors considered. Weather records, soil and topographic variations, erosion trends, soil impairment, weed control, reseeding, varations in grazing practice, and forage production for old and introduced species are indicative of other factors involved. Every factor that can be recognized is tested for its influence.

Research men and organizations have been wisely dissociated from the pressures of administrators with policies to support, and from the need for making expenses. They seek truth, not proofs for contentions. And interested, cooperating stockmen and agencies responsible to the people have kept this research practical. *In the long run* we have no reason to doubt American scientists, whether they work with airplanes, automobiles, the proximity fuse, atomic bombs, small pox, penicillin, cultivated strawberries, or range production.

In the short run, by comparison, we find disagreement. In 1915 the Secretary of Agriculture wrote of national forest ranges (Houston, 1915): "The productivity of the land for forage in most places has been restored and everywhere is increasing."

Many believed this. But later, after modern research began, range deterioration was found and livestock reductions were recommended. Still later it was found that reductions had not been made fast enough to halt deterioration. Range research men discovered that forest supervisors and other area managers did not see the damage as clearly as they.

At first the range managers were primarily range conscious. Then, as improving techniques distinguished between natural erosion and that caused by man, they became erosion conscious. Lately, as growing cities, expanding irrigation, and spreading industry proved (Titus, 1944) that water does not exist for every desired use, they became water conscious.

Deepening gullies, muddied streams, silted reservoirs, deltas of raw soils covering fertile bottoms, and scouring and fluctuating streams; all these were measured and proved to the scientist a need for herd reduction in many places.

Forest Service men, always sincere in efforts to do a good job, went into action. They had the assurance of a long, good record. Hibbard (1924) had said of them "The best public land policy now in operation in the United States is that of the Forest Service." Perhaps they were a bit arbitrary as the result of confidence gained from able protection and administration of the Nation's forests.

Unfortunately, range conditions are difficult to describe to just any one. When a forest is but stumps or tiny trees too small for use, its condition is apparent. But though the range expert may know how a certain grass should appear under optimum conditions, his knowledge is in his head as far as the casual onlooker is concerned, unless a protected sample is near by.

Drought in the forest merely narrows tree rings, but on the range it can be blamed for impoverished forage in a manner hard to refute. It is easy to convince people that adverse seasons explain scant forage, and that another year will bring improved conditions. Old-timers reminisce over thick grasses "tall enough to polish the brass on our stirrups,'' but when pressed for valid reasons often admit that their ideas may be chiefly opinion. Range management evolves into a very definite science, but it will take time to convince citizens that all which is green may not be nutritious grass.

Range managers sharpened their appreciation of range productivity by naming as their objective maximum forage production instead of greatest animal numbers. Some uncrowded stockmen shared this view and found that they obtained greatest gains per animal unit and dollar through moderate stocking. But other herdsmen whose lands were few or whose desires for money were great preferred maximum cattle production expressed in numbers. With enough cow units their income was still high, though the gain per unit was sometimes low—and they hoped that range deterioration would not overtake them.

Difficulty in proving what range conditions actually are, coupled with the increasing need of many stockmen, underlies most of our disputes. Too few realize that we are caught in an inexorable formula with changing values:

| Human Populations | + | Human Desires | = | Usable Land Areas | + | Productivity |
|---|---|---|---|---|---|---|
| (These Are Increasing) | | | | (These Diminishing) | | |

The shoe of civilization pinches ever harder. To buy industry's novelties and conveniences the herdsman must sell more livestock units. High prices and restricted meat imports help him now, but the spectre of lowered prices and imported meat forever haunts him. In addition the stockman who grazes his herds upon public ranges was shaken by his lack of stability when the Forest Service and later the Grazing Service recommended fewer animals upon allotted areas.

June 11 homesteads failed not so much because the idea was wrong, but because conditions changed. Dobbin could beget more horses, but the family wanted automobiles, radios, and nicer clothes. The homesteader, caught by increased need for dollars, worked his land the harder. For a time his soil gave of its stored fertility and then, that gone, failed him.

The pinch of civilization took another form. Always in the range country the big operator believed that he was entitled to what he controlled, and that the small-time homesteader was an intruder. The Forest Service, following the policy of "the greatest good to the greatest number in the long run," granted permits to new settlers and cut allotments of established ranchers proportionately. Two decades ago Dillon (1926) called this "the policy of peasantry," and strong western livestock interests sought permanent irreducible grazing rights for ranchers using public ranges or, lacking that, transfer of public lands to private ownership.

Upon eastern Colorado range lands we found that a family must have at least 2,000 acres to earn a livelihood under modern standards. Where does your quarter-section, or the half-section, or section which seems ample in the humid East give understanding of this need? Some stockmen bought out their neighbors; others became desperate upon the only lands available to them. I know couples who when young began ranches of their dreams dependent upon grazing permits within the Pike National Forest. That forest contains a coarse soil divested of cover by decades of grazing and logging patterned after methods brought from better soils and less violent climates. Some areas lack any vegetation. Highways are blocked by gravel washed out of side valleys. Principal streams which supply water for 400,000 people in Denver and vicinity are choked by gravel. Matters are made worse when some cattlemen, caught by diminishing range resources, grazed cattle in trespass above numbers allowed under their permits. Now my friends are faced with cancellation of grazing permits upon this problem area.

Bernard DeVoto (1946, 1947) eloquently pictures western range destruction in Wyoming. He brands cattlemen guilty. He states that they "hope to shovel most of the remaining West into its rivers." I do not doubt the truthfulness of many of his awesome statements, but I wish that he had left the horns on the cattle, where they belong, instead of placing them upon my friends. What we need to consider, what I have tried to show, is what has happened to both the range and the stockman. Now we need to see where we are and where we go.

Last year the stockmen introduced into Congress Senate Bill S. 1945, which provided for turning public lands over to the states in the Dakotas and the 11 Western Mountain States. This included lands from national forests, national parks and monuments, and game and bird reservations. That bill "died" with the 79th Congress.

This year the Joint Livestock Committee on Public Lands, meeting in Denver in December, agreed (Simms, 1946) "that public use lands must be preserved for recreation, for timber, for watersheds, etc." But it formulated the following principles to guide contemplated legislation:

"1. Owners of dependent private land would be permitted to purchase public lands which have been allotted to them through existing laws for use in connection with their private lands.

"2. The lands sold to such permittees would be at a fair appraised value upon the carrying capacity of the land.

"3. Ten per cent of the sale value of the land would be paid down at the time of purchase. The balance would be payable at the option of the purchaser in not more than 30 equal annual installments, with interest at 1½ per cent, or to amortize for a period of not more than 30 years at the same rate of interest.

"4. Ninety per cent of the funds received from the sale of the lands would be returned to the state in which the land is located, to be disposed of as the legislature of the several states would determine.

"5. The patent to the lands disposed of would contain provisions reserving oil and mineral rights, together with the right of ingress and egress for prospecting, development and extraction of oil, gas and minerals.

"6. The patent would also contain the provision that the owner of the surface right would be reimbursed for damages occasioned to crops, including grass and improvements, by prospectors and operators."

The price suggested by this committee as typical was 70 cents per acre, though many recreationists coming to Colorado and Wyoming would willingly pay far more than that for bottomlands including trout streams and other attractions.

This year's plans are based upon broader realizations than that of last year. This is heartening, but the whole problem still is one that dare not be decided within one year. Nothing is said about permitting recreationists to enter public lands transferred to private ownership, for hunting and fishing and similar purposes. I hear ranchers say that such provisions could be included, but we know that general restrictions upon trespassing limit recreational uses, though the game is state owned and hunting and fishing are apparently guaranteed. The lands most desired by the stockmen are the more productive bottomlands. These control the remaining range, include streams not already in private ownership, contain most of the roads, and control access to other lands.

Some areas, of fair value for cattle, are within areas critical for deer and elk winter range and need to be definitely managed for both. Uncoordinated ranch use would result in winter damage by deer and elk, leading to law suits involving the state.

In Colorado, national forests form 20.69 per cent of the total area, Taylor Grazing Lands 11.78 per cent, national parks 0.79 per cent, and all national lands 36.86 per cent. Here you have lands low in food and meat production, but lands upon which most of the vigorous outdoor sports concentrate. Indeed, in Colorado last year the irrigated lands, making up 6 per cent of the total, produced 49 per cent of all agricultural wealth. But Hunter (1946) states that in 1945 "98 per cent of the elk were killed within the national forests," and approximately 94.55 per cent of the deer were killed upon public lands. In Colorado, recreational use is increasing and its income overtakes the value of livestock production, including that upon all agricultural lands.

Antelope herds are particularly dependent upon Taylor Grazing Lands, for their continued existence and for public hunting. Yet both game management and range management men are studying competition between livestock and big game, to determine fair rules affecting each.

Danger exists that we may quickly transfer these important lands to private ownership. Cattlemen are prosperous, powerful in public affairs, and with their colorful dress, traditions, and public spectacles like rodeos gain quick support from that portion of the populace which thinks with its emotions. They have just finished a splendid job of producing meat for our armies and our allies.

Federal bureaus are in ill repute. The public still complains of wartime regulations and numerous federal agencies. It does not clearly distinguish between land-management agencies of long standing and mushrooming-emergency bureaus. The Grazing Service was destroyed by lack of appropriations last year and its functions turned over to the Bureau of Land Management. The Forest Service, unhappily for this contest with the stockman, has also lost favor with private timber operators. Under administrative policy it has been urging public regulation for private timber lands. It now has only the complete endorsement of recreationists and scientists. Grahame's (1946) "More Game for our Public Grazing Lands," typifies sportsman interest, but gives no indication of dependable support. The U. S. Chamber of Commerce, with typical zeal and boasted ability to count dollars, but with biological ignorance, supports transfer of public lands to private ownership. It supports strongly the principle of increasing the lands upon the tax rolls, but forgets that land taxes make up increasingly smaller percentages of tax income, that the lands concerned will pay very low taxes, and that a generous tax equivalent is already paid.

This is a problem of increasing intensity of overlapping land uses. The livestock men in their isolation were the last to feel its effects. Many would move to other wide spaces if they could find them. Freest of men, they smart under the crush of civilization. But I fear that even a greater pressure, one long common in populated centers, heads towards them—the right of eminent domain. Can we doubt that if recreational areas upon national forests and Grazing Service lands pass into private ownership, the public will demand them back for more national parks and public hunting areas?

Changing conditions bring hardship. There will be more as growing transportation ease compels us to share our problems. Some ranchers, caught in the mills of public need, may need public aid in resettlement and in obtaining supplementary income. Like the livery stable, *some* ranchers may be displaced by the changing order.

It is doubtful that, in the long run, meat production for the Nation will be increased by placing these lands in private ownership. It is certain that we will be wisest to move slowly in disposing of these lands and in allotting their use. The Society of American Foresters, which deals with wild-land management, has already suggested (Allen, 1946) to the President, a complete study of public land use and disposition, and the establishment of a comprehensive policy governing public lands. This must be done.

We must remember that in the East, the public is buying back national forest and national park lands from private ownership. All of us, including stockmen, like vast lands upon which we may adventure. Our resources are still great, but they are now within reach of all of us, and many of their riches must be shared. Together we can build a greater Nation with no lands which are abused. But divided and without full knowledge of what we do, we may destroy our substance and all that is fair and good.

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DISCUSSION

CHAIRMAN ALLEN: That is a pretty live subject. Does anybody have any comment to make or question to ask?

MR. ARTHUR H. CARHART (Colorado): I think there is a point in all the discussion of this particular problem that should be brought out and driven home and that is that this is not the livestock industry that is asking for this. I have been in the thick of this and I know the facts of the situation. If you take the national setup, there are 56 million beef cattle in the United States. There are 11 million of those in the 11 Western States where these lands lie. Of the 11 million, all but 1,225,000 don't want the national forest at all. They are on there for an average of 4½ months which represents .748 per cent of the total national beef production.

It is only a portion, there is only one in six or eight of livestock units that get on the national forest and cattle grazing in the 11 Western States, so that we have that cut down in proportion to those that are interested at all. Then we have only the portion of those, the gang leaders if you want to call them that, that are pressing this thing at all so that is the status of those that are trying to drive this thing through and it isn't the livestock industry as such, but this small group that is railroading it, trying to get this particular thing through, so that they can buy lands in which they are particularly interested.

I want to absolve the large portion of the livestock industry from pressing this. I want to get the perspective of the small group actually in the saddle and in the position to be heard and they are driving at it. That is the thing to be heard, the small, hard, driving, controlled organizations that represent themselves as the livestock industry and are not.

DR. WAGAR: Thanks, Art, for particularizing some of my more general statements.

# ACKNOWLEDGMENT OF APPRECIATION

CHAIRMAN ALLEN: As we come to the close of this international gathering, I think it is only fitting that we call upon Mr. Gutermuth, vice-president of the Wildlife Management Institute, to officially close this Conference.

VICE-PRESIDENT GUTERMUTH: Friends, as we come to the close of the Twelfth North American Wildlife Conference, I can't help, after hearing this splendid summarization of our program, from expressing sincere thanks to Dr. Leopold. He said to you he had a deep responsibility and it is a job, a difficult task to attempt to summarize a program that is as broad as the program that was presented during the past 3 days.

Texas has been a grand and generous host. The dinner last evening almost broke a record. In fact, I believe that it did break a record, if you want to ignore the meetings held in New York City where we are always supposed to be able to get a large crowd. If my memory serves me correctly, we had 549 people at the banquet in New York last year. That, with the exception of the 1936 banquet in Washington which, you remember was called by the President of the United

States, was the largest banquet that we ever held at a North American Wildlife Conference.

Last evening, believe it or not, there were 503 people in this ball room and here again I want to thank you folks for being so patient in letting us rearrange things to make ample space for the cock fight and other entertainment.

In these closing remarks, I want to thank all of the many organizations and individuals who have made this Conference so extremely successful. I want to thank the Wildlife Society; this galaxy of stars, this row of national organizations that we had up here last night was very encouraging to me. We had, I believe, practically every national conservation organization represented. That is a grand thing. That type of cooperation is the thing that has made these Conferences successful, has made them possible, and in closing I should say that as I look out over this group, one of the largest closing sessions that I have ever seen in all of the years that I have been coming, is here this afternoon.

We do have closer cooperation and better understanding, although we do have, as Dr. Leopold pointed out, many, many things that must be learned before we will be able to properly and effectively manage the natural resources of this great nation.

I hope you all feel as though you had been well repaid for this visit. I hope all of you will be able to have time to unlax a little bit now that this session is over. I do want to pay particular thanks to Dr. Walter P. Taylor and his brethren over there at Texas A. & M. College. Folks, they helped to make this thing prove up. These local organizations here in Texas—they are the ones that helped us put the banquet over. The press has been most generous. If you have been well repaid, you will come back again next year and we will try to make the program worth-while to you.

MR. SETH GORDON (Pennsylvania): You gave us the information on the number at the banquet. What is the comparative number of registrants?

VICE-PRESIDENT GUTERMUTH: The last figure I had, Mr. Gordon, was well over 700. We don't have an exact count yet.

MR. GORDON: What was it last year?

VICE-PRESIDENT GUTERMUTH: Last year, we figured that we had an unofficial attendance of about 1,400 but the actual registration was only around 950, there again, so you can see that Texas and all of the rest of you really came through—and thanks, in behalf of the Wildlife Management Institute. You have been swell.

# PART II

# TECHNICAL SESSION

# TECHNICAL SESSION

## Monday Afternoon—February 3

*Chairman:* NEIL W. HOSLEY
In Charge, Wildlife Investigations on Public Lands, Division of Wildlife Research, U. S. Fish and Wildlife Service, Chicago, Illinois

*Vice-Chairman:* L. A. STODDART
Head, Department of Range Management, Utah Agricultural College, Logan, Utah

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## WILDLIFE OF GRASSLANDS AND FORESTS

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# THE ROLE OF BRUSH CONTROL IN HABITAT IMPROVEMENT ON THE ARANSAS NATIONAL WILDLIFE REFUGE

HAROLD L. BLAKEY
*U. S. Fish and Wildlife Service, Austwell, Texas*

Brush control has become a serious but poorly attended problem for wildlife management in many regions. Our early naturalists could hardly believe that the hordes of wildlife on the range would not long survive the competition of human requirements. We, of the same clan, are just now becoming actively aware of our vanishing species that approach their end by loss of habitat requirements. Some of us have not as yet fully appreciated the significance and enormity of basic changes in wildlife environment that are unfavorable to some species and prohibitive for others. True, we have made great strides in conservation and, in some instances, have improved upon our wildlife resources, but the progressive loss of suitable habitat for some of our most important species is too often permanent and can have but one end unless checked. Fortunately, we may still supply those checks in regard to the brush problem, if we will.

Encroachment of brush jungle upon formerly open forest and prairie range is insidious in that it has both good and bad effects upon certain wildlife species, and in some areas has the constant potential for near total exclusion of all valuable forms. Creation of barren wastes and eruption of formerly stabilized plant associations in some of our forests as the result of harvesting of forest products has been accompanied by eruption in the populations of animals favored by the changes in food and cover relationships, while at the same time other species have been unable to adapt themselves to the change. Exclusion of natural and planned burning in others has resulted in a jungle of mixed hardwoods that definitely limits the carrying capacity for wildlife. It is in our forest areas, however, that the most progress has been made to provide a suitable habitat for the community of forest dwellers. When we turn to our prairie range, it is entirely a different story. Very little has been done to halt the rapid disappearance of prairie or to take advantage of the benefits that accrue in favor of wildlife by expansion of brush cover .

This loss of prairie range has become particularly critical in the State of Texas, where it is conservatively estimated that more than 35 million acres of agricultural lands have progressed from open prairie to some stage of brush cover in a very few years. Potential range for deer and turkeys has been greatly expanded, while at the same time that of quail, prairie chicken, antelope, and possibly others has been equally restricted. The grazing industry suffers an economic loss of major proportions that turns any remedial measures into a practical business proposition.

Since grazing is the primary use of this western range, it is obvious that adjustments in favor of wildlife made on any large scale must be in keeping with practical grazing economy. At the same time, since grazing has been a primary contributing factor in creation of these conditions, it is equally as obvious that grazing must be regulated in accordance with requirements for perpetuation of the best range resources. I am confident that somewhere in between these qualifications lie the best interests of both wildlife and the grazing industry.

The Fish and Wildlife Service has studied and practiced brush control as a means of wildlife habitat improvement in the live oak range at Aransas National Wildlife Refuge on the South Texas Coast. Successful accomplishments designed for wildlife purposes alone appear to hold equally as much advantage for practical grazing use.

Aransas Refuge covers a 47,000-acre peninsula bounded by St. Charles and San Antonio Bays and consists of a series of motts, ridges, and upland flats interspersed with sloughs and swales. The average annual rainfall is in the neighborhood of 30 inches. The soils are uniformly sandy and typical of the northward limits of the south Texas brown sands. Erosion is not a problem. In the absence of burning, plant succession goes directly into a brush cover dominated by live oak in association with laurel oak, black jack oak, sweet bay, yaupon, and huckleberry. Intensive cattle grazing, indiscriminate burning, and irregular attempts at farming in the past have resulted in variable distribution of brush age class from place to place. This is not a true shinnery; each stem is capable of maturing a tree normal for the species, but the advanced age class timber is highly vulnerable to destruction by frequent hurricanes. A rootstock of live oak is well established throughout the upland and all true prairie has disappeared. Brush densities range upward to 250,000 live stems per acre at a height of from 1 to 10 feet. In this stage, the range is impenetrable for any of the large animal forms and is practically worthless for either wildlife or livestock purposes.

A suitable open brush range has a high carrying capacity for many upland species. The Refuge supports at least 1,000 turkeys at a density of 1 bird per 40 acres, which is twice the density of population on most of the wild turkey range in Texas. A white-tail deer population of 1 animal per 5 to 10 acres demonstrates phenomenal productivity, 7,000 deer having been removed by trapping in the past 6 years for stocking purposes, without evidence of fully controlling the increase. Quail are abundant in the remaining openings. Peccaries, sandhill cranes, jacksnipe, doves, and a large wintering population of migratory song and insectivorous birds inhabit the range. Red wolves, coyotes, and bobcats are favored by the brush cover. However, all of the brush range is progressing toward a density that will exclude or seriously limit use by most of these animals for an unpredictable period. It is to restore and preserve an optimum habitat for all wildlife species now on the range that certain measures have been taken to control this brush cover.

Operations have preceded research in brush control in Texas with very little results that appear practical for either wildlife or livestock management on a large scale in typical range country. Hand clearing is too slow, too costly and does not take care of accelerated replacement of the stand. Use of bulldozers, treedozers, root cutters, and plows has the disadvantage of destroying established vegetation other than brush, throwing the succession back to a dominance of weed pioneers at a very low level, retarding recovery of suitable grasses, necessitating seeding in the manner of improved pasture methods, providing no control over replacement of the original stand, and involving an initial cost out of proportion to benefits derived for either wildlife or livestock returns.

We have successfully used a roller-type brush cutter at Aransas Refuge at the rate of 2 to 4 acres per hour and a cost of from $1.00

to $1.50 per acre cleared, where cutting must be thorough. This treatment may then be followed at 2-year intervals with a lighter weight cutter of the same type at a cost of $0.50 to $0.75 per acre as a control measure. This restores a high level of wildlife use immediately after the first cutting and admits practical livestock grazing within the first 12 months and thereafter. We have not carried this process to an end result but the results following the second cutting and the third year of conditioning are favorable. It appears that over a 10-year period the cost would not exceed $10.00 per acre, which equals the sale value of most of this land in normal times and exceeds the annual grazing rental values by 300 per cent per year. There remain much more efficient and economical practices for wildlife purposes and long range livestock objectives.

Possibilities in the use of chemical poisons and hormone herbicides are being studied by several agencies but as yet very little has been demonstrated that is applicable to the brush control problem in the live oak type. The per unit cost of materials and their application are individually impractical for the purposes herein stated, and even minor control of dense hardwood stands is undemonstrated.

In view of the foregoing inefficiencies, we have concentrated upon adaptation of the principles of burning that have proved practical for control of hardwood cover in the forest areas of the Southeast. This involves initial cutting only where the first fire does not establish suitable openness for those animals that would normally occupy the range. Regulation of grazing to preserve a suitable stand of grass to support effective burning at the required intervals must be instituted from the start. Thereafter, fully planned burning is the means of establishing and maintaining the desired condition of control and major improvements in the habitat.

It has been possible to establish the first stage of control and restore utilization by both wildlife and livestock in closed stands of 250,000 stems per acre density in a period of from 6 to 18 months. The initial cutting may be made at the rate of 2 to 4 acres per hour with a cost of from $0.50 to $1.25 per acre. The burning operation does not exceed $0.05 per acre per year. In stands less than 3 feet high and not exceeding 150,000 stems per acre, the same degree of control and improvement in habitat may be developed over a 10-year period with fire alone at a cost of less than $0.05 per acre per year, or 25 per cent of the customary annual livestock grazing rental value of typical south Texas range land. The costs and results are practical for either wildlife or livestock objectives or a combination of both.

It is regrettable that the great volume of literature on fire so seldom relates the specific results of properly planned and fully controlled burning that can be demonstrated experimentally. Let us examine briefly some of the results of this combination of cutting and burning, restricting our conclusions to the region of the south Texas brown sands bordering the Gulf in the live oak brush range and a region where rainfall is at least 30 inches per year and erosion is negligible.

Cutting is largely an aid in rapidly opening and conditioning the cover for burning. Grass is the medium for carrying a controlled fire, without which no beneficial burning can be accomplished. No fire of any intensity obtainable under natural conditions will consume live oak brush larger than ¼- to ½-inch stem diameter. Fire of suitable intensity consumes very little brush of any size. Fire of the least intensity possible to obtain a clean burn will kill any class of brush up to 2-inch stem diameter and 10-foot height. Debris from an initial cutting may be removed by immediate burning but shrinkage after 30 to 60 days defeats a cleanup with fire.

Cutting has several other advantages. It cultivates the soil without interference with fixation of established sod, increases water penetration and retention, exposes mineral soil, and improves seed germination.

Subsequent burning at frequent intervals retains the succulent new growth stage of brush remaining in the stand. As the brush becomes less and less dense, competition by the taller grasses exercises an effective control of brush during the interval between fires.

Fire of suitable intensity for brush control does not blast all standing vegetation. Leaf and grass litter, constituting a thin semi-duff on the ground is not removed. Many stems of tall bunch-grass, with full seed heads, remain upright and unburned in the path of the fire and drop their seed upon an improved seed bed. There is good reason to believe that proper burning increases the soil moisture available to plants, and that the physical process of burning does not decrease soil fertility by consumption or dissipation of nutrients in the vegetative plant bodies. Of the 76 grasses identified on the experimental area, only 6 are annuals. Proper burning does not kill the stand of perennials or destroy the seed of the annuals remaining viable in the unburned litter. Some of the most valuable forage and wildlife food plants are stimulated by the burning process. Some of the most valuable grasses appear most abundantly immediately after the burning. Panicums, paspalums and legumes, in particular, are cultivated by both burning and cutting. In fact, it is doubtful that a rich leguminous flora can be retained for long without some amount of burning or that such can survive under heavy grazing in any appreciable amount without some fire.

Cutting reduces the height and age class to annual growth. Burning maintains it in that stage and progressively reduces density and vigor of the remaining brush. Cutting during the hot summer months may result in as much as 40 per cent direct root kill. In stands of 150,000 stems per acre or less at a height of less than 3 feet, it appears that fires alone may be used to reduce density and height class by 65 per cent in two successive annual treatments, and that progressive root deterioration is present following the second burning. At this stage, brush is reduced to weak sprouts from 6 to 10 inches high and as they become fewer in number competition for sunlight and water by taller herbaceous vegetation holds further growth in check, thereby permitting progressive elimination by burning at 2- or 3-year intervals. It is important to stress that the brush will eventually, and within 5 years or less, release itself by overtopping the grasses, if fire is not repeated at proper intervals. We have not reached the end result of this process but it is apparent that live oak can not survive properly planned and executed burning.

Benefits derived for wildlife are evident in the physical recovery of range in a usable condition, improvement in wildlife food resources and cover relationships, and response by various animals in their activities on the range. Deer congregate in the cut-over areas within a matter of hours or days. Turkeys are attracted by the burning and the increased crop of their preferred foods. Quail find a suitable year around range where they could not exist before. Doves feed in the burned-over tracts. Jacksnipe and sandhill cranes prefer the burned sites and congregate there. Only a portion of the wintering population of song and insectivorous birds is temporarily readjusted to unburned tracts. Predators find less protection for their movements. All in all, we find this a very satisfactory, efficient, and economical means of habitat improvement. Managers of range land should give attention to the possibilities of its use wherever the principles and mechanics of cutting and burning may be properly applied.

## DISCUSSION

DR. TRACY I. STORER (California): What is the machinery used in this cutting? I would like to know a bit about it.

MR. BLAKEY: The cutter that has been used at Aransas is the conventional roller-type. It is manufactured by the Marden Manufacturing Company, Auburndale, Florida. It is the only one of its type and design that is available, but it has been used throughout the country. This is a machine built on the basis of a stalk cutter with blades mounted on a drum 7 feet in length, heavy duty type; 42 inches in diameter; blade goes into the ground 9 inches; pulled in section of two in tandam, one behind the other, with a variable drag link, between the two that permits one to be pulled to the left and one to the right, and both of them in a forward direction. That effects several activities and you should see the machine to appreciate its real significance.

It actuates a chop and a slice which causes it to cut much heavier brush than the chop alone would, and, at the same time, it cultivates the soil to a depth of 7 inches without disturbing the sod or its primary surface root system.

This equipment has been fully described before, I believe, in the *Journal of Wildlife Management* with both an illustration of the equipment and a discussion of its construction.

MR. W. C. ROCHELLE (Texas): How much power does it take to pull that equipment?

MR. BLAKEY: This particular machine we were just speaking of is the heavy duty equipment, the largest manufactured for the purpose. It will handle stands up to 10 feet in height and from 2 to 4 inches in diameter and density including all stems up to 250,000 stems per acre. The machine weighs 10 tons including 5 tons of metal and 5 tons of waterload and is pulled by an 80 horse power, that is 80 horse power on the drawbar of a crawler track, or industrial-type tractor.

# RANGE USE OF THE PRONGHORNED ANTELOPE IN WESTERN TEXAS

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The present paper is based on 6 months of research from June to December 1946, and represents a preliminary report of a 15-months project on the range ecology of the pronghorned antelope in the Trans-Pecos region of Texas.

Pronghorned antelope in the State of Texas have increased to about 9,000 since the first closed season on hunting in 1903. Many ranches are so well stocked with antelope at the present time that ranchmen are becoming more and more concerned over the amount of forage consumed by these animals. Competition between the pronghorn and domestic livestock has always been a problem among ranchers, its importance varying with the number of antelope. One of the principal causes for the decline of antelope in Texas was excessive killing by ranchmen who considered them severe competitors for range grasses. Some of the ranchers believe that antelope are in such great competition with domestic stock at the present time that they wish to have the animals completely removed from their ranches. This attitude is spreading while at the same time the antelope are increasing through proper management and protection.

Management of the pronghorned antelope in Texas must be carried out on privately owned lands, and the proper attitude among ranchers, based on accurate knowledge, is necessary for a sustained harvest,

[1]Agricultural and Mechanical College of Texas, U. S. Fish and Wildlife Service, Texas Game, Fish and Oyster Commission, and Wildlife Management Institute cooperating.

an extension of present antelope range, and an increase in population over the state as a whole.

Many landowners in western Texas are not interested in the small income derived from annual antelope hunts on their lands. The 1946 income of $40.00 per buck, although increased from $25.00 during the first two hunts in 1944 and 1945, is not considered full compensation for the amount of range forage consumed. This opinion is based on the assumption that antelope food habits are essentially the same as that of cattle, and that the game consumes a considerable amount of grass which could be utilized by cattle. Lack of intensive research on antelope forage habits has brought about this unfavorable conception. Since the grasses are most abundant and dominant in the range vegetation of west Texas, it has been assumed that the pronghorn must live largely on these grasses. Furthermore, the ranchers have been informed that five antelope are equivalent to one mature cow (one animal unit). This misinformation has led many to become more

TABLE 1. SUMMARY OF ANTELOPE FORAGE CONSUMPTION

| | Summer | | | Autumn | | |
|---|---|---|---|---|---|---|
| | Number of species | Antelope minutes Number | Antelope minutes Per cent | Number of species | Antelope minutes Number | Antelope minutes Per cent |
| Forbs | 55 | 88 | 62 | 75 | 224 | 59 |
| Browse | 15 | 32 | 23 | 15 | 130 | 34 |
| Grasses | 7 | 21 | 15 | 8 | 26 | 7 |
| Total | 77 | 141 | 100 | 98 | 380 | 100 |

than ever concerned over the numbers of antelope on their pastures. Actually the antelope animal unit equivalent is 9.4 in the Trans-Pecos region. This figure was obtained by dividing the average weight of west Texas cattle (850 pounds) by the average weight of the antelope (90.5 pounds).

Information about antelope food habits secured to date during this investigation is based primarily on field observation with a 6-power binocular and a 20-power spotting telescope. Supporting evidence is being obtained through stomach analyses. Antelope minutes feeding time on various species of the range flora have been accumulated, and help to determine preferences. So far, valuable qualitative and quantitative information has been obtained on 135 species of plants.

A summary of the summer and autumn forage consumption of antelope is presented in Table 1. From these data it can be seen that about 85 per cent of the summer diet and 93 per cent of the fall diet consists of forbs and shrubs. The smaller percentage of grass and larger percentage of browse taken during the autumn is primarily a result of the fall curing process of the grasses. By the end of October, most of the grasses were dry and practically unpalatable to antelope.

Summer forage of the pronghorn consists of about 62 per cent forbs, 23 per cent browse, and 15 per cent grasses. These percentages are based on observations on 77 species of plants for a total of 141 antelope minutes (1 antelope minute equals 1 antelope feeding for 1 minute). The actual number of species in the summer diet far exceeds the number reported upon here, the number observed being determined by the limitations of the investigator. As field technique improved and a wider range of habitat was covered, new species were steadily added to the list. Some of the favorite summer foods are as follows: *Aplopappus spinulosus* (cutleaf aplopappus), *Clematis drummondii* (virgin's bower), *Dalea frutescens, D. jamesii, D. wrightii, Desmanthus cooleyi* (prairie mimosa), *Dyschoriste decumbens, Gaura coccinea, Hesperidanthus linearifolius, Melampodium leucanthum* (white daisy), *Mentzelia multiflora* (stick-leaf), *Physalis hederaefolia* (clammy ground cherry), *Psilostrophe tagetinae* (paper flower), *Rhynchosia texana* (rosarybean), *Senecio longilobus* (groundsel), *S. riddellii, Sida procumbens, S. hastata,* and *Simisia calva.* Of the grasses, *Bouteloua curtipendula* (side-oats grama), *B. eriopoda* (black grama), and *B. gracilis* (blue grama) are preferred. All palatable and available parts of the plants were consumed, including stem leaves, stems, basal leaves, flowers, and fruits. Antelope have a particular fondness for flowers and fruits. The flowers of cutleaf aplopappus, white daisy, stick-leaf, paper flower, and groundsel were consumed in large quantities. Although paper flower is poisonous to sheep and groundsel is poisonous to cattle, antelope apparently suffer no ill effects from either. Antelope do suffer from loco weed *Astragalus mollissimus* and some die each year from its effects. The flowers and fruits of stick-leaf seemed to be almost irresistible to the pronghorn and were seldom passed up. Other such "ice cream" plants, although scarce on the range, include *Hesperidanthus* and clammy ground cherry. Grasses formed a remarkably small part of the diet; of 214 feeding observations, only 22 were on grasses.

Autumn forage of the antelope consists of about 59 per cent forbs, 34 per cent browse, and 7 per cent grasses, based on observations on 98 species of plants for a total of 380 antelope minutes. All but 29 of the plants found to be used during the summer continued to be utilized for at least part of the fall. Conversely, many of the additional 50 new species recorded as fall foods were used throughout the summer. During the early part of autumn, *Gutierrezia sphaerocephala* (broomweed) became abundant in limited areas and was used extensively by antelope, the upper leaves and flowers constituting most of the forage. Following late summer rains, the grama grasses, principally blue grama, black grama, side-oats grama and *Bouteloua hirsuta* (hairy grama), began flowering prolifically. The heads of these grasses were consumed with relish by the pronghorn. Some ranchers feel this does considerable harm, but practically no reseeding takes place on present day overstocked ranges, and the beneficial effects of the antelope in consuming poisonous groundsel and paper flower, as well as other weeds, more than offsets any harm that might be done by eating the heads of grama grasses. Progressively throughout the fall, the following plants became increasingly important: *Actinea scaposa* var. *linearis* (stemmed bitterweed), cutleaf aplopappus, *Buddleja scordioides, Dalea wrightii, Eriogonum tenellum* (wild buckwheat), *E. wrightii, Microrhamnus ericoides* (little buckthorn), paper flower, groundsel, *Sphaeralcea angustifolia* (globe mallow), *S. coccinea, Ephedra trifurca* (jointfir), *Adolphia infesta,* and *Erigeron nudiflorus.* Among these fall foods are many browse plants and

TABLE 2. SUMMARY OF TEN ANTELOPE STOMACH ANALYSES

| | Number of species | Volume (c.c.) | Per cent |
|---|---|---|---|
| Forbs | 33 | 888 | 96 |
| Browse | 5 | 6 | 1 |
| Grasses | 7 | 28 | 3 |
| Total | 45 | 922 | 100 |

shrubby perennials that were not utilized during the summer. Most important of the browse species is *Buddleja scordioides.* After the first killing frost when the grasses began curing and many favorite summer foods, such as prairie mimosa, *Dyschoriste decumbens,* and *Sida procumbens* became unavailable, antelope began subsisting on the new basal leaves of cutleaf aplopappus, *Berlandiera lyrats* (lyrateleaf berlandiera), *Gaura coccinea,* paper flower, groundsel, globe mallow, and *Sphaeralcea coccinea.* The percentage of grass in the fall diet was less than half of the amount consumed during the summer; of 428 feeding observations, only 37 were on grasses.

During the hunting season, from October 1 to October 11, 1946, 86 stomach samples were collected. An analysis of 10 of these stomach content samples is presented in Table 2. Forty-five species of plants have been identified in the stomachs, eight of which were new species added to the list of antelope food plants. Conforming with field observations, most of the plants found in the stomachs were forbs, 33 known species, together with several unidentified species, constituing 96 per cent of the diet by volume. Five species of shrubs represented 1 per cent of the stomach contents. Only 3 per cent of the food in the stomachs consisted of grasses. Seven species of grass were found, but most of the grass was blue grama.

Throughout the summer and autumn seasons no differences could be detected in special physiological needs of the different age classes. Adults, yearlings, and fawns all utilized the same forage as far as could be determined by the antelope minutes observation method employed. No difference could be found between the foods of does and bucks, although their physiological needs would appear to be somewhat different, bucks requiring certain minerals in the diet for the production of large horns and does requiring special foods for the nourishment of the young. The principal reason why the different sexes and age classes eat the same food on present day ranges is that the range has been overgrazed by livestock to the extent that the pronghorn must accept what palatable green forbs he can find. If the vegetation were in climax condition, selection of certain foods by sex and age classes might be apparent.

TABLE 3. PERCENTAGES OF LIVESTOCK AND ANTELOPE FORAGE CONSUMPTION

| | Cattle | Sheep | Antelope |
|---|---|---|---|
| Grazing | | | |
| Grasses | 69.0 | 61.0 | 11.0 |
| Forbs | 6.9 | 18.9 | 60.5 |
| Browse | 8.4 | 10.1 | 28.5 |
| Miscellaneous[1] | 13.8 | 7.4 | 0.0 |
| Supplementary | 1.9 | 2.6 | 0.0 |
| Total | 100.0 | 100.0 | 100.0 |

[1]Mostly *Nolina texana* (sacahuista)

Antelope preference ratings are considerably influenced by the degree of livestock overgrazing. About 80 per cent of the range lands in western Texas are overstocked at the present time. Many of the highly preferred antelope food plants are eliminated or scarce on the range today, and inferior forbs are utilized extensively in their place. This is particularly evident in late autumn when many summer forbs are not available. Most important of the inferior forbs upon which antelopes are forced to subsist to a large extent during late fall are: cutleaf aplopappus, paper flower and groundsel. These species remain in green and succulent condition until late in the season, and when the upper parts begin to wither after the first frosts, new basal leaves appear. When the grama grasses have cured, antelope make little use of them, and prefer any green forb or browse to the grasses. Although forbs and browse may be scarce on the range, the pronghorn subsists almost entirely on these plants.

Competition between livestock and antelope is indicated in Table 3.

The percentages of forage consumption for livestock represented in the table are taken from Cory (1927) and are based on 3 years of observation in central Texas. The vegetation of the antelope range in western Texas consists of considerably less browse and more forbs than the central region. Nearly all of the browse in central Texas is composed of *Quercus virginiana* (live oak), *Q. breviloba* (shin oak), and *Rhus trilobata* (ill-scented sumac). Oaks and sumac provide practically no browse in the Trans-Pecos region, livestock spending less time browsing and more time on forbs here than in the central region. The degree of livestock- antelope competition must, therefore, be only approximate in this paper.

Antelope prosper well on cattle ranches, even on overgrazed ranges, since the cattle are grass consumers and leave most of the forbs and browse for the antelope. As shown in Table 3, cattle graze on forbs about 7 per cent and browse about 8 per cent, while antelope feed on grasses 11 per cent of the time, the total representing a competition of 26 per cent. Analyses of antelope stomachs indicate a consumption of only 3 per cent grass, which would place the competition at 18 per cent.

The situation is quite different on sheep ranches, where antelope and sheep are in severe competition on year-long ranges. Sheep graze about 19 per cent on forbs (Table 3) and browse 10 per cent, which, together with 11 per cent grazing on grasses for antelope, makes a total competition of 40 per cent. Moreover, sheep ranches are usually so overstocked that the forbs are nearly eliminated from such ranges, forcing the antelope to give way. The pronghorn's reluctance toward jumping sheep proof fences is to his detriment and die-offs caused by starvation on sheep pastures are not uncommon in Texas. Most sheep ranchers are not concerned over the decline or complete elimination of the antelope on their ranges. On the contrary, nearly all the ranchmen are glad to be rid of the pests so that they may carry a few more sheep. Antipathy is aroused among some cattlemen who feel that they are being penalized because antelope do well on their ranches, and they must carry the burden of perpetuating this game animal.

With our present knowledge of the forage habits of the antelope, it can be shown that these animals are an asset to the cattle rancher, rather than a liability. The number of antelope equivalent to one animal unit (one cow) is 9.4; but since antelope consume only about 25 per cent of the forage utilized by cattle, it takes four times as many antelope, or 38 antelope, to consume as much *cattle* forage as one cow. About one fourth of the buck population can be harvested annually. From 38 antelope, 5 bucks can be taken each year, yield-ing an income, at $40.00 per buck, of $200.00. Only one cow or two calves can be produced from the amount of cattle forage consumed by 38 antelope. This would yield an income of about $100.00 at current prices. These figures show that it pays to include antelope along with cattle in a multiple use range management program. A reasonable population of antelope, although considered excessive by ranchers, is about 10 antelope per section (square mile), an equivalent in cattle forage consumption of one fourth of one mature cow. Ten antelope should be calculated in the ranch-stocking program as one fourth of one cattle animal unit per section. As shown above, the income from the antelope will be twice as much as from the number of cattle that could be grazed in their place.

The figures employed in the above economic discussion are of necessity only approximate, particularly since the per cent of antelope-livestock competition has not been measured with greater accuracy. Supporting these figures in showing the value of antelope to the rancher, is the beneficial effect of these animals in keeping down undesirable weeds. Cutleaf aplopappus is an increaser on overgrazed ranges, but it is kept in partial check by antelope. The poisonous paper flower and groundsel are also held in partial check from increase. Reduction in competition from weeds also provides an opportunity for the valuable grasses to spread and maintain themselves when grazing pressure is reduced to improve overgrazed ranges. Although the value of the antelope in this respect may be small, it is highly significant on overgrazed lands.

Another fact not to be overlooked is that the rancher has no expense in the way of labor, materials, or maintenance to pay for permitting a population of antelope to build up on his range. His profit for allowing hunters to kill antelope on his land is almost a gift.

Our problem today in maintaining and developing the pronghorned antelope in Texas is one of getting accurate information to the landowner concerning the antelope on his range. Only through his cooperation can the Texas Game, Fish and Oyster Commission manage the antelope on sound and profitable principles, so that thousands of people may enjoy the esthetic sight of the pronghorn or the thrill of an antelope hunt in the beautiful Texas Rockies.

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## DISCUSSION

CHAIRMAN HOSLEY: I am sure that there will be discussion of this very fine paper. Who is the first one to comment or ask questions?

MR. W. L. JOHNS (South Dakota): What was that $40 deal he talked about when he first started out? He went over that too fast.

MR. BUECHNER: In the State of Texas, in order to go on an antelope hunt, the hunter has to pay $40 to the rancher for the privilege of killing a buck on his land.

MR. GRADY HILL (Texas): I would like to know the common names of those obnoxious weeds that the antelope will eat.

MR. BUECHNER: The names of the poisonous weeds are paper flower and groundsel. And they also eat loco weed, but that does have a harmful effect upon the antelope.

MR. HILL: Did you indicate bitter weed as one of the weeds they eat?

MR. BUECHNER: Yes, they don't prefer it, but they eat large quantities of bitter weed in late summer and early autumn.

MR. HILL: Do they get along all right with it?

MR. BUECHNER: Yes.

MR. ELLIOTT S. BARKER (New Mexico): Do you have any figures as to how much of your Texas antelope range is being fenced up in sheep fences?

MR. BUECHNER: I don't have those figures personally but I believe that the Game Department does have. It is considerable and is having a harmful effect upon the antelope.

MR. BARKER: Have you any figures on the minimum size of sheep pasture that antelope may be expected to survive in?

MR. BUECHNER: No, I do not, but the size will not have much to do with it. It's mostly a matter of how many sheep are on that particular pasture.

MR. W. C. ROCHELLE (Texas): In eastern Texas, would the antelope survive? Around Texarkana?

MR. BUECHNER: No sir, I do not believe so. I base my statement on the fact that the native, natural range of the antelope in the old days did not extend quite that far.

MR. ROCHELLE: Is that the only reason?

MR. BUECHNER: That's right. They could be forced to live there, but they wouldn't prosper under natural conditions.

COLONEL M. L. CRIMMINS (Texas): What sort of fence stop is there?

MR. BUECHNER: Sheep-proof fences, either a netted fence or a 7-strand barbed wire fence, stop them. They can go under and once in a while through a 4- or 5-strand barbed wire fence.

# NINE-YEAR OBSERVATION OF A DEER PROBLEM AREA

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Perhaps one of the most pitiful sights is that of deer wandering daily throughout devastated ranges in winter, avidly seeking enough food to sustain life, the larger living usually at the expense of the smaller. Confronted with such problems, the first urge is to prevent losses and this is usually accomplished by killing more deer. It is an accepted pattern throughout the land. The fearsome thought of the game manager, if he thinks through the cycle, must be that such a combination of events may soon reoccur, therefore, this solution is only a temporary expedient.

I fear that my attack on this subject will be woefully inadequate since the need for range improvement, which seems to me to offer the best solution, is not a new concept. Since the real substance of this presentation must rest in the photographic records, only a small part of which can be used in the printed report, help must be sought from you game managers and research or range men present who already consider range improvement to be a basic need. The task, then, is to bolster wavering courage for the all-out attack necessary to improve the western mule deer ranges readily classified in the "problem" group.

We all know that ranges change. Why and how long it takes are matters we may wish to analyze, and if our concepts of time required have been too great, we may be heartened in our task.

Fortunately, we have numerous examples of range improvement in the West. With the inauguration of the Grazing Service program, especially in the nonforest areas, rapid strides were made. When domestic herds were withheld or controlled in the late 1930's, vast acreages, long considered "waste land" in Malheur and Harney counties in Oregon, developed grass stands reminiscent of the days of the buffalo on the prairies.

The Hart Mountain Wildlife Refuge in south central Oregon became so productive of grasses after two seasons of deferred grazing that cattle and sheep were needed to remove a fire hazard in an arid range where summer drought and lightning is common.

The timbered range lands operated on a multiple use program have been, however, the critical habitat areas of mule deer. One of the most spectacular and well-known examples is that of the Kaibab. A few years ago you heard of a potential second Kaibab, the Murderer's Creek Basin of Oregon. You may well wonder why this basin with its prophetic name no longer claims the common attention, although it still exists as a latent problem area. The entire story is simple.

Murderer's Creek Basin, following a history of excessive grazing, became a sanctuary for deer by legislative enactment in 1926. The protected deer increased while cattle, sheep, and horses roamed the same range lands in numbers excessive for the available food. The grasses weakened. The soils became unstable. The browse plants, closely cropped by farm animals and deer alike, barely existed. Finally, in the middle 1930's came a period of winter deer and stock losses and a realization that rigid legislative regulations were sometimes unwieldy tools of sound management.

Following the usual period of heated argument and evaluation, a series of events took place which collectively emphasized the several contributing causes of the crisis. The sanctuary was dissolved and an eventual adjustment of the number of all animals using the basin was made. Drift fences were built, grazing seasons were readjusted and enforced, and penalties were levied. In a few seasons partial order came out of chaos and deer losses stopped in the greatly reduced herd. With the dramatic aspects of the problem gone, public interest waned and shifted to some other current issue and Murder's Creek problem today is but a faint memory to many and unknown to others.

We are inclined to believe that such situations develop only over long periods of time, and that impending events cast their shadows far before them. In general this may be true, but transitions are often rapid or the shadow cast is faint. The skill of the field worker is sorely tested in determining the trends. It is surprising what a short time it may take to bring about a change on the range. This paper deals only with the general phases of range successions in support of the foregoing contention.

By maintaining a controlled exclosure on the public lands on Murderer's Creek range from 1937 to 1946, it was possible to record the difference in ground cover. The exclosure was about an acre in area. It was established in the basin on unstable, overgrazed land with the thought that if forage recovery could be induced here, as much could be expected under satisfactory management of the better areas as well. A 12° slope was chosen to provide excessive runoff in order to retain a minimum of moisture in a district where the rainfall averaged 11½ inches per year (U. S. Dept. Agr., 1941). This ground was intentionally selected so that any changes in vegetation would be directly attributable to the prevailing conditions of environment and management, the latter consisting primarily of the exclusion of deer and domestic animals (Figures 1 and 2). The plot was fenced with 6-foot galvanized netting and with one strand of barbed wire at the

Figure 1. This exclosure or trial plot was fenced in March 1937. It was located on overgrazed range land with eroding soil

Figure 2. The ground was barren both inside and outside the fence.

top, making a fence about 7 feet high. The plot was laid out in eight sections consisting of seven seeded plots, the eighth being left as a control. Plots were seeded in April following a rain in the manner customary on open range land, averaging about 6 pounds of seed per acre. The following seeds were used:

| Plot No. | |
|---|---|
| 1 | Crested wheat-grass |
| 2 | Western wheat-grass |
| 3 | Slender wheat-grass |
| 4 | Bluebunch wheat-grass |
| 5 | Idaho fescue and brome (cheat) |
| 6 | Smooth brome |
| 7 | Tall fescue |
| 8 | Check plot |

At the beginning of the study the plot was almost bare. With the exception of shrubbery, ground cover was about what you might expect in a chicken run. Observations in 1937 showed that many of the seeds had germinated but as the summer progressed it became evident that Plot No. 5, containing Idaho fescue and the common range "cheat," was making the best progress (Figures 3 and 4). The vigor of cheat is commonly appreciated since it claims vast acreages of the hoof-scoured or burned-over range lands of the West. Since it is an annual with a heavy seed crop, this succession is natural. On the trial plot, however, it was found that the Idaho fescue quickly became dominant and rapidly replaced the cheat. As soon as the fescue began to establish itself, little islands of turf developed and spread, and in 2 years' time it was apparent that fescue would be the dominant plant over the entire tract, including the check plot. It likewise expanded to barren ground outside the plot, but survived there only when its seeds fell on protected ground such as in the center of a bitter-brush or sage-brush stand where it was inaccessible to the domestic animals and deer. To an observer who came but once, a casual scrutiny of the plot would not be particularly revealing. To the observer who came regularly to make comparisons both by observation and photographs, the changes in ground cover were phenomenal. It was like watching a river freeze up in the fall; first, the drifting crystals of ice formed, and then slush ice followed by pan ice, and finally the river was completely frozen (Figures 5 and 6). In 4 years (1937-1941), the entire trial plot became a solid island of grasses in this vast expanse of overgrazed land. In spite of good growing conditions throughout the basin, there was no comparable range improvement there. Deer losses were prevented by maintain-

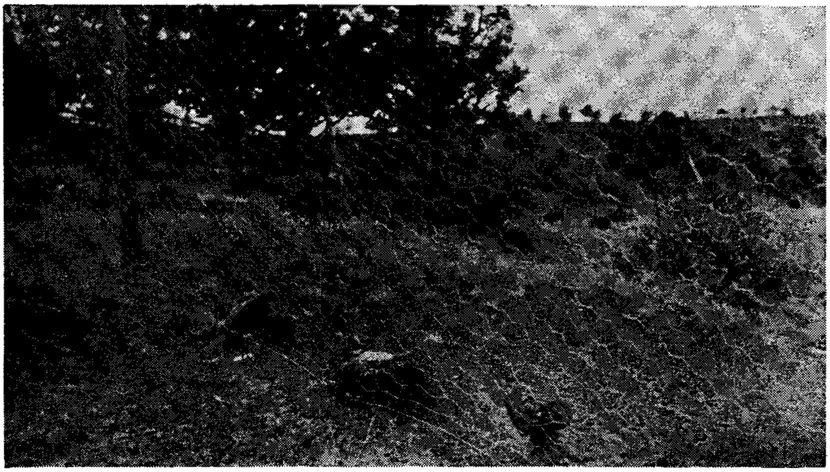

Figure 3. In 1938 fescue, one of the seeded grasses, was beginning to stool.

Figure 4. In 1939, the spring stools looked quite vigorous.

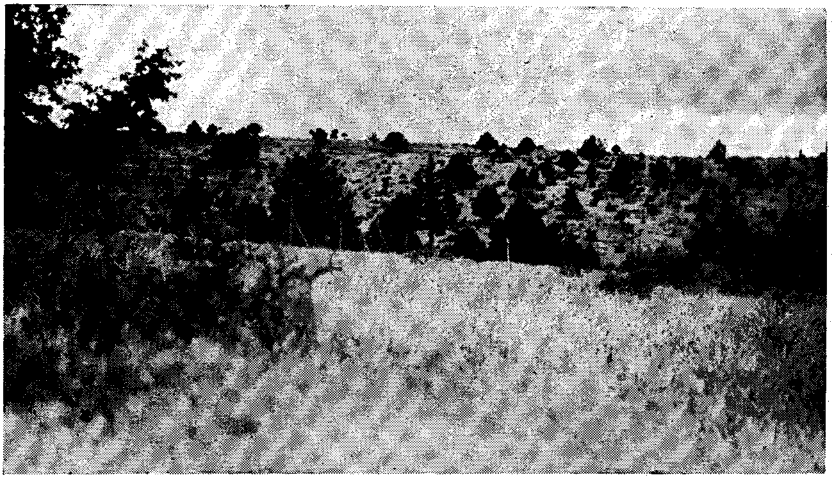

Figure 5. This is the trial plot in midsummer 1940. What a contrast with the adjacent range!

Figure 6. The grass stand and seed crop was good in 1941.

ing their numbers below the critical level, thus allowing a small reserve of browse to accrue.

In this basin winter snows rarely exceed 10 inches in depth, less than in other portions of the Blue Mountains, since a high rim surrounds the basin and moisture is precipitated before it crosses this barrier. This is one of the natural factors which encourages the winter concentration of deer in the basin. When the growing season begins, which may occur as early as February, cheat is the principal grass.

In 1942, April had about an inch of rainfall which is a little less than normal. May had 2.8 inches, about 1.6 inches above normal. June followed with 1.4 inches, almost 0.3 inch above the usual rain-

Figure 7. In 1942, a wet spring followed by excessive heat withered the grasses and little but dry stalks remained. Grasses which matured that year were scarce.

fall for that period. July followed with 0.3 of an inch and in August the rainfall was barely measurable, a not unusual situation since July and August are usually the drought months. The spring growth was lush and cheat was purple on the hillsides. Transpiration surfaces on most plants were great.

Late in June, a series of extremely hot days and nights occurred. Temperatures at Dayville, the nearest official weather station, hovered around 102° for a considerable period. These extremes—first, excessive moisture, second, excessive heat, and third, drought—were quickly reflected by vegetation and by August 25, range and the adjacent trial plot carried few living grass or browse plants (Figure 7). Not only were the succulent grasses reduced to dry prostrate stalks, but in early July the undeveloped leaves on the bitter-brush withered and fell.

In 1943, cheat was again abundant and scattered stools of Idaho fescue struggled for recovery on all plots which had reverted to conditions similar to those in 1937. Obviously, an abundant cheat crop produced near at hand accounted for its rapid reoccupancy of the trial plots. Upon investigation it developed that the massive hair root system of the fescue accounted for its survival. Each fescue plant sent down hair roots in a mat which occupied about 2 square feet of ground area immediately surrounding the plant, thus nurturing a feeble growth of a few blades under drought conditions. In the

**Figure 8. The spread of grasses on the plot in succeeding years was gradual. In 1946, ground cover was again sufficient to hold the soil with fescue predominant.**

successive years the Idaho fescue struggled for dominance and by 1946 reoccupied the plots almost to the exclusion of other forage plants (Figure 8). Again the adjacent range failed to reveal any similar conditions. Lupine, abundant locally in overgrazed ground and which grew profusely in the basin, was represented by only one plant on the trial plots.

There were 34 living bitter-brush plants on the plot in 1942. All of them were defoliated and showed direct reaction to the extremes of moisture, heat, and drought. Immature leaves withered and fell in midsummer. In 1943, of those inside the plot, 22 showed signs of recovery, a survival of about 64 per cent. Just beyond the exclosure in a like amount of area and marginal to the the plot, where browse showed almost complete annual utilization, four bitter-brush plants were growing. More striking, however, was the case of one plant which was intersected by the exclosure fence at the time of its construction, leaving about the same amount of plant on either side of the fence. Naturally, that inside the exclosure was more heavily foliated at the time of the drought, since the remainder of the plant was persistently browsed with about complete utilization. In the face of these extremes of weather, the part of the plant outside the fence failed to show a comeback in 1943 and in 1946 and was obviously dead. The part within the exclosure from the same root stock showed a feeble growth in 1943 without producing any seed crop, but in 1946 was loaded with seed which matured. Similar observations on overbrowsed bitter-brush on the range indicated their lack of seed production, a critical factor in the failure of reproduction in this vital deer browse.

Ground forage and browse plants are impossible to separate in the program of multiple use management. Mule deer here show little interest in grasses except when they spring up as tender shoots, and will starve to death in abundant stands of dried bunch-grass. The irrefutable fact remains, however, that cattle and sheep likewise follow somewhat the same pattern, and in Oregon will change from the range grasses to browse plants as early as July 15th. If ground forage is abundant and palatable this may not occur until late in the summer.

During this period of observation, grass seeds were found to be well formed as early as June 15th, and by July 15th of each year an examination of the ground showed that seeding was well under way. This was particularly true of the Idaho fescue. It is obvious then that three important issues must be considered in range management:

1. Whether grazing ground can stand annual seasonal use or must have periodic rests.

2. Whether the ground in multiple use areas carries sufficient forage to delay the attack upon browse plants by domestic animals until late in the season.

3. Whether to defer grazing until natural reseeding can be assured, at least in some degree, by the maturity of the plant.

Unfortunately, a misconception has arisen over the usefulness of range lands. Many look on them as "waste lands." It is more or less accepted that these grounds are suited for little, and we are, therefore, not startled by their lack of productiveness. In reality, much of this land is not waste land. It has been laid waste by the use to which it has been put. Murderer's Creek Basin has been commonly considered as an area of little promise, yet a soil analysis contradicts this evaluation. The terse report which follows classifies the ground as suitably productive for range. Our own experience with trial plots shows it to be potentially rich in forage possibilities.

SOIL TEST

Soil classification[1]: Heavy clay loam soil

Soil content: Above average in available phosphates
Very high in available potassium
Above average in active organic matter (amount of nitrogen)
pH 7.2 Just slightly above neutral (alkaline)
(A very desirable condition for soils)

Erodability: High (If the plant cover is removed from this soil, it will erode very easily.)

Albrecht (1944) has said that the deficiencies in soil fertility are closely linked with use by wildlife and domestic animals and affect reproduction and abundance quite directly. In this particular situation we need not be as actively interested in this phase of investigation as in the fact that the soil analysis shows that erodability is high. Its productive peak can, therefore, never be determined if the plant cover is removed, a situation which has been historically true of the Murderer's Creek Basin from early occupancy.

These experiences focus attention on the possibility of improvement in range conditions. In 9 years, the trial plots passed through two cycles of plant scarcity and two cycles of relative abundance. During the same years, forage on adjoining range was never good. It is apparent that the causes of range forage scarcity can be either weather, pests or other natural agents, man-made, or a combination of these causes. If there is a tendency to consider a restoration program which relies on seeding and deferred grazing to be too slow, may we not review these experiences? Is 4 years long when we should plan in centuries? We have accepted summer fallowing as a necessity in dry farming. In that productive bread basket of the West, the wheat country, it is easy to determine the acreage already classified as summer fallow ground. There is no similar policy in regard to range, yet the need is as great. In range management there is a definite need for a common understanding that in many areas seeding and periods of rest are necessary for stabilized forage production.

There is too-evident proof, both on public and private lands, that many ranges are not in optimum forage production, simply because

[1]Soil sample taken at Murderer's Creek Basin, July 10, 1946. Analysis made under the direction of C. V. Ruzek, Professor of Soil Fertility, Oregon State College.

we fail to see a crisis impending or have not the heart to begin a sound usage program. There is a stern warning to be read in these now barren "problem" range lands of the West.

## SUMMARY

1. The Murderer's Creek Basin became a problem area under a multiple use program.

2. Through the use of trial plots, it was found that on denuded ground forage was restored in 4 years by excluding deer and livestock.

3. Common cheat (*Bromus tectorum*) showed an ascendency in the first year after the exclosure was established, but Idaho fescue (*Festuca idahoensis*) revealed vigor also.

4. In the succeeding years the Idaho fescue, through self-seeding, increased until 1941 when it occupied a dominant position over all other forage plants.

5. Lupine, recognized as an obnoxious weed on eroded soil, still was expanding beyond the exclosure while it had been reduced by the grasses to one plant within the exclosure.

6. Bitter-brush, overbrowsed and exposed to excessive spring moisture, summer heat, and drought, had a low survival rate. Bitter-brush plants inside the exclosure showed a high survival rate.

7. Bitter-brush plants which were continually browsed showed no inclination to produce seed crops. Those inside the exclosure produced seed crops every year from 1938 to 1941.

8. Game managers responsible for forage must be alert and observe transitions on the range and can improve conditions by insisting on sound management practices.

9. Much of the western lands in problem areas could be improved by a re-evaluation of the multiple use plan and adjustment could be made, allowing for rotational use when needed for forage restoration, a procedure in which stockmen and conservationists have a definite responsibility.

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# PLANNING OF MANAGEMENT PROGRAMS FOR WESTERN BIG-GAME HERDS

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Predicting the nature and direction of future changes is not usually considered to be within the realm of wildlife managers. In recent years, however, many of the wildlife administrators and managers have correctly foretold an increasing interest and participation in the out-of-door recreation furnished by hunting and fishing. And the end is not yet in sight. A great deal of the discussion of this Twelfth North American Wildlife Conference will be devoted very appropriately to the subject of how to meet this constant increasing demand for more hunting and fishing.

Examples of the tremendous increases in the number of big-game hunters has recently been summarized by Leonard (1946) from replies to a questionnaire sent to the conservation department of the 48 states. For the years 1937 and 1945, 16 states reported a total of 777,406 and 1,423,871 resident big-game hunters, an increase of 83 per cent. With 11 states reporting, nonresident big-game hunters increased in numbers from 5,979 to 29,187, an increase of 388 per cent.

In Utah, the records show a total of 5,657 big-game hunters in 1925 and 23,050 in 1935, an increase of 407 per cent, and 93,707 in 1945, another 407 per cent increase over 1935 numbers. Also in Utah there were 11,000 applicants for 1,060 special elk permits in 1946, or approximately twice as many as the combined number of all deer and elk hunters in 1925. The story in many of the other big-game states is very similar.

Accompanying the increase in the numbers of big-game hunters over the past 20 years, there has been also a sensational increase in certain big-game species. Lack of information on definite numbers makes it impossible to make a direct comparison. Practically all big-game states, however, can testify to recent marked increases in some species and the development of overpopulated areas in spite of this increase in total numbers of hunters.

Although the number of hunters may continue to increase, limits are being reached in the size of big-game populations. There are some understocked and unstocked areas where increases are possible. Also, there are definite possibilities of range and habitat improvements to increase the size of the herds. No serious student of the situation, however, is optimistic enough to believe increases in big game can continue indefinitely and keep pace with the increased hunter demand.

The logical alternative to constantly increasing numbers, in an attempt to supply the hunters' demand, is a better and more intensively planned management of optimum sized herds with increased efficiency in harvesting the annual increase. The evidence from those many states reporting the development of overpopulations and big-game problem areas, indicates repeated failures at harvesting available surplus. This has usually been due to legislative restrictions and public opposition.

I am not naive enough to believe we have solved this big-game overpopulation problem. There is still much well-meant opposition to desirable and needed removals that are essential to remedy overpopulations in the West, as well as other parts of the country. There are, however, some shining examples where we are apparently approaching the goal of stabilizing herd numbers within the carrying capacity of the ranges, and obtaining near maximum yields of big-game animals for hunter harvest. Where this is occurring, we are extremely interested in its continuation and in knowing the mechanics of what is actually happening. Of primary importance is an analysis and determination of the productivity of these herds by species and herd units to aid us in extension of planned management of other herds.

Intensive unit management of a western big-game herd can perhaps be best compared in other fields with operation of a western livestock ranch. Fundamentally, the objectives of the two undertakings should be the same.

1. Maintenance of a long-time stable operation.
2. Maintaining a balance between animal numbers and available forage.
3. Obtaining a maximum annual harvest of surplus animals.

A study of "Cattle Production on Wyoming's Mountain Valley Ranches" by Vass and Pearson (1933) illustrates some of the mechanics of livestock management and production that appear to be applicable in big-game herd management. Table 1, modified from Vass and Pearson, shows the composition and annual sales (productivity) of a ranch herd of cattle.

In such an operation the rancher, by planning, attempts to continue in business, to maintain a maximum sized stable herd, and to market as many pounds of beef as possible. In this example the calf crop is 70 per cent based on the number of mature cows. The annual sales, or productivity, is 30.2 per cent of the numbers in the winter herd, and consists of 18 per cent female calves and 82 per cent adult animals of both sexes. Forty-seven per cent of the animals sold are females and 53 per cent are males.

Obviously, management of a big-game herd can not be conducted as efficiently where harvesting is dependent on the hunters and the uncertainties of the hunting season. Also, it is not possible to control game removals in such a way that all losses from old age are avoided as the ranch manager attempts to do.

It has, however, been demonstrated in a number of big-game herds, particularly elk and deer, that a productivity figure can be determined. That is, a fairly definite percentage or number of animals can be harvested annually while maintaining the herd at a relatively stable number. It has been definitely proved (although surprisingly not generally accepted) that to maintain stable big-game numbers in a healthy herd, a definite and substantial part of the removals must be from the females in the herd.

TABLE 1. CATTLE INVENTORY AND SALES FROM A WYOMING "STANDARD RANCH ORGANIZATION"

| Class | Herd composition January 1 | | Annual sales | |
|---|---|---|---|---|
| | Numbers | Per cent | Numbers | Per cent of January 1 herd |
| Cows, mature | 340 | 46 | 66 | 8.8 |
| Females 2's | 76 | 10 | | |
| Females 1's | 78 | 11 | | |
| Steers 1's | 119 | 16 | | |
| Steers 2's | 117 | 15 | 115 | 15.4 |
| Bulls | 27 | 2 | 4 | .5 |
| Total | 747 | 100 | 185 | 24.7 |
| Female calves | | | 41 | 5.5 |
| TOTAL | 747 | 100 | 226 | 30.2 |

Elk herds have provided us with better information on productivity than perhaps any other game animals. As a species they are more easily censused than most other big game, making it possible to obtain reliable figures on total herd numbers. Sex and age ratios can be accurately made and tradition has not generally prevented hunts for animals of both sexes.

An outstanding example of planned management and full utilization of the full productive capacity of a big-game herd, is the Nebo elk herd on the Uinta National Forest in Utah. The history of this herd has been given by Olsen (1942). Since that time the annual regulated hunts have continued. A tabulation of the total removals, including the 1946 hunt, shows that this original plant of 48 animals, made in February 1914, has, in 33 years, produced 3,595 animals including 1,350 cows and calves. Of these, 3,364 were taken by sportsmen hunting during 19 hunting seasons and 88 were live trapped and used in stocking other ranges. At present there is a herd of approximately 1,000 animals. This herd has supplied uncontroversial evidence that a number of both male and female animals, equal to 20 to 25 per cent of the numbers in the winter herd, can be harvested annually by regulated sportsmen hunting without reducing the herd.

This fall careful prehunt sex ratio counts were made of the Nebo and Manti National Forest elk herds in Utah. In these herds the bull: cow ratio was 1:1.6 and 1:1.8; and the cow: calf ratio was 1:0.56 and 1:0.53, respectively. In these two examples, the calves constituted approximately 25 per cent of the total herd.

Table 2 shows the composition of and removals from a typical Utah stabilized elk herd. The sex ratios are based on September or prehunt counts of 1 bull to 1.68 cows, a cow-calf ratio of 1:0.53, and counts showing calves making up 25 per cent and spike bulls, 10 per cent of the herd. Figures represent per cent, or numbers on the basis of a herd unit of 100 animals.

TABLE 2. SEX RATIOS OF AND REMOVALS FROM A UTAH ELK HERD

| Class of animal | Year (a) | All removals | Year (b) |
|---|---|---|---|
| Total cows (counted) | (47) | | (47) |
| Cows, mature (estimated) | 28 | —9 | 28 |
| Cows, 2 years old (estimated) | 9 | | 9 |
| Cows, yearling (equal spike bulls) | 10 | —1 | 10 |
| Calves, females (estimated) | 12.5 | —2.5 | 12.5 |
| Total calves (counted) | (25) | | (25) |
| Calves, males (estimated) | 12.5 | —2.5 | 12.5 |
| Bulls, yearling (spikes counted) | 10 | —10 | 10 |
| Bulls, over 1 year (counted) | 18 | | 18 |
| Total bulls (counted) | (28) | | (28) |
| Total | 100 | —25 | 100 |

Between years "a" and "b," the total removals from all causes is 25 animals and is balanced by the replacement of 12.5 female and 12.5 male calves per herd of 100 animals. The calves in this highly productive herd represent 25 per cent of the herd and a potential increase of approximately 33⅓ per cent of the adult stock (25 to 75). The absolute maximum increase is, therefore, 33⅓ per cent assuming there are ***no other losses of any kind.*** When due allowances are made for natural losses, such as old age, predation, accidents, losses of wounded animals, and all other causes, it is believed actual hunting removals of 20 to 25 per cent is the maximum for this elk herd. This appears to be high for elk generally but has been attained in Utah herds and is possible if the herd is maintained in a healthy condition and is efficiently harvested.

Losses from old age, although a definite drain on most wildlife populations, can be reduced to a minimum in heavily hunted big-game herds. The calculated survival of any elk age class subjected to 10 hunting seasons, would be 5.7 per cent (of original numbers), if 25 per cent of the surviving animals were removed each year, or 10.7 per cent if 20 per cent were taken annually. Field observations in the Intermountain region fail to show any serious or marked drains on elk herds caused by predators.

A count of a herd of 9,841 animals on the Elk Refuge at Jackson, Wyoming, in the winter of 1940-41, showed a ratio of 1 cow to 0.38 calves. Rush (1932) tabulates the September composition of the northern Yellowstone herd in 1932 as a cow-calf ratio of 1: 0.43. In a report on the Olympic Peninsula Elk Herd, Schwartz and Mitchell (1945) give the cow-calf ratio as 1:0.45 for September during the years 1936-38.

On the basis of these published reports, the Utah counts are above average. The difference, however, is not so great that it can not be reasonably assumed that elk as a species, under favorable conditions, is capable of producing for hunters' harvest, near 20 per cent of the numbers in the overwintering population. Recent studies of the Jackson Hole elk herd indicate an annual hunter harvest, equal to 18 per cent, or possibly more, can take place in that herd. The Jackson herd has appreciable winter losses of both calves and mature animals during the usual winter.

Although hunting of female elk is fairly well accepted procedure in the Western States, suggesting the hunting of female deer as a method of providing more deer for hunter harvest, as well as a necessity in stabilizing herd numbers, is still vigorously opposed in a number of the states. Idaho is definitely fortunate in not having acquired either a "don't kill the does" or short season tradition habits that make difficult needed and improved deer management in some other Western States. In Idaho, a deer of either sex is legal, and although they still have some areas of overpopulation in inaccessible districts, regulation of total numbers by limiting removals has proved to be a very workable program on the more accessible areas.

On the Cassia division of the Minidoka National Forest in southern Idaho, there is a herd of approximately 12,000 mule deer. This area is located near centers of large hunter population, and is very accessible to hunters because of the type of terrain and numerous roads. Uncontrolled hunting would definitely result in overshooting. A cooperative management plan in operation on this area calls for hunting by a limited number, determined by a drawing, and maintenance of present deer numbers. The success of such a program is attested by the fact, in the past 11 years, 21,750 permits have been issued (3,250 in 1946), and 16,940 deer (2,514 in 1946) have been legally removed for a hunter success ratio of 78 per cent. Removals from this herd have averaged 51 per cent bucks, 39 per cent does, and 10 per cent fawns. A kill by sportsmen equal to approximately 25 per cent of the winter populations, has proved to be possible on an annual basis without diminishing the herd.

In formulation of a management plan for the Dixie deer herd in southern Utah, it was determined that a herd of 8,000 deer could be maintained in a balanced program with other range usages. To date, control of the number of buck hunters has not been deemed necessary on this area. In addition to the unlimited buck hunt, a limited number of permits have been issued annually to remove antlerless deer. These permits are intended to result only in the removal of surplus females from this herd, and thereby provide a method of controlling

TABLE 3. SEX RATIOS OF AND REMOVALS FROM A UTAH DEER HERD

| Class of animal | Year (a) | All removals | Year (b) |
|---|---|---|---|
| Total does (counted) | (43) | | (43) |
| Does, matures (estimated) | 31 | —12 | 31 |
| Does, yearling (from kill) | 12 | | 12 |
| Fawns, females (estimated) | 16 | —4 | 16 |
| Total fawns (counted) | (32) | | (32) |
| Fawns, males (estimated) | 16 | —4 | 16 |
| Bucks, yearlings (equal yearling does) | 12 | | 12 |
| Bucks, 2's and over (estimated) | 13 | —12 | 13 |
| Total bucks (counted) | (25) | | (25) |
| Total | 100 | —32 | 100 |

the total numbers. A doe kill equal to 10 per cent of the winter herd is indicated as the desirable removal to accomplish this objective. Here also under intensive management, the herd is producing approximately 2,000 deer annually to sportsmen hunting with a hunter success ratio of nearly 70 per cent. Careful counts during recent years show the doe-fawn ratio in this herd to average 1:0.60.

Robinette and Olsen (1944) have reported on a detailed analysis of the productivity and losses of the deer herd on the Fishlake Forest in Utah. September and October doe-fawn ratios for this herd averaged 1:0.77, and the productivity of this herd of 44,650 animals is calculated at 12,250 animals, or 27.4 per cent. The hunting loss of 15 per cent of the legal kill would reduce the number actually removed to 23.9 per cent.

Numerous sex, doe-fawn and age-class counts have been made in the field and by checking the removals by hunters from different Utah deer herds. Table 3 is prepared as an example of a productive and stabilized Utah mule deer herd based on a prehunt buck-doe ratio of 1:1.72, a doe-fawn ratio of 1:0.74, an adult doe-yearling doe ratio of 1:0.39, and an adult doe-fawn ratio of 1:1.03, ratios which are near typical in Utah. Figures represent per cent, or numbers on the basis of a herd unit of 100 animals.

Between the years "a" and "b" the total removals from all causes is 32 animals, and this is balanced by the replacement of 16 female and 16 male fawns per herd of 100 animals. The potential or absolute maximum increase of the herd is 47 per cent on the adult stock (32 to 68). With allowances for natural losses, such as predation (a definitely important factor in deer herds), old age, accidents, hunting losses (determined to be 15 per cent to 25 per cent of the legal kill in Utah), and all other causes, legal hunting removals of 30 to 25 per cent appear to be the maximum possible in this deer herd.

Legal hunter harvest in mule deer of numbers equal to near 25 per cent of the winter's numbers, is not believed to be the exception, but rather represents a near normal condition of the species. This can occur, however, only if both sexes are harvested, and where predator losses and illegal kills are limited.

The number of yearlings that survive until the second hunting season appears to be indicative of the productiveness of a big-game herd. In the example given in Table 2 for elk, 20 animals out of a herd of 100 are in this class. In the example, Table 3, 24 of the 100 animals in the herd are in this class. In both cases there is close agreement between this number and possible removals as shown by field investigations.

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## DISCUSSION

MR. ELLIOTT S. BARKER (New Mexico): I believe you said that you could figure about a 25 per cent increase on your herd annually.

DR. RASMUSSEN: Yes, in mule deer.

MR. BARKER: I am referring to elk.

DR. RASMUSSEN: It appears to be just a little under 20 per cent for elk. Actually about 18 per cent. Fifteen per cent is, I believe, low, but in the one herd that I referred to here, it has exceeded 20 per cent.

MR. BARKER: What do you consider your breeding herd, just the animals 3 years and over?

DR. RASMUSSEN: No, it's the total numbers in the winter herd. The breakdown of the sexes in this Utah elk herd, before the hunt, is about 28 per cent cows of breeding age, 9 per cent 2-year-old cows, 10 per cent yearling cows, and 10 per cent spike bulls, and 18 per cent larger bulls. In this herd, 25 per cent are calves which would be the equivalent of 33 per cent of the winter herd.

MR. BARKER: Is that a herd where you have a season on both cows and bulls?

DR. RASMUSSEN: Yes, both sexes but the numbers of each are limited. About two thirds of the kill is males and one third females.

MR. BARKER: If any herd was hunted without restrictions, would an equal number of cows and bulls be killed each year?

DR. RASMUSSEN: The Jackson Hole herd is hunted pretty much by that method. One of either sex is permitted and the kill is about half males and half females. The productivity figure for that herd should be a little less than where the kill is two thirds males. This Utah herd when they kill about a third females and two thirds males is, I believe, near the peak of efficiency as far as yield is concerned.

MR. BARKER: Have you any figures on the annual losses to other causes other than legal hunting?

DR. RASMUSSEN: No, only that they appear to be fairly constant. Other causes normally reduce the potential 33-1/3 per cent increase in elk down to a possible harvest of 20 or 15 per cent.

MR. BARKER: Do you have any figures on the life span of your elk?

DR. RASMUSSEN: Only in the case of a few individuals.

MR. BARKER: Do they live about 12 to 13 years?

DR. RASMUSSEN: Some that we know of have lived as long as 16 years.

MR. BARKER: Individuals?

DR. RASMUSSEN: Yes, known individuals.

MR. BARKER: If the life span is 13 years, wouldn't you have to take about a 10 per cent loss annually on your breeding herd of 3 years and over?

DR. RASMUSSEN: Yes, in an unhunted herd, however, in a heavily hunted herd you harvest the majority of them before they die of old age.

MR. BARKER: With unrestricted hunting, won't your kill run very heavy to your young stuff—to your calves and yearlings, not wise to hunters like the older animals, and still leave a heavy per cent of the annual death loss from old age?

DR. RASMUSSEN: Yes, in some cases, but the bulls are usually heavily hunted even in the open hunts. In the Utah herd I have discussed specifically, the number of cows and calves killed from a herd is definitely limited.

MR. BARKER: Our experience has been that they kill more of the younger ones than the older ones—more calves than any other class.

# RELATIONSHIP OF WEATHER TO WINTER MORTALITY AND POPULATION LEVELS AMONG DEER IN THE ADIRONDACK REGION OF NEW YORK[1]

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It seems evident that the central Adirondack region of New York has always been marginal range for the white-tailed deer (*Odocoileus virginianus*). In colonial days, deer were very scarce in this region but relatively numerous in lowland areas such as the valleys of the Hudson, Mohawk, Delaware, and Susquehanna, and the Ontario–St. Lawrence plains. As the forests in the northern part of the state were opened by lumbering and other means, and as the principal predators of the deer—the wolf and panther—were exterminated, the suitability of the region for deer improved. As a result, the deer population began to increase and the pattern of this increase apparently followed the exploitation of the wilderness by man. As deer abundance rose in the absence of natural predators and under increased restrictions as to hunting by man, winter losses brought on by malnutrition became more important. By 1895 reports were received by the Forest, Fish and Game Commission that hundreds of deer had died throughout the Adirondack region during the winter of 1894-95. Ever since then, although it is quite certain that it had occurred before that date, winter mortality had been chronic.

Critical study by the Conservation Department of winter losses in this region started in 1930-31. Since then, spring surveys to determine the severity of these losses have been conducted each year. It soon became evident that weather conditions were a major factor governing the degree of mortality. Accordingly, data pertaining to this relationship have been compiled and analyzed. It is the purpose of this paper to discuss certain phases of this study.

*Material and methods.*—One of the largest known winter concentrations of deer in the Adirondack region of New York occurs in the vicinity of the "Plains" along the south branch of the Moose River in Hamilton County. Here, deer, which range over an area of about 70 square miles during the summer months, congregate on about 14 square miles during mild or moderately severe winters and, during more severe seasons, concentrate on about 8 or 9 square miles of

[1]A contribution from Pittman-Robertson Wildlife Restoration Projects 1-R and 26-R, N. Y. State Conservation Department, Bureau of Fish and Wildlife Investigations. Robert W. Darrow, Supervisor of Game Research, N. Y. State Conservation Department, has greatly facilitated the work of these projects and has been very helpful to the author during the course of this study; E. L. Cheatum and C. P. Brown gave advice and criticism in the preparation of the manuscript.

lowland area. This section of the region also lies within the zone experiencing the most rigorous winter climate in the State. Thus it has afforded an excellent situation in which to study the relationship of weather to deer mortality.

Since 1931 surveys have been conducted each spring to appraise the degree of winter losses among deer occupying this area. Field work consisted of traversing the wintering grounds on foot. The location of each dead deer found was plotted and the sex, age (fawn or adult), and apparent cause of death were recorded as well as data on the quantity and quality of nearby food and shelter. Prior to 1939, the area surveyed was covered in its entirety. Beginning in 1940, however, a sampling method of gathering field data was initiated which facilitated covering a great deal more territory in a given amount of time. This method consists of laying out traverse lines parallel to the major water courses. These lines are then followed in making the survey. In general a crew of two men, working abreast, has been found most practical. In this way each man covers a strip about 200 feet wide, equivalent to 24 acres or 0.0375 square miles per linear mile of survey line. By laying out the lines as indicated it has been possible to cruise the area satisfactorily. Once laid out, the same route was followed in subsequent years. Comparable values for the relative severity of winter mortality were obtained by computing the number of dead deer per square mile of strip surveyed.

Weather data were compiled from publications of several governmental agencies. *Climatological Data,* a bulletin issued monthly by the U. S. Weather Bureau, was the source of figures for average monthly temperature, average monthly fall of unmelted snow, and the departure of these averages from the normal. For the purposes of this study data were used from eight stations situated at nearby points on all sides of the area. Figures for accumulated snow depths were derived from the Cooperative Snow Reports of the U. S. Geological Survey and the Ski Reports of the N. Y. State Department of Commerce. Here also only information applicable to the section under consideration was used. In order to provide a knowledge of the full winter season, these data were compiled for the period from October through May each year.

*Comparison of deer mortality and weather conditions recorded.*— A summary of the deer mortality recorded from 1930-31 to 1945-46 shows that, over this period of 16 years, losses were negligible during two winters, low during four, moderate during six, high during two and very high during two. In terms of dead deer found per square mile losses ranged from less than one in 1936-37 to 21.8 in 1943-44.[3] For the six moderate winters they averaged about 10 per square mile. During moderate winters about two thirds of the deer found dead were fawns, but in the two most severe seasons adult losses, principally does, increased until the two were about equal. Unfortunately, no practical method has been developed for obtaining specific values for the number of deer occupying this area from winter to winter.

To illustrate the type of weather associated with different rates of loss, 4 years have been selected. These comprise 2 years when the rate of loss was negligible (1936-37 and 1945-46), one when it was very high (1943-44), and one when it was moderate (1944-45). Data depicting the weather experienced during these winters are presented in the accompanying graphs. In constructing these charts both the long-term normals and the specific figures for the year involved in each case have been shown for temperature and snowfall. No "normal" is available for accumulated snow depth. Regarding the latter, the section of the chart designated as "measured" represents that period of the winter for which relatively complete data are available, whereas there are only partial records for the preceding and following periods.

Deer mortality was negligible in 1936-37. In Figure I the coincident weather conditions (temperature and snow) are graphed. It is immediately evident that the accumulated depth of snow was very low. As a result, deer had almost unrestricted freedom of movement and could forage widely. Field experience has shown that when this depth exceeds 20 inches deer have difficulty in traveling. During this season that level was reached only for about 2 weeks in late March when heavy snowfall was accompanied by below-normal temperatures. The low accumulation early in the winter resulted from above-normal temperatures and below-normal snowfall for the period December through February.

In 1945-46, also, deer mortality was negligible but it was associated with a quite different weather complex (Figure 2). In contrast to 1936-37, roughly average temperatures and slightly above-normal snowfall allowed a gradual accumulation which reached 20 inches by mid-February and 36 inches later in the month. At this time conditions had all the earmarks of a hard winter for deer. From 6 to 8 weeks of deep snow might have occurred if cold weather had continued. Beginning early in March, however, the weather turned unusually warm and the snow melted very rapidly. By March 20 much of the ground was bare. Deer had been little restricted in their movements until late winter and the early spring "break-up" re-

[3]These figures apply only to the wintering ground proper and cannot be extended to the surrounding territory in general.

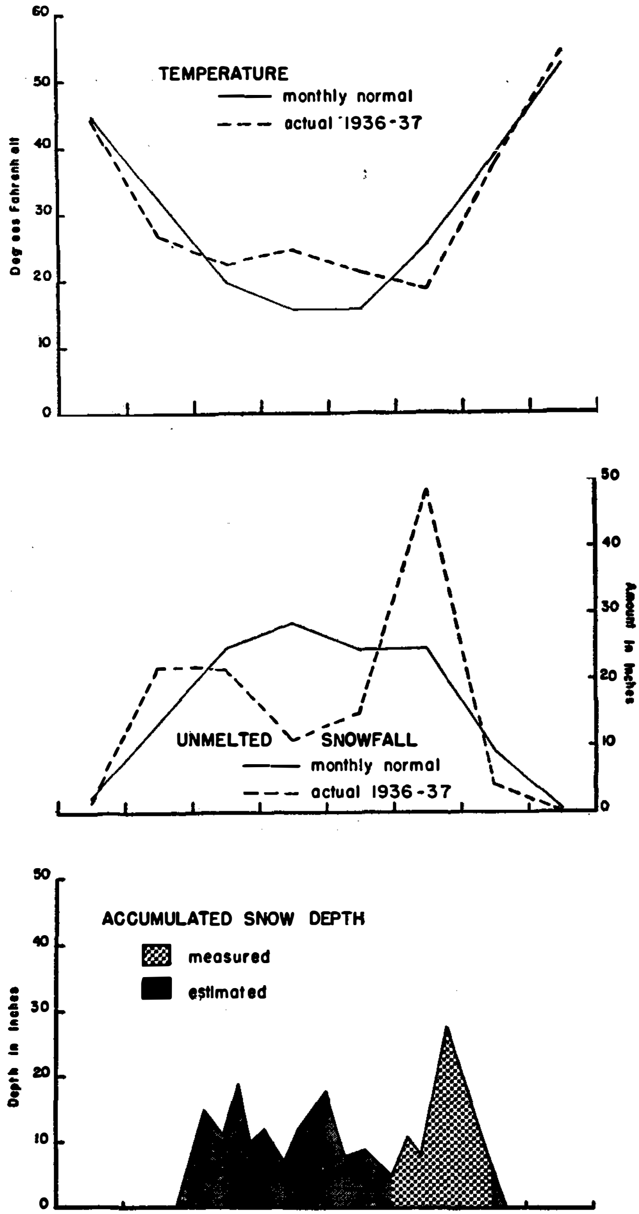


FIGURE 1. TEMPERATURE and SNOWFALL CONDITIONS in ADIRONDACK REGION -- 1936-37

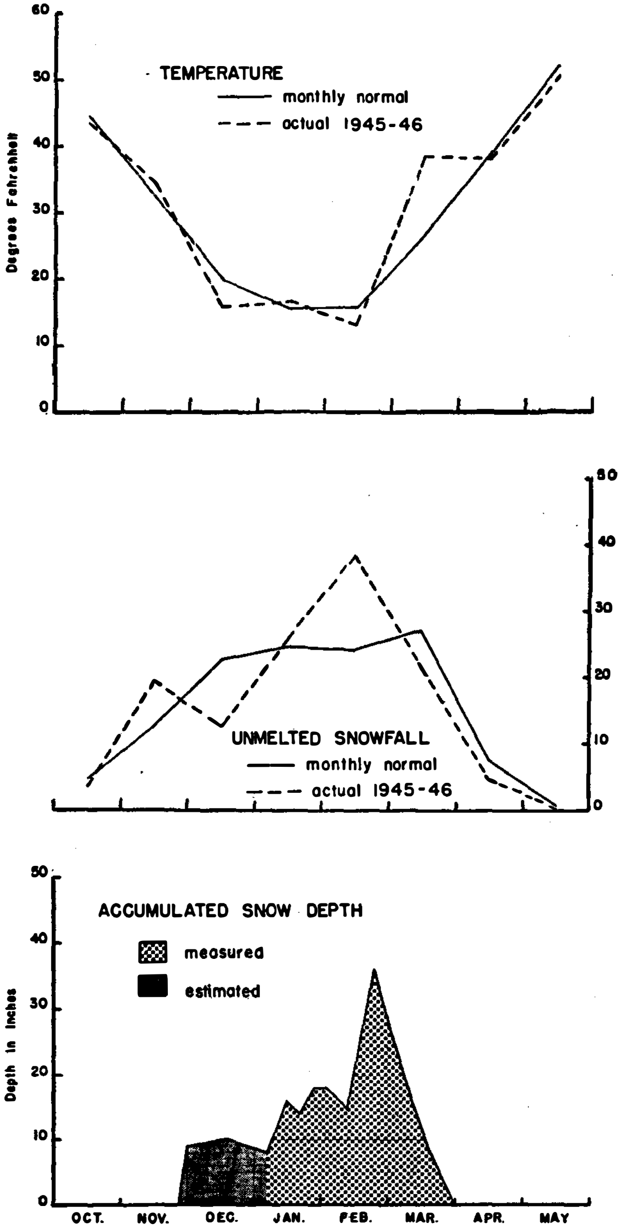


FIGURE 2. TEMPERATURE and SNOWFALL CONDITIONS in ADIRONDACK REGION -- 1945-46

duced to between 3 and 4 weeks the time their range was significantly limited.

At the other extreme, deer mortality was very high in 1943-44. The weather conditions experienced are shown in Figure 3. Beginning in late November the snow depth rose rapidly and approached 20 inches in mid-December, a month earlier than in 1945-46. This trend continued until by late February it had reached 44 inches which was maintained for about 3 weeks after which spring thaws set in. This great accumulation of snow occurred primarily as a result of generally below-normal temperatures since snowfall was less than average during most of the winter. Moreover, the consistently low temperatures during February and March served to prolong the period of deep snow. As late as April 4 an average depth of 20 inches existed. Thus, throughout a period of more than 3 months and extending into early April, deer had to contend with conditions which made travel difficult and which severely curtailed the availability of food.

Between the above extremes, deer mortality in 1944-45 was moderate. In this instance, as in 1943-44, below-normal temperatures resulted in an early accumulation of deep snow (Figure 4). The trends in depth were almost identical until the last week in December when a heavy snowfall brought the level to nearly 26 inches on January 1. From that point it increased steadily to 41 inches in mid-February but began to drop immediately thereafter. The subsequent decline was accelerated by an unusually warm March, and the snow was largely gone by the end of the month. Although the onset of conditions restricting deer movement was slightly earlier, if anything, than the year before, their duration was about 3 weeks less.

*Range quality.*—In the Moose River area available shelter for deer is good to excellent, although it is restricted largely to valleys and lowland areas. While detailed data are lacking, forest composition has been estimated roughly as follows: Hardwood slope, 75 per cent; upper spruce slope, 5 per cent; spruce flat, 15 per cent; and open swamp, 5 per cent. Winter shelter, therefore, is restricted to about 15 per cent of the total land area; the upper spruce slope type generally being at higher elevations and not accessible to deer during critical periods.

The interspersion of shelter (evergreens) and food-producing areas (largely hardwoods) is generally poor so that deer do not have an abundance of food easily available during severe winters of deep snow. This is even more pronounced on portions which have been cut over, because the cutting has been largely limited to conifers. As a result, rather sharp lines of demarcation exist between coniferous and hardwood areas. Nevertheless, within the shelter areas, a limited

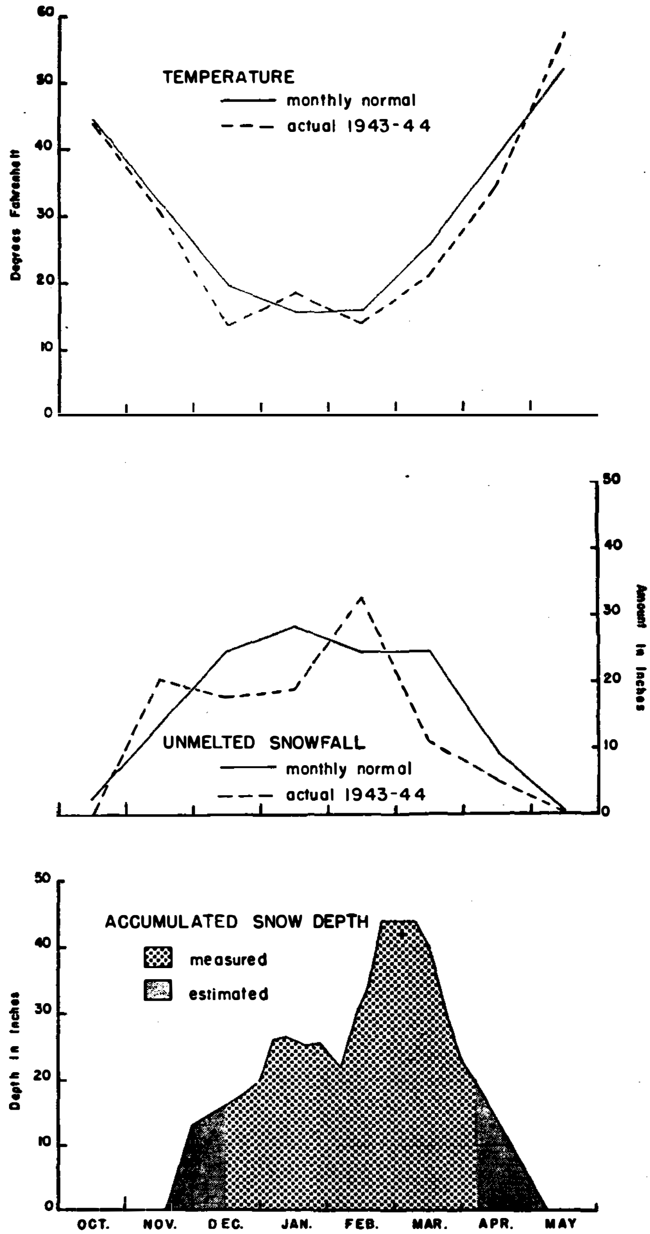


FIGURE 3. TEMPERATURE and SNOWFALL CONDITIONS in ADIRONDACK REGION -- 1943-44

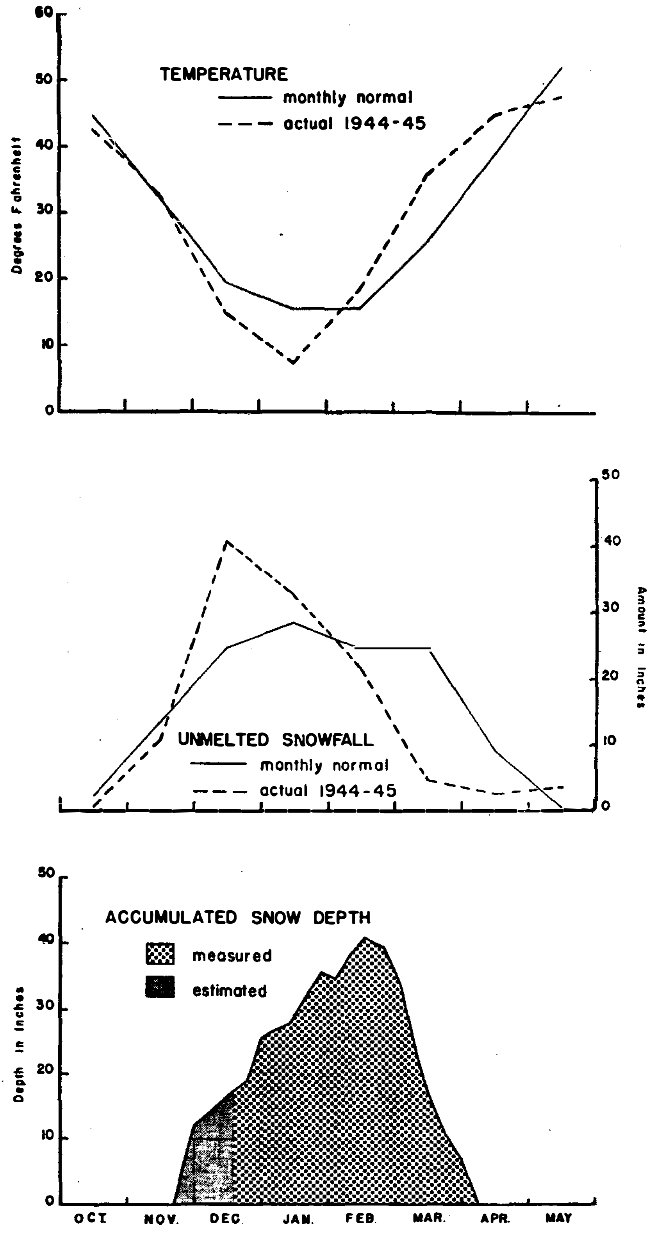


FIGURE 4. TEMPERATURE and SNOWFALL CONDITIONS in ADIRONDACK REGION — 1944-45

amount of good quality browse is available. Most of this, however, is heavily to completely eaten by mid-January in average years and, during severe seasons, is completely gone by this time.

## DISCUSSION

It seems evident from the data presented that, in the Adirondack region, snow depth is the critical weather factor affecting winter mortality among deer, and that the effect of deep snow becomes more severe when it remains for prolonged periods, especially late in the season. Prolongation of this period into April in 1943-44 was the chief difference between conditions that year when mortality was very high and those in 1944-45 when losses were only moderate. Conversely, in 1936-37, deep snow which lasted only 2 weeks, even though late in the season, was not associated with appreciable mortality.

As has been noted, observations by project personnel have shown that snow depths which exceed 20 inches greatly retard a deer's freedom of movement. This critical depth can be readily appreciated when one realizes that, during the winter, a fawn's height above the ground at its breast bone is only about 18 or 19 inches and that that of an adult is only about 20 to 22 inches.

The condition of the snow under certain circumstances, especially its density or water content, may modify this figure of critical depth, however. Typically, it applies to light, fluffy snow which provides no base so that a deer sinks through practically to the ground. On the other hand, snow which has thawed and frozen may often have a crust heavy enough to support a deer, thus facilitating travel and often enabling deer to reach food otherwise unavailable. Intermediate conditions also occur and some, particularly a very light shell crust, may reduce a deer's desire to travel. Such variations must be considered in appraising the effect of any given situation because it is the actual depth through which a deer must wade in places where no trail has been broken that is the determining factor.

When deer are forced to contend with deep snow for extended periods they weaken rapidly. Not only must they expend more energy in traveling than when the snow is not deep, but the availability of food is sharply curtailed under such conditions. Food quality is also involved. Winter feeding experiments in New York have demonstrated that deer on poor diets will lose their maximum allowable weight loss in 3 to 4 weeks. As pointed out earlier in this paper, the quantity of good quality browse is inadequate in the lowland shelterbelts of the Moose River and other Adirondack wintering areas. As a consequence, during years when deer are on a restricted range at this season, they are forced to eat poor quality browse or eat very little.

This relationship is reflected in the coincident degree of mortality. During the winters of 1936-37 and 1945-46, for example, 20 inches or more of snow lasted for from 2 to 3 weeks, yet deer mortality was negligible. During 1943-44 and 1944-45, on the other hand, such accumulations of snow existed for 14 and 11 weeks, respectively, with corresponding mortality rates of 21 and 12 dead deer per square mile. Another example, between the above two groups, may be cited. In 1941-42, deep snow lasted for between 5 and 7 weeks, and mortality was three dead deer per square mile. Therefore, it may be concluded that, under range conditions of which this area is representative, deep snow must last at least 5 weeks to significantly affect deer mortality and that when the duration of such periods exceeds 10 weeks the effect becomes severe.

At the same time the effect of any given snow condition is also modified by the particular part of the winter season during which it occurs. In the Adirondack region a deer's vitality normally declines as winter progresses. For this reason a period of adverse weather during March and early April will have a much more severe effect on deer than the same conditions would have if they occurred earlier in the season and were followed by an early spring "break-up." This principle is illustrated by comparing the data for 1943-44 and 1944-45.

Accumulation of snow is a result of snowfall combined with temperature low enough to keep it from melting. Temperature also has a direct effect on deer because the demand for caloric energy to maintain body heat is greater in cold weather than in mild, thus increasing their requirements for heat-producing foods.

Just how great an influence low temperature alone has in causing winter mortality, however, is not clear. In this connection, Gerstell (1937) discussed winter losses in Pennsylvania as related to temperature and other factors, and stated that "during weeks when the average mean temperatures were considerably below freezing, as was the case during the winter of 1935-36, regardless of the amount of the foods offered, all experimental animals lost weights in amounts ranging between 3 and 12 pounds per hundred pounds of body weight each week." These observations were on penned deer. Projected, such a rate of weight loss would result in death in about 3 weeks based on experiments in this State (Maynard, et al., 1935) which indicated a deer cannot lose more than about 25 per cent of its weight and survive. Yet in the Adirondacks in 1945-46, for example, mortality was negligible although mean temperatures of 15.5°, 16.4°, and 13.2° were recorded for the months of December, January, and February, respectively.

Further evidence on this question was obtained in the present study.

Comparison of the winters of 1936-37 and 1945-46 shows that temperatures for the period December through February averaged approximately 23° and 15°, respectively. In spite of this difference snow conditions were very similar and mortality was negligible for both years. On the other hand, little temperature difference existed between the winters of 1943-44 and 1944-45. In this case the respective averages for the same period were approximately 15° and 13°. Snow conditions, however, were more severe during the warmer of the two winters and were associated with a higher degree of mortality.

*Influences of winter mortality on population levels.*—From a practical standpoint winter mortality is most significant with respect to its effect on the number of deer available for hunting. Evidence of this relationship is being gathered by recording the age-class composition of sample groups of deer taken during the open season each fall. The technique used, based on dentitions, is new (unpublished ms.) and has been applied only to the seasons of 1945 and 1946.

In the sample taken in the Adirondack region during the fall of 1945 the proportion of 2½-year-old deer was less than that of yearlings, which is to be expected, but it was also less than that of 3½-year-olds. The latter seems to reflect the heavy mortality of 1943-44 when the animals of this class were fawns. At the same time the yearling class also appears to have been somewhat low, which probably may be correlated with the moderate mortality among fawns in 1944-45 as well as with the above-average losses among adult does in 1943-44. In 1946, the proportion of yearlings increased markedly and that of 2½-year-olds fell more nearly into line, apparently reflecting the negligible losses of 1945-46.

These results give promise that a combination of both types of data, taken from representative localities throughout a region or state, will provide a valuable guide for designing the most appropriate deer-management measures as well as for predicting hunting prospects.

## SUMMARY

1. Winter mortality among deer in the Adirondack region of New York has varied from year to year with the severity of the weather.
2. Correlation of mortality records and climatic data for a major wintering area in the region indicates that deep snow is the principal weather factor involved.
3. Snow depths of 20 inches or more appear to represent critical conditions.
4. Low temperatures function chiefly in facilitating the accumulation of deep snow.
5. Evidence of the influence of winter mortality on population

levels has been found in the age composition of sample groups of deer examined during the hunting season.

6. A combination of both types of data seems to afford a valuable guide for deer management.

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# RANGE COMPETITION BETWEEN MULE DEER, BIGHORN SHEEP, AND ELK IN JASPER PARK, ALBERTA

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On the winter ranges of the Athabasca Valley, Jasper National Park, Alberta, mule deer, bighorn sheep, and elk are the main game species utilizing the forage. In some parts of the valley one or another of these species winters alone or with a small population of one or both the other species, while over a large part of the area all three are to be seen feeding upon the same range.

The mere presence of two or more species on the same range or even intermingled on the same feeding areas does not justify the assumption that they are eating the same things in the same proportions and are consequently direct competitors for the limited winter food supply.

To determine the actual degree of competition between deer, sheep, and elk feeding upon the same areas in the Athabasca Valley, a special study of their winter food habits was undertaken between December 16 and 29, 1944. Food habits were determined by direct observation of feeding animals. Feeding was recorded in animal-minutes. One animal feeding on a certain plant species for one minute constitutes one animal-minute. Observations were made in the vicinity of Jasper and at Devona by two observers and were so distributed as to involve not less than 50 different animals of all ages and sexes in each species. In this way individual peculiarities in food preference can be eliminated.

The results of these observations are set forth in the following tables. It should be mentioned that at the time the study was made the ground was either snow free, or covered with so fine a film of snow that virtually all ground vegetation was still available without pawing. It might be expected that a snowfall of 6 inches or more would somewhat alter the nature of the food consumed.

The findings of this study confirm for the Jasper area what has been known of the general food preferences of mule deer and elk in other areas. The mule deer is by preference a browsing animal and it will be noted that in Jasper the browse species comprise 79 per cent of the December diet, whereas grass and grasslike plants make up 15 per cent and forbs, 6 per cent of the winter diet. Bearberry is by far the most important item in the diet. Not only is it highly palatable but it is abundant, and relatively little utilized by the two other species. Under existing range conditions it is only the abundance of bearberry that permits continued existence of a fairly large population of mule deer. The buffalo berry item includes both the tips of new twigs and the shed leaves. The latter were sometimes

TABLE 1. FOOD OF MULE DEER (*Odocoileus hemionus*) IN THE ATHABASCA VALLEY, JASPER PARK, DECEMBER 1944

| Vernacular name | Technical name | Animal-minutes | Per cent of total food |
|---|---|---|---|
| Grass | | 175 | 13 |
| Sedge | *Carex (nigricans?)* | 31 | 2 |
| Total grasslike plants | | | 15 |
| Everlasting | *Antennaria parvifolia* | 20 | 2 |
| Pasture sage | *Artemisia frigida* | 6 | tr. |
| Misc. forbs | | 53 | 4 |
| Total forbs | | | 6 |
| Bearberry | *Arctostaphylos uva-ursi* | 794 | 58 |
| Buffalo berry | *Shepherdia canadensis* | 122 | 9 |
| Douglas fir | *Pseudotsuga taxifolia* | 116 | 8 |
| Lodgepole pine | *Pinus contorta murrayana* | 36 | 3 |
| Mountain juniper | *Juniperus scopulorum* | 18 | 1 |
| Common juniper | *Juniperus communis* | 1 | tr. |
| Total shrubs and trees | | | 79 |
| Totals | | 1,372 | 100 |

sought out eagerly and eaten with apparent relish. Lodgepole pine was out of reach in many areas but branch tips broken off by the wind while in a frozen condition were available in small quantities and were eagerly sought after. It is significant to note that pine is refused in the areas where more palatable browse is available.

One of the most significant items discernible from these studies is that in neither the elk nor the deer observations is there any record of browsing upon aspen or willow despite the fact that these are the two most palatable browse plants on the area. The explanation is not hard to find. Overbrowsing of the two species has removed them from the browse available to deer, and there are few places where even elk can still obtain them. As has been emphasized elsewhere in this report these are the two key species and the game population should be reduced until aspen and willow are once more able to establish new plans. The absence of young aspen from both the Athabasca Valley in Jasper and the Bow Valley in Banff is due to no other influence than overbrowsing. One of the outstanding demonstrations of this is to be seen in the buffalo paddock at Banff. The buffalo is strictly a grazing animal, and within the paddock can be seen a fine stand of young aspen coming up beneath the mature trees, whereas outside the enclosure not a sapling has survived the onslaught of the deer and elk.

It is apparent also from Table 2 that the elk is feeding almost exclusively upon grass during the winter months. A snowfall deep enough to cover the grass would doubtless force the elk to take more browse. It is pertinent to note that the data here presented suggest little apparent conflict at present between mule deer and elk. It is probable that the worst of the conflict is already a thing of the past. The elk have made a clean sweep of that part of the highly palatable

TABLE 2. FOOD OF ELK (*Cervus canadensis*) IN THE ATHABASCA VALLEY, JASPER PARK, DECEMBER 1944

| Vernacular name | Technical name | Animal-minutes | Per cent of total food |
|---|---|---|---|
| Grass | | 1,795 | 97 |
| Douglas fir | *Pseudotsuga taxifolia* | 33 | 3 |
| Bearberry | *Arctostaphylos uva-ursi* | 1 | tr. |
| Lodgepole pine | *Pinus contorta murrayana* | 1 | tr. |
| Total browse | | | 3 |
| Totals | | 1,830 | 100 |

browse formerly available to deer so that the conflict is no longer apparent. Furthermore, even the small percentage of browse required by the elk when considered in the light of the large size and consequent bulk demands upon the food supply, and also in view of the abundance of elk, even now produces serious conflict between the two species on certain areas, and forces the deer to live on a diet upon which they cannot maintain full health and vigor.

The presence of herds of elk on the range has yet another effect. During the periodic thaws, the herds of elk so trample the snow as to cause an icy crust to form. Forage on such crusted areas is in large measure useless to the sheep and deer.

It was thought that the elk results might be somewhat biased in the favor of grazing by the greater visibility of elk when grazing on the open hillsides than when feeding in forested or wooded areas. However, three stomachs examined during the same period showed grass, 93 per cent; Douglas fir, 6 per cent; bearberry, 1 per cent, and thus confirm the results based upon observation.

The major details of winter sheep food are believed to be accurately represented by the present data. It is revealed that the bighorn is essentially a grazing animal with grass and sedge comprising 83 per cent of the December diet. Pasture sage was taken in preference to grass on one occasion, and the bulk of the 390 minutes tallied on this item was obtained from this sheep band on one afternoon. This same band on the following day was not touching sage.

It will be apparent that the herds of elk feeding over the winter sheep ranges of the Athabasca Vally are competing directly with the sheep for the available grass supply. Deer are not abundant on the sheep hills, but prefer to remain close to the forested margins or on the flat areas intervening between or at the bases of the hillside sheep pastures. For this reason the two species actually compete less than the small degree indicated by a direct comparison of Tables 1 and 3.

TABLE 3. FOOD OF BIGHORN (*Ovis canadensis*) IN THE ATHABASCA VALLEY, JASPER PARK, DECEMBER 1944

| Vernacular name | Technical name | Animal-minutes | Per cent of total food |
|---|---|---|---|
| Grass | | 3,848 | 82 |
| Sedge | *Carex (nigricans?)* | 22 | 1 |
| Total grasslike plants | | | 83 |
| Pasture sage | *Artemisia frigida* | 390 | 10 |
| Various forbs | | 3 | tr. |
| Total forbs | | | 10 |
| Bearberry | *Arctostaphylos uva-ursi* | 247 | 6 |
| Mountain juniper | *Juniperus scopulorum* | 50 | 1 |
| Douglas fir | *Pseudotsuga taxifolia* | tr. | tr. |
| Total shrubs | | | 7 |
| Totals | | 4,060 | 100 |

That is to the degree that the sheep eat bearberry and the deer eat grass.

It is apparent then that the elk are in serious competition with both sheep and mule deer in the Athabasca Valley of Jasper Park, while the mule deer and sheep compete only to a very minor degree.

Comparison of the present study with those made elsewhere in western North America upon the same species brings out one effect of overbrowsing upon the normal diet of game animals. For example, in northern Idaho and Montana de Nio (1938) found that winter stomach contents of elk showed browse 27.21 per cent of volume; grasses and grasslike plants, 64.97 per cent; weeds, mosses and lichens, 7.6 per cent. On the same mule deer winter stomachs contained browse, 88.14 per cent; grasses, 5.32 per cent; weeds, mosses and lichens, etc., 6.5 per cent.

In a more limited study of elk food habits in Virginia, Baldwin and

Patton (1938) found grasses constituted only 26 per cent, while browse made up 44 per cent.

In the Blue Mountains of Oregon, Cliff (1939) found that winter food of elk consisted of browse 82 per cent; grasses, 10 per cent; and weeds, 8 per cent, while that of deer was browse, 93 per cent; grasses, 1.6 per cent; and weeds, 5.4 per cent.

Comparison of these figures with those given above for Jasper reveals that the Jasper deer are eating much more grass and less browse than is normal and to this degree have been forced to modify their preferred diet. Then, too, they have only been able to retain their present browse percentage by shifting their main feeding effort to bearberry, a plant known to be of very little value as browse and of low palatability to game.

The elk diet in Jasper with its component 97 per cent grass can be seen to be greatly distorted from that taken elsewhere. This distortion has undoubtedly been forced upon the animal by its own destruction of the desirable trees and shrubs.

To the degree that the elk and deer are forced to increase their percentage intake of grass their competition with sheep is increased, and to the degree that the deer is forced to modify its diet either in proportion of browse to grass or in the consumption of less palatable browse the elk are making it increasingly difficult for the deer to survive the winter in a healthy condition. Any reduction in physical well-being as a result of malnutrition has immediate implications in higher losses from other causes such as disease and predators.

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# TECHNICAL SESSION

## Monday Afternoon—February 3

*Chairman:* R. William Eschmeyer
Assistant Chief, Fish and Game Division, T.V.A., Norris, Tennessee

*Vice-Chairman:* Bruce F. Stiles
Assistant Chief, Fish and Game Division, Iowa State Conservation Commission, Des Moines, Iowa

## INLAND FISHERIES AND FRESH-WATER AREAS

# BOTULISM CONTROL BY WATER MANIPULATION

Charles C. Sperry
*U. S. Fish and Wildlife Service, Denver, Colorado*

Very early in the study of botulism in wild ducks, it was found that many of the afflicted birds would recover if removed from the field and placed in a fresh-water environment. Experimental treatment of such birds was varied and more or less successful. In recent years, a very high rate of recovery was achieved when botulinum antitoxin was used. Collection of the sick birds is extremely laborious and economically feasible in only a small per cent of the areas where botulism occurs. Nevertheless, such salvage operations have for many years been about the only means of lessening botulism losses among our western ducks.

One of the areas where serious botulism among waterfowl was first noted and where annual losses due to this disease have been high is the Bear River Migratory Bird Refuge in Utah at the north end of Great Salt Lake. In fact, one of the prime reasons for creation of that refuge was the belief that impoundment of fresh water over the salt flats at the mouth of the Bear River would tend to eliminate much of the botulism annually prevalent in that area.

The completed refuge, now a home for hundreds of thousands of resident and migrant ducks, has not terminated the hazards from botulism since that malady still kills thousands of ducks at Bear River each year. To prevent even more serious losses at Bear River, a duck hospital was constructed and its operation promptly became a major refuge activity during the botulism seasons—late July to early October. Coincidently with this salvaging of otherwise doomed ducks, research field workers of the U. S. Fish and Wildlife Service attempted to learn more of the details incident to the malady itself. Earlier research, notably that of E. R. Kalmbach, had demonstrated that western duck sickness was a form of botulism poisoning resulting from ingestion of a toxin. The botulism organism is prevalent in the Bear River region and the refuge area produces an abundant plant and animal life, the seasonal decay of which probably furnishes ample media for toxin production. Certainly, there are thousands of duck botulism victims in the Bear River area each year, and it is presumed that they obtain the poison while feeding or drinking. The digestive tracts of birds, sick or dead from botulism, however, usually contain little if any food, so field observations remain the sole hope of answering the all-important question, "Where and when do the ducks obtain the fatal toxin?" The essential need for some field localization of such observations will be apparent if it is remembered that the Bear River Refuge is made up of 5 units or water impoundments, each of which comprises some 5,000 acres of shoal water and adjacent mud flat.

Early in the 1942 botulism season two research men, then working at the Bear River Refuge, became convinced that there was a direct correlation between local botulism outbreaks and water movements on feather edges in the areas involved. Limited experimentation later that year resulted in adoption of a water-level-control program for the entire refuge. This program, initiated in 1943 and continued in 1944, 1945, and 1946, was predicated on the theory that steadily lowering (or rapidly rising) water levels were not conducive to botulism outbreaks and, conversely, that stabilized water levels, where the shore lines are exposed and on nearly flat lake bottom, were in some way directly associated with major waterfowl losses.

In planning this important water manipulation, the original schedule outlined a particular water-handling program for each of the five refuge units at Bear River with the expectation of repeating those same procedures on each unit for at least four, and perhaps five consecutive seasons. The limited summer water supply normally available at Bear River narrowed the range of experimentation so that the water handling involved in the schedules finally selected embraced three kinds of water-level lowering, one case of maintaining stable levels against abrupt banks, and one example of a fluctuating level that moved up or down, dependent on availability of surplus water. In each unit, regardless of the type of water handling, research workers recorded the water level changes and movements due to inflow, outflow, or winds, and kept detailed notes on the waterfowl, including the number and species of afflicted ducks observed each day, their location in the field and any apparent relationship between their numbers or location and the waterfowl usage of areas involved.

Because of adequate facilities for water handling, the Bear River Refuge was nearly ideal for these experiments, especially for reducing levels. Study of results of 3 years of these water manipulations along with other pertinent data from observations on the area brought out the following conclusions:

1. That botulism rarely kills many ducks on an impoundment that has its shore line against steep banks.

2. That duck sickness is directly related to the production of toxin in shallow alkaline impoundments with an exposed, nearly flat, lake bottom as a shore line.

3. That an abundance of water coming into and going out of a lake has little beneficial effect on sickness trends if extensive shore lines remain on the flat terrain of an exposed lake bottom.

4. That water can safely be put over a thoroughly dried lake bottom provided the flooding does not create stable shore lines during the process.

5. That the theory, linking major botulism outbreaks with changes in water levels and movements of shore lines, should be given a severe test. This theory, in brief, is that stabilization of a shore line on a gently sloping old lake bottom is so favorable to toxin production that the fringe area from the water's edge to dry land is a serious danger zone whenever shallow inundation makes it a feeding ground for ducks.

Consequently, the 1946 research assignment at the Bear River Refuge was to attempt to hold botulism at a minimum on one impoundment (Unit 3), that had annually produced a high loss in the past, and to induce a major botulism loss in an adjacent impoundment (Unit 4) where past losses had been less severe. In each case the only working tool was to be water level manipulation.

Botulism in Unit 3 and in Unit 4 appeared as expected late in July 1946, and by the end of the first week in August had increased markedly in both of these lakes. During this early period the water manipulation was alike in both units, that is, each had been filled to a high level and each lowered simultaneously a few inches so that on August 7 the levels were the same and the feather edge( water margin on gently sloping shore) in each unit was on old exposed lake bottom.

At this point the major water manipulation experiment began. The level of Unit 3 was lowered by one half inch per day (including evaporation), and that of Unit 4 was held constant by regulating the inflow to offset evaporation. Thus the stage was set to test the theory that, other factors being equal, a constantly retreating shore line, caused by lowering water levels, is not conducive to a botulism outbreak but that a shore line stabilized on an old lake bottom will produce such an outbreak *as soon as wind or inflow pushes water back onto the flats and makes the previously stabilized feather edge a feeding ground for waterfowl.*

The first such wind in 1946 (at Bear River it must come from a southerly direction to flood the flats of Units 3 and 4) came on August 21 and caused a pronounced outbreak of botulism in Unit 4. Dike side pickup of sick and dead ducks in that unit increased from 8 to 281, while in Unit 3 it rose only from 18 to 61. Additional south winds during the last week of August emphasized the danger of stabilizing levels on old lake bottoms for the dikeside collection of sick and dead ducks from August 25 to 30 was 1,227 from Unit 4 and only 208 from Unit 3, even though Unit 3 had more than twice the duck usage of Unit 4 during that period. There were over 200,000 ducks feeding in Unit 3 (200 per surface acre) and approximately 100,000 in Unit 4 where acres of water surface were somewhat greater. The record thus shows that during the August 7-30 period when Unit 3 was gradually but steadily being drained and the Unit 4 level was fairly well stabilized, there were approximately five times as many botulism duck casualties in Unit 4 as in Unit 3 even though Unit 3 had a much greater waterfowl usage.

Additional conclusions based on records and observations during the water manipulation experiments at the Bear River Refuge are the following:

1. Duck sickness is a serious hazard to waterfowl using shallow alkaline lakes whose shore line rest on the flat terrain of exposed lake bottoms.

2. Sickness in such areas is likely to occur any year during July, August, September, and possibly early October.

3. The severity of sickness on any given area of this type is correlated with climatic factors, water levels, wind action, and waterfowl usage.

4. Stabilization of lake bottom shore lines is almost certain to be

followed by a pronounced flare-up in sickness when the adjacent damp mud flats are submerged.

5. The majority of sick birds become afflicted soon after very strong winds have occurred.

6. Fluctuation in water level is a key factor in decreasing or increasing a sickness trend.

7. Delivery of water over the flat terrain of mucky delta formations is likely to increase botulism losses, so water should be delivered to an impoundment only through deep channels that extend far into the basin.

8. The severity of duck sickness can be effectively reduced by progressively lowering the water levels in such an impoundment.

9. The rate of reduction in water levels should be rapid enough to prevent reflooding of exposed and drying lake bottom by any normal winds.

10. When shore lines tend to stabilize for several days, the rate of drop-down in levels should be increased.

11. Reduction in levels should be steadily downward until the impoundment is dry, or until the available water supply is sufficient to place the shore line against steep banks or on dry soils which have not previously been submerged that year.

12. Areas that are part marsh and maintained for the production of waterfowl can produce many birds and at the same time avoid a heavy botulism loss if levels are kept low during the growing and nesting seasons and later raised to place the shore lines against banks or on nonlake bottom soils.

13. In actual practice the application of the procedures outlined are dependent on a terrain that will permit drainage as indicated, while water disposal will have to be of such a character that other areas are not flooded in a dangerous manner during the botulism season.

## DISCUSSION

MR. JOSEPH HOGAN (Arkansas): Would your suggested water level fluctuation tie in with mosquito control?

MR. SPERRY: I am not informed on that subject. It didn't prevent the production of an enormous number of mosquitoes at Bear River.

MR. B. W. CARTWRIGHT (Manitoba): We have had considerable experience with the botulism outbreaks, and we tried an experiment on the lowest San Francisco lakes. In one, it was fed by irrigation waters. We can take water in but we can't drain it out, so when we took water in in 1943, we had a very serious outbreak of botulism.

In 1944, we shut off the water supply and let it gradually recede by evaporation, and the botulism outbreak practically disappeared, and last year we maintained that same technique and we had practically no loss from botulism. We haven't been able to use the other method of raising the water level against steep banks yet, but in one shallow marsh area we are planning to cut off a portion of it by building a dike and will create a steep bank so we can cut the water off in that area.

MR. SPERRY: Theoretically, we believe that movement of the level upward, if done regularly and as consistently, would be just as effective as moving it downward, though we haven't had an opportunity to thoroughly test this.

MR. FRANK C. BELLROSE, JR. (Illinois): I don't quite get that. If you raised the water over the plane where botulism bacteria are present, wouldn't that develop into a botulism condition?

MR. SPERRY: I didn't make it quite plain. The theory is that the dangerous area is that narrow section of shore line from the water's edge back to dry land. It may vary from a few feet or yards in very quiet water to several yards where the water is rough. If that area is allowed to thoroughly dry before the water is put on it, we seem to be able to flood it without getting an outbreak. It is this stabilized zone which causes difficulty if flooded, and if the ducks follow the retreating water to it. As long as this zone is kept retreating we run no risk.

MR. BELLROSE: If you built the lake to a certain level which could not be exceeded, your policy would be to lower the water gradually during the season?

MR. SPERRY: Yes, unless it is a steep bank. Where the bank is steep you don't have a botulism problem.

# THE MANAGEMENT OF FRESH-WATER FISHERIES IN TEXAS

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One vital question confronts those of us who attempt to manage the inland fisheries of our various states. This question being: "Is our management program designed to provide an increase in the number of successful fishing trips?" Such a question should be obvious to all. Still, many of us lose sight of the fact that we are hired to help the public catch fishes. One example that can be cited concerns one of the large reservoirs in Texas. Several years ago, shortly after Lake Buchanan, a 23,000-acre reservoir, was impounded, the anglers were having excellent fishing success catching largemouth bass from a tributary entering the lake. The Game and Fish Department immediately decided that such phenomenal angling success would soon deplete the lake of bass and declared the tributary a fish sanctuary thereby denying the public a chance to enjoy excellent fishing for a change. Of course at the time this occurred it was the accepted course to follow by all conservation dictates. Since then, large numbers of white bass and black bass are found dead or dying on the surface of the lake each year and careful examination indicate that old age was the cause of death. After seeing these large, excellent fishes going to waste, it makes one realize that only by helping the anglers catch the fishes produced each year, can true conservation be practiced.

Although Texas is generally thought of as being synonymous with cattle, cowboys, cactus, and deserts, there is still quite a bit of surface water around the state. In fact, there are over 1,049 lakes of over 5 acres in size, which have a total surface acreage of 362,726 acres; 42,000 miles of fishing streams and rivers; and about 125,000 farm ponds. By checking fish applications requesting fishes for new ponds and lakes we find that an average of 5,148 new ponds and lakes are being built each year.

Since Texas is a cattle state, we have long had numerous farm and ranch ponds scattered throughout our boundaries. In recent years, a farm pond building program was instituted by the Soil Conservation Service. This has further stimulated the construction of farm ponds. In addition to ponds, we have numerous private and club lakes. Most of the club lakes were constructed years ago before many reservoirs were built and they have proved successful enough in providing good fishing to create the desire in individuals to build similar lakes. This practice has become so common that one of the gages of a successful businessman is how many private lakes he owns.

These private ponds and lakes are of extreme importance in our inland fisheries and are treated accordingly, in our management program. The owners invite friends to fish in their private waters and greatly reduce the fishing pressure on our public waters. The owners all desire excellent fishing and many are willing to finance any management program that will maintain excellent fishing. The Commission furnishes the initial stock of fishes to these lake and pond owners. If a pond goes dry or is drained, the owner is given additional fishes. It requires practically the entire fingerling output from our state and federal hatcheries to take care of these requests, but we know that hatchery fingerlings so used create excellent fishing and thereby justify the existence of our hatcheries. This was borne out by a survey made in Young County of all the ponds in the county. Part of the ponds were stocked by the owners who obtained their stock from streams, rivers, and other ponds and the rest of the ponds in the county were stocked by one of our hatcheries. The fish populations of the two ponds were so different, that one seine drag immediately showed how the ponds had been stocked. The hatchery stocked ponds all contained large catchable fishes and the other ponds were full of trash fishes. In 1944, we set up experimental farm ponds in some of our hatcheries to try to learn more about stocking small ponds. At that time we were using a 1 and 10 largemouth black bass and red-eared sunfish (*Lepomis microlophus*) ratio per acre, red-eared sunfishes being substituted for bluegills because they consistently attain a larger size in Texas than do bluegill sunfish, and 200 southern channel catfish (*Ictalurus lacustris punctatus*) per acre if the pond was to be fertilized. A 2.23-acre pond of the Huntsville Hatchery was stocked with 223 four-inch bass, 223 golden shiner minnows, and 2,200 small red-eared sunfishes on January 3, 1944. Shortly thereafter, on January 30, 1944, a 2.07-acre pond was stocked with 416 channel catfish. Both ponds were fertilized with 2,000 pounds of cow manure in 1944 and with the same amount in 1945. Because of yields obtained upon draining these ponds, it should be pointed out that the ponds of the Huntsville Hatchery are filled by gravity flow water that comes from a small everflowing spring creek on which a small lake was constructed. However, all water entering the ponds is carefully screened. The catfish pond was drained on January 9, 1946. This pond yielded 653 pounds of fishes composed of the following: 56 channel catfish that averaged 2 pounds each, for a total weight of 112 pounds; one 4-pound largemouth black bass; 5 white crappie that weighed 1 pound each; around 92,500 small sunfishes whose total weight was 532 pounds, and 1,500 golden shiner minnows averaging 3 inches in length. In the bass bluegill pond thousands of bass fry and numerous red-eared sunfishes on nest were observed in March 1945. The pond was fished several times during 1945, and bass were caught that would measure from 12 to 14 inches in length, but all bass caught were returned to the pond. The pond was drained on January 10, 1946 and its total yield was 754¼ pounds, composed of the following: 165 bass averaging 1 pound each for a total of 164 pounds; 20 bass whose total weight was 5½ pounds; 245 bass fingerlings 3 inches long; 278 red-eared sunfishes weighing 139 pounds, and about 77,000 small red-eared sunfishes whose total weight was 443¾ pounds. No golden shiner minnows were recovered from this pond. These data very graphically show that sunfishes are capable of overpopulating a pond and also the rapid growth rate of fishes in Texas waters. Present stocking ratios have been changed, and new ponds are stocked with either 150 bass and 100 red-eared sunfish per acre, 200 bass per acre, or 75 channel catfish per acre. Beginning this year we will attempt to produce hybrid sunfishes for small pond and small lake stocking in hopes of obtaining a more sterile sunfish population.

The largest number of requests received from private owners asking for aid from the fishery division concerns vegetation control. Other important requests are for fertilizing information and pond or lake rehabilitation. The small size of the staff prevents personal investigations and help from being extended to all lake and pond owners making request each year. Most such requests must, unfortunately, be answered by mail. Fishery students and professors from some of our colleges and universities help the fish-management program greatly by managing some of the lakes. One definite fact is readily discernible, it being that private ponds and lakes do much toward increasing the number of successful trips made by the anglers.

The management of farm ponds and small lakes is very simple when compared with the management of our large reservoirs. Our reservoirs are constructed for either flood control, power, municipal water supply, or irrigation. Some are designed to serve two or more purposes. Fishing is, of course, incidental and the well-being of the fish population is never considered in the management of the reservoir. Nevertheless, fishing does become an important part of every reservior as the following figures show. Anglers are required to purchase special licenses to fish in five of our reservoirs. Lake Texoma, the major part of which is in Oklahoma, was opened to fishing on the Texas side on October 20, 1944. During the fiscal year of 1944-45 (which ends on August 31st), 8,460 people purchased licenses. The report for the next fiscal year showed that 16,530 residents bought licenses to fish in that lake. The license sale for fishing in Possum Kingdom, another recently built reservoir shows that 9,383 people fished there in 1941-42; 9,054, in 1942-43; 12,750, in 1943-44; 19,066, in 1944-45; and 36,794, in 1945-46.

In trying to provide more successful fishing trips for these anglers, various experimental management practices have been executed. We have always tried to do only those things that were feasible.

Since we had a good hatchery organization, we decided to see if part of their output could not be used to good advantage. We knew from experience that largemouth black bass fingerling plantings made in large reservoirs did little toward affording better fishing and as was previously pointed out, they were essential for the farm-pond program. Apparently, the failure of bass fingerling stocking in reservoirs was due to the fact that sufficient numbers could not be produced to make an observable change in the population of the lake. We knew that we could produce largemouth bass fry in huge numbers. This was done and several new reservoirs were stocked with bass fry at the rate of 150 per surface acre of water. Boats were designed and built in order that bass fry could be spread thin along the whole shore line. One large reservior, Lake Travis (11,000 acres), was completed and filled just prior to the completion of Possum Kingdom (26,000 acres) and later Lake Texoma (95,000 acres). Lake Travis was not given an initial stocking of bass fry, but fry were planted in Possum Kingdom and Lake Texoma. Bass fry placed in Lake Texoma in April attained an average growth of 10 inches by October 20, when fishing was opened on the Texas side. A like growth rate was noted in Possum Kingdom Lake. It should be pointed out that the planted fry were not marked, but their growth rate was checked by periodic seine sampling. The fishing in Possum Kingdom and Lake Texoma has been extremely good from their opening days, but the fishing in Lake Travis was very disappointing for a new lake.

From observations, the ability to catch fishes from a lake declines as the forage crop increases. In order to crop some of the forage fishes, we continued our black bass fry stocking program, placing fry in most of our reservoirs whether new or old. In our chain of hatcheries we hatch bass fry from February at Brownsville until May near Wichita Falls. Consequently, fry can be planted in a lake months before a natural spawn occurs in the lake, thus giving the newly planted fry less competition for food than it would have if it was surrounded by millions of fry from shad, carp, and, other fishes. These bass fry plantings were followed by seining in Lake Travis and the survival and growth rate was found to be good. By the time the shad spawned in the lake, the bass had grown sufficiently to eat part of the new crop of shad. This program was only initiated 2 years ago and additional research must be done to determine its value.

The Commission has been able to increase the number of successful fishing trips to reservoirs by stocking them with white bass (*Lepibema chrysops*) after largemouth black bass fishing declines. Many anglers criticize these fish, their objection being that even inexperienced fishermen can catch them. This statement is not quite true because experience helps fill the creel.

Any information that can be given the anglers to help them catch fishes, as the Tennessee Valley Authority is now doing, is very desirable and has been incorporated into our management program.

In 1946, three aquatic biologists were added to the fishery division to work on several reservoirs in the state. The following program is that which they are following in managing their respective lakes.

### TENTATIVE PROGRAM FOR AQUATIC BIOLOGISTS IN THE MANAGEMENT OF THE LAKES OF TEXAS

Objective:

To improve fishing in all lakes.

Procedures:

1. Shelters

Construct brush shelters in all lakes where cover is needed. The number and location of shelters are to be determined by the number of fishermen and accessibility to them. It is suggested that the shelters be of not less than 50 feet in diameter and of the "row" type, that they be at least 150 feet in length. All shelters should be marked in a similar manner for public convenience.

2. Erosion
   Various sections of the watershed should be frequented for the purpose of determining occurrences of excessive erosion. Suggestions should be made as to methods of prevention of excessive erosion for the area concerned.
3. Physical and Chemical Conditions
   Data concerning physical and chemical conditions of the lake should be recorded daily. These data should include temperature, turbidity, pH, oxygen and carbon dioxide concentrations at various depths.
4. Check List
   Maintain a list of species of fish occurring in each lake. Identifications may be made by the biologist or through the central office. At least one specimen of each species should be preserved by the biologist. However, for identification purposes, it is desirable to retain more than one specimen of a series.
5. Censusing
   Taking census by stringer count, netting, seining, and by questioning the fishermen.
6. Netting
   Gill nets should be set out for 2 days each week and the following notations made: (1) Number of fish caught and depth of occurrence by species; (2) measurements and weights. Scale samples should be taken from all fish caught and stomach analysis from not less than 10 per cent of the total catch.
7. Seining
   Shore seining should be accomplished in order to determine: (1) Growth rate of fry; (2) spawning area and time of spawning of rough types; (3) spawning of game fishes.
8. Records and Reports
   Accurate records should be kept and incorporated into the quarterly reports which are to be sent to the central office January, April, July, and October of each year.
9. Fishing Information
   Information concerning time, place, or occurrence of fishes of of which may prove beneficial to the general public should be made known and made available to the public.

Thus far we haven't had sufficient personnel to attempt any extensive stream and river surveys and improvement. From limited stream surveys that have been made, incorrect land use, and pollution seem to be the main factors that reduce the numbers of successful fishing trips.

From the Edwards Plateau region westward, the major land use is goat, sheep, and cattle ranching. These animals have been pastured on this area in such large numbers within recent years that the low ground cover has been seriously depleted thus enabling large floods to occur. Large cypress trees that have stood for years have been washed out along with the aquatic vegetation and bottom fauna of the streams. As a result, many complaints reach the Commission asserting that the fishing that was formerly so good is now on a decline. This section of Texas is also the major game area of the state and the game has also suffered from the sheep and goat competition, consequently, both the game and fishery divisions have been conducting a campaign against overgrazing ranch lands. At a recent wildlife meeting held in the Edwards Plateau region, it was gratifying to note that many of the ranchers present realized that they were overgrazing their land and were now removing part of their sheep and goats.

The streams in the farming sections of the state are rivers of mud after rains which is due to poor land management. Such conditions are not conducive to successful fishing trips. The Soil Conservation Service is doing a noteworthy deed in clearing up some of these streams.

The Game, Fish and Oyster Commission and the State Health Department both are charged with preventing the pollution of our streams. At one time waste oil and salt water, produced in the numerous oil fields of Texas, caused the major part of our pollution problems, but the fines assessed against the oil companies by the Game, Fish and Oyster Commission for killing fishes have succeeded in preventing such pollution. The majority of the oil companies now work with the Commission to prevent pollution, even to the extent of reporting accidental pollution and offering to pay fines for damages caused by them. Only isolated industrial and municipal sewage pollution remains to be cleaned up.

Our best stream fishing was provided by the construction of large reservoirs since they clear up the streams and concentrate many fishes below the dams. The best natural stream fishing is found in the upper southeastern part of Texas. Apparently, these streams are good because they are located in a section that is still covered with forests and the land has not been misused by man.

After working on the waters of Texas for a number of years it seemed that a change in fishing regulations was needed and that a liberalization of the regulations would be a sound management practice and provide better fishing. At the Ninth North American Wildlife Conference held in April 1944, I found that other fishery workers had the same opinion. Shortly after this Conference, a group of men, composed of instructors from our various colleges and universities who are teaching fish-management courses, angler club presidents, and a few interested parties from the Game, Fish and Oyster Commission were selected to meet and discuss what changes, if any, should be made in our regulations. Our present regulations are those that were agreed upon by that group.

These regulations removed the closed season, reduced the legal size of largemouth black bass, removed the size limit on white bass, crappie, and catfish, and liberalized the bag limit of all fishes with the exception of black bass.

The first criticisms against removal of the closed season were received after what normally would have been the closed season. Many fishes of all kinds were taken and some of the ardent black bass fishermen claimed that the new regulation was robbing them of the black basses they would be able to catch later. The public generally was well pleased with the new regulations. After trying the new regulations for 2 years the Game, Fish and Oyster Commission is still definitely for it. Lake Buchanan, previously mentioned, is now 9 years old and the fishing is on a decline. The anglers who fish that lake attribute its decline to the removal of the closed season, rather than to the fact that practically all lakes as they grow older show such declines even with closed seasons. Because of this a law will be introduced in the present session of the legislature to restore the closed season.

A few points in favor of a change in regulations can be pointed out. Mr. David Homer Buck, our biologist on Lake Texoma, assisted by W. O. Thompson, Oklahoma aquatic biologist, examined hundreds of adult white bass with attention given to general conditions, size, incidence of parasitism, and scale readings. Many age determinations were made from fish found dead or dying in the water. All fish they examined seemed organically sound, were very fat, and showed no signs of disease or excessive parasitism, and the only plausible conclusion was that the deaths had occurred as a result of old age or of having completed a very accelerated life cycle. The most illuminating disclosure from age determinations was that not one white bass was examined that had progressed beyond the second year. As was pointed out at the beginning of this paper, it is best to let fishes die or to let someone catch them.

In 1940, a creel census was taken on Lake Worth and Eagle Mountain Lake by the Fort Worth Anglers' Club. Just prior to the closed season of March and April that was then in effect, 92 fishermen spent 176 hours catching 49 fishes from Lake Worth. Only 33 legal game fish were taken. The time of effort for each legal fish caught was 5 hours and 20 minutes. On Eagle Mountain Lake, 537 fishermen spent 1,488 hours catching 377 legal game fish which was 82 per cent of the entire legal catch. The time of effort for each game fish caught on Eagle Mountain was 3 hours and 15 minutes. Figures are also available for the month of September 1940. Fishing was better during this month since one legal game fish was caught for every 1.82 hours of fishing effort in the two lakes collectively. In 1946, the Anglers' Club held a fishing rodeo in the same two lakes. The rodeo was held from March 12 to June 9, a period that was formerly the closed season. Fishing rodeo data compiled by Mr. Leonard D. Lamb, our biologist stationed on Lake Worth and Eagle Mountain Lake, show that 230 fishermen turned in 520 cards, that the total number of man-hours was 2,557. These fishermen took 736 legal game fishes which was 63 per cent of the entire legal catch from Lake Worth. The time of effort for each legal game fish caught was 28 minutes. The rodeo fishermen took 5,711 legal game fishes which was 67.9 per cent of the entire legal catch from Eagle Mountain Lake. The time of effort for each legal game fish caught was 23.2 minutes.

Camp operators estimate that only 25 per cent of the fishermen on the lakes turned in cards. These data indicate that the removal of the closed season increases the number of successful fishing trips at least during the period formerly closed but reports received from the Fort Worth Anglers' Club and Mr. Lamb claim that fishing was better in 1946 than it was before the closed season was removed.

Fish management in Texas has just begun and vast amounts of work remain to be done. Future plans call for an enlargement of our staff so that personal attention can be given to more of our reservoirs. Students, studying fish management in our colleges and universities, are employed during the summer months so that we can ascertain their ability and industriousness before permanently hiring them and so that the students can acquire some practical experience along with their theoretical training. These students would work in fish hatcheries, assist in making stream surveys, and assist our lake biologists. We also feel that a rough fish removal program should be organized and are now making plans to enter into this phase of fish management.

Our waters prevent us from offering the anglers such treats as angling for trout, muskellunge, and other northern game species, but we are happy to report that most fishermen can and do catch fishes rather consistently in Texas.

## SUMMARY AND CONCLUSIONS

A fishery worker should remember that he is working to provide the public with better fishing.

Farm ponds and private lakes are capable of increasing the number of successful fishing trips and are treated accordingly in our management program.

Reservoirs are hard to manage because of their size and because the lakes are managed without consideration of the fish population. By stocking bass in a newly impounded lake at the rate of 150 per surface acre, fishing will prove to be better than if a lake is not so stocked. Bass fry stocking programs for old lakes need to be investigated further to determine the feasibility of that program. When largemouth black bass fishing declines in a lake, fishing can be improved by stocking white bass. Brush shelters should be provided for crappie fishermen and population studies should be made so definite information as to where to fish, what types of bait to use, and other pertinent fishing information can be passed on to the public.

The ability of streams to produce good fishing is reduced on account of poor land use and pollution. Additional work needs to be done on our streams.

Liberalized regulations are desirable and when put into effect will increase the number of fishes that can be cropped each year.

Our fishery staff needs to be enlarged to extend our work. Fishery students will be used to help prepare them for their future work.

A rough-fish program is desirable and will be incorporated in our management program.

# HOW CAN WE PROVIDE MORE SUCCESSFUL FISHING TRIPS IN THE SOUTHEAST?

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All fishery programs have as their primary objective better fishing. To find how this can be brought about, and then to give practical application to the findings, constitutes the fishery worker's principal endeavor. This is as true of the Southeast as it is of any other region. The Southeastern States are sometimes thought of as being backward in recognizing their fish and wildlife problems and even slower in adopting the more advanced management measures. This may be true, but the situation has had its merits and has enabled the Southeast to avoid many of the fads and cure-alls which have had their day among our northern neighbors. Fishery biologists, working in the Southeast, realize that they are dealing with a resource which has often been disregarded, even severely abused, but which is still beyond compare with that to be found in most other portions of the United States. The region offers almost every variety of water and of fresh-water fishing to be found in the Nation. The clear trout streams of the Southern Appalachians, the smallmouth waters of the foothills, the extensive system of reservoirs in the Piedmont and intermountain region, and the rich brown waters of the lower Coastal Plain challenge the biologist and the angler alike.

The interest in fishing has doubled, if not trebled, in the Southeast in the past 10 years. Even during the war period there was no recession. Fishing is the most democratic outdoor sport; its adherents come from every strata of society, represent all ages, colors and creeds. There is every reason to believe that this interest will continue to grow, making it imperative that fishery workers be alert to maintain and further develop the aquatic resources of the region. The means whereby more successful fishing trips can be made possible group themselves in three categories: (1) Improvement of existing waters; (2) better utilization of fish already present, and (3) creation of new fish supporting waters.

1. *Improvement of existing waters.*—Under this category can be mentioned, only briefly, what has been done in this region, and what the prospects are for more productive work in the future. It must be admitted that many streams, particularly in the Piedmont, are in poor physical condition through misuse by industry and through a type of land use that has brought on the destruction of the land as well as of the stream. The first objective must be to further the

adoption of better land management practices. This requires time and a great deal of public education. Improvement is coming slowly and an appreciable change for the better can be expected within our lifetime. One small example is worthy of note. Soil conservation activities carried on by 22 landowners in Person County, North Carolina, in cooperation with the Soil Conservation Service, were applied to the watershed of a city reservoir. Actual records show that the rate of siltation has decreased almost 50 per cent over a 5-year period. Only one third of the planned work has been completed, yet the life of the reservoir has been almost doubled. There are thousands more projects now in operation that are accomplishing the same thing. Silt laden waters are poor producers of fish.

Stream improvement in the more restricted sense has had little opportunity to demonstrate its value in the Southeast. This is readily explained. The states have not owned or controlled the streams where the usual improvement practices could be carried out nor have they had the money to acquire the lands and waters or to finance extensive projects of this type. In North Carolina, for instance, the only stream improvement work done in the days of the Civilian Conservation Corps was in Pisgah National Game Preserve. A little of this work remains to the present and appears to be of some value. There is opportunity to do work in stream improvement, but in most instances a program of education in soil conservation and stream bank protection is the first requirement.

It is generally admitted that the only way known to maintain reasonably good fishing on heavily fished trout streams is by spring and summer stocking with legal length trout. The work done by Chamberlain (1942) in Pisgah National Forest and King (1942a) in the Great Smoky Mountains, bears this out. The same conclusion has been reached elsewhere. The relatively good trout fishing afforded by the Cooperative Wildlife Management Areas in National Forests in the Southeast continues to support this policy. Even so, this management measure is limited because of the expense involved in providing legal length trout and the extent of waters which are suitable for this management. Stocking gives little prospect of improving fishing in other waters which already carry a breeding population of the species desired.

Endeavors aimed toward the improvement of the environment in lakes and ponds can be grouped under two heads. The first has to do with the improvement of the physical features of the environment. Under this head can be listed brush shelters, spawning beds, and water level stabilization. Brush shelters were considered valuable to fish life a few years ago but at present the balance of opinion is in the other direction. Their chief value seems to be in forming a point of concentration where fish will gather for the benefit of the angler. This may be of value in large bodies of water and where the water remains clear. Too much protection is one of the handicaps of many of the waters in the Coastal Plain. Many old mill ponds, impounded without complete clearing of underbrush, are a haven for small fish, and would be greatly improved by a thorough cleaning operation. Building of spawning beds is not considered necessary except in rare instances. Production in some of North Carolina's hatchery ponds has been increased by putting in beds of gravel which are used by bass in spawning. In nature the problem frequently is not getting more spawning but holding the population down. The stabilization of water levels makes for better fishing and may be necessary to allow successful spawning, at least occasionally. Certain of the reservoirs of the Tennessee Valley Authority have been held to near constant level during the early summer in an effort to aid fish populations and fishing.

The second management tool available aims to improve the fertility of the aquatic environment. The methods advocated by Swingle and Smith, including the application of commercial fertilizers, are in general use in the Southeast. The plan is limited in its application to relatively small ponds that have a minimum flow, are clean of emergent vegetation, and free of silt. The cost of the fertilizer and the labor required to apply it makes the plan prohibitive when dealing with large bodies of water. The future may bring a cheaper fertilizer that will stimulate aquatic life in the desired fashion. When this day comes, it will be a great one for the fish manager as well as the angler. Practical means are still to be found for enriching the aquatic life of streams.

A third way by which improvement in the aquatic environment is sought is the control of fish populations. The Coastal Plain offers the biggest field for work along this line. The control of predaceous species such as gar and bowfin is a very important problem and one receiving little attention. Many potentially good game-fish waters now are poor producers of game fish but have tremendous populations of bowfins, gar, catfish, and members of the sucker family. The time has come to do some practical work, combining investigation and control. North Carolina is inaugurating a program of licensing nets and seines in designated waters where nongame and undesirable fish are abundant. There is some opposition to the program from the fish and game protectors, but the public reaction is generally favorable. These fish, properly harvested, are a welcome source of food to many families. The project was first started in the Waccamaw River in 1942. A report was required on the catch, and fish and game protectors checked the operation closely. The results are given in Table 1. The project was successful from every standpoint. The system is being expanded this year, and will include the taking of shad and herring by nets and seines, and the use of seines in designated waters. Alabama has a similar provision for the taking of nongame fishes from fresh waters. Many administrative agencies have gone too far in prohibiting the use of commercial gear in inland waters, and protection of nongame species has been the rule, with the take of game species continuing at an increasing pressure. The population balance can swing to the wrong side under this treatment.

The biggest single avenue open for the betterment of fishing appears to be the abatement of pollution. Kentucky, North and South Carolina rank pollution as the worst enemy to be dealt with in fishery work in those states. If not first, it certainly is a close second in the

TABLE 1. FISH TAKEN BY GILL NETS FROM WACCAMAW RIVER, NORTH CAROLINA, MONTHS OF JANUARY AND FEBRUARY

| | 1942 | 1943 | Total |
|---|---|---|---|
| Number of permittees reporting | 29 | 34 | 63 |
| Carp | 189 | 85 | 274 |
| Suckers and redhorse | 1,163 | 1,214 | 2,377 |
| Catfish | 689 | 806 | 1,495 |
| Blackfish (bowfin) | 974 | 385 | 1,359 |
| Gar | 125 | 275 | 400 |
| Pickerel | 22 | 15 | 37 |
| Largemouth bass | 28 | 3 | 31 |
| Bluegills | 172 | 27 | 199 |
| Other fish (mostly sunfishes) | 66 | 30 | 96 |

other Southeastern States. This phase of the problem could be dealt with at great length, but it is so familiar to the fishery worker that further attention need not be given to it here. Most of the Southeastern States are attempting to strengthen their anti-pollution laws. Tennessee and Mississippi probably have accomplished the most. North Carolina has hopes for the future in better legislation, better cooperation from industry, and, most important, an awakened public conscience which will make it an unpopular thing for an industry to pollute or continue to pollute an otherwise relatively clear stream. North Carolina's three largest and best smallmouth bass streams are now black sewers, carrying wastes discharged by pulp mills, acid plants, and tanneries. The fishery worker cannot carry the campaign against pollution alone. He must unite his efforts with those of conservation clubs, state health departments, and with the Federal Government, when enabling legislation is passed.

2. *Better utilization of fish already present.*—This method of

attacking the problem is closely allied with the control of nongame species. However, the emphasis is on harvesting the crop by building up public interest rather than as an aid to game species. It is next to impossible to sell catfish in the fish markets of North Carolina. The fisheries that take catfish from North Carolina waters look to the Middle West and the North for their market. The same is true of carp. When the pressure on game species becomes so heavy that the return for time spent fishing is too great in proportion to the return, then attention will be shifted to other fishes that are just as good to eat and almost as much fun to catch. North Carolina has many streams and lakes in the eastern part of the state that are good pickerel waters and afford excellent sport. The pickerel (***Esox niger*** LeSueur) is still an unprotected species, but probably will be given better recognition in the future. The pressure of fishing on the largemouth bass is reaching the point where the pickerel gives promise of taking up considerable of the fishing load. If the fishing is purely a sporting proposition, the field is untouched as far as the utilization of gar and bowfin are concerned.

Better utilization of the fish crop is being brought about through more liberal fishing regulations. North Carolina, Alabama, Georgia, South Carolina, and Florida (except for black bass) have abolished the closed season on warm-water species. There is no evidence to indicate that any harm is resulting from the removal of the closed season. Tennessee and Kentucky have removed the closed season from many impounded waters. The removal of size limits on most varieties of sunfishes is a fairly recent venture in the Southeast. All the Southeastern States except Georgia, Florida, and Mississippi have removed size limits from sunfishes, excepting the black basses. Credit for investigational work which led to the liberalization of the closed season regulation goes to the biologists of the TVA who studied impounded waters and seasonal take of fishes (Eschmeyer, 1945). Removing the closed season has resulted in a doubling of the catch of fish from TVA reservoirs and is credited with bringing an additional $5,000,000 worth of related business to the communities serving the reservoirs.[1] Research pays in more ways than one! The failure of size limits as a tool for managing many species of fish was demonstrated by the work carried on at the Alabama Agricultural Experiment Station by Swingle (1942).

Fishery biologists of the TVA have rendered still another valuable service to anglers in the vicinity of Norris Reservoir. They have prepared a weekly forecast of reservoir conditions and fish movements. Anglers are advised as to the best areas for fishing, the depth where

[1]Personal communication from R. W. Eschmeyer, January 9, 1947.

success is most likely, type of lures to use, etc. Predictions are based on measurements of temperature, oxygen content, and other physical phenomena which contribute to the picture. The activity, naturally very popular locally, is worthy of being copied by fishery workers elsewhere. This is a definite service which contributes to more successful fishing trips.

3. *Creation of new fish supporting waters.*—This means of enlarging the aquatic environment and spreading the fishing load is one that must be depended upon heavily in the future. When and where the fishing load catches up with nature's ability to produce catchable fish, the escape is the creation of more fish supporting waters. Some of the pressure is being absorbed by the development of private ponds. The Southeast has led in this endeavor, and the movement is just getting underway in many areas. More is probably known about managing small ponds than about other types of fish supporting waters, except possibly trout streams. There is reasonable assurance that a crop of fish can be produced, given a pond of known physical character, and a fish population that can be measured and controlled. If things don't work out as desired, the pond can be drained and the operation started over. This is not often true in a public stream, lake or reservoir. Valuable as the movement is, the developement of private ponds cannot be considered the answer to the public fishing problem. The states on the whole reap little financial benefit from private ponds and acquire quite a series of headaches. The demand for fish for stocking new ponds in most states far exceeds the capacities of the state and federal hatcheries to produce them. Ponds that are improperly stocked with undesirable species of fish never are satisfactory, and there are other pitfalls all along the way.

The Southeast has gained a vast aquatic resource in the impoundments of the Tennessee Valley Authority (Table 2). By count, three of these reservoirs, Norris, Cherokee and Douglas, all in Tennessee, provide over 100,000 man-days of fishing each. It is reasonably estimated that all TVA reservoirs afford a million days of fishing annually. These reservoirs are an exceptional example of a creation of the Federal Government. The projects have been followed through, and the administration of their natural resources placed in the states' hands. The TVA recognized the need for continuing study of the sequence of events in these reservoirs, and the Division of Biological Readjustment has continued to serve the public interested in the conservation phases of the developments. Information obtained by full-time, qualified workers has been used by the states in their administrative programs, and has helped in managing the resources of other waters of similar type. Other regions of the country have not been so fortunate in connection with reservoir developments as have the states that fall within the Tennessee Valley.

Some of the reservoirs constructed by private power companies produce good fishing. The owners are almost always willing for this type of public use. However, all efforts to obtain authorization for instituting management measures on the reservoirs, other than closed seasons and stocking, have been denied.

TABLE 2. MAJOR TVA IMPOUNDMENTS

| Project | State | Area of lakes (acres) | Shore line (miles) |
|---|---|---|---|
| Kentucky | Kentucky and Tennessee | 158,300 | 2,200 |
| Pickwick Landing | Tennessee | 42,800 | 496 |
| Wilson | Alabama | 15,800 | 154 |
| Wheeler | Alabama | 67,100 | 1,063 |
| Guntersville | Alabama | 69,100 | 962 |
| Hales Bar[1] | Tennessee | 6,010 | 100 |
| Chickamauga | Tennessee | 34,500 | 810 |
| Watts Bar | Tennessee | 38,700 | 783 |
| Fort Loudon | Tennessee | 14,600 | 368 |
| Norris | Tennessee | 34,200 | 800 |
| Hiwassee | North Carolina | 6,240 | 180 |
| Cherokee | Tennessee | 30,200 | 463 |
| Apalachia | North Carolina | 1,123 | 31 |
| Nottely | Georgia | 4,190 | 106 |
| Ocoee No. 3 | Tennessee | 572 | 24 |
| Chatuge | North Carolina and Georgia | 6,950 | 132 |
| Fontana | North Carolina | 10,570 | 274 |
| Watauga[2] | Tennessee and North Carolina | 7,120 | 117 |
| South Holston[2] | Tennessee | 9,105 | 241 |
| Douglas | Tennessee | 30,600 | 556 |
| Ocoee No. 1[1] | Tennessee | 1,900 | 18 |
| Blue Ridge[1] | Georgia | 3,290 | 60 |
| Great Falls[1] | Tennessee | 2,270 | 120 |

[1]Purchased with other electric properties from the Tennessee Electric Power Company.
[2]Under construction.

Principal game species taken are largemouth bass, smallmouth bass, wall-eye, crappie, bluegill, channel catfish, white bass. Other species include the spotted bass and other small sunfishes, a variety of nongame species such as carp, buffalo, drum, suckers, redhorse, catfishes.

There is left for consideration the development of new lakes under the direct supervision of the state fish and game divisions. This type of project has gone slowly in the past because of lack of suitable locations in state ownership and lack of funds. Florida is so well blessed with natural waters that there is no great pressure for artificial impoundments. The same is true for the lower Coastal Plain of the other Southeastern States. The heaviest population centers are through the Piedmont belt where natural waters are the scarcest and the poorest. The development of new lakes offers the only way to provide public fishing to the masses of the people in those regions.

Tennessee pioneered in this undertaking and now has 5 lakes totaling approximately 350 acres. From May 30, 1945 to April 1, 1946, 12,617 fisherman-days were spent on these lakes. The Kentucky Division of Game and Fish owns and operates one lake of 78 acres. The Virginia Commission owns or leases seven lakes with a total acreage of 492 acres. The Commission also directs the fish management policies on eight lakes built on state park lands by the C.C.C. These lakes cover 583 acres. Alabama is inaugurating a lake-development program and has $250,000 available for use in 1947 on these projects. Other states appear to be dormant on this activity. North Carolina manages public fishing on two small lakes on National Forest Service lands (20 acres), and, prior to World War II, conducted a public-fishing program on the Sandhills Wildlife Management Area. This area is owned by the U. S. Fish and Wildlife Service, and was leased to the state on a 99-year lease. Unfortunately, it was claimed by the Army and became Camp Mackall, a training ground for paratroopers. The Army is still reluctant to release the area to public use, and our Division is anxious to resume management. The area, located in the Sandhills region of the state, contains 12 or more small lakes, from 3 to 75 acres in size, which are ideal for management and public use (King, 1942b). Further developments are planned for the Piedmont section of the state. In most of the states of the Southeast the fish and game divisions cooperate in managing the fishing on lakes in state parks and state forests, but full figures are not available to the writer.

Experience has shown that many projects have been too ambitious, and served to satisfy a political hunger rather than meet a need for public use. Often a group of small ponds or lakes, which can be managed as a unit, are more desirable and less expensive to construct than would be the case if all available funds were put in one basket. Only a few years ago an effort was made to locate a new lake on the largest stream available. Now it is known that the smallest watershed possible is best, and only enough water is needed to keep the lake full. More intensive management on smaller lakes will produce more fishing than will larger lakes left to the mercy of nature. A federal program of aid to fisheries would be a welcome friend to the state fish and game administrators. It is certain that the development of new lakes for public fishing would be one of the most popular projects.

*Conclusion and recommendations.*—The question is raised, "How is each state to meet the schedule outlined above?" It cannot be done overnight, yet much valuable time has been lost. Dr. Eschmeyer and

I agree that in the Southeast a bass seldom lives over 6 years. Fish are a crop, and public use is the aim of our efforts. The logical course upon which to proceed follows two paths, one of which leads into the other.

The first is the completion of basic surveys or inventories at the earliest possible date. No state in the Southeast has adequate up-to-date information on its streams and lakes. The information needed is of the practical type. It need not involve the more complex ecological studies which may be required for special problem areas. How many fish supporting streams do we have and what is the mileage of those streams? What is their physical condition? What are they producing now? If all states would set as their goal the use of 10 per cent of their funds for investigational work, and then direct the studies toward a practical end, the returns would be worth many times the outlay.

When the necessary basic information is at hand, then the development of a management plan is possible. This plan need not start out as an elaborate or complicated affair, but should state its objective and that objective be kept always in mind. Fishery managers are too prone to let their programs develop on a piecemeal basis. The result is confusion and a failure of the ultimate objective—more successful fishing trips.

## SUMMARY

The primary question facing the managers of fresh-water fish resources in the Southeast is, "How can we provide more successful fishing trips?" The increased public interest in fishing makes a constructive line of endeavor imperative.

The solution promises to come through three general channels:

1. The improvement of existing waters. Here land management practices are basic. Stream and lake improvements have a relatively minor role. Stocking is recognized as being necessary in newly created waters and on heavily fished trout streams. A reduction in the load of pollution is of first importance in several states. The improvement of fish populations in many waters can be accomplished by removal of certain predaceous and nongame species.

2. A better utilization of fish already present is frequently possible. The interest in fishing for nongame species can be encouraged. The removal of unnecessary and hampering restrictions is an easy way to spread the fishing and bring about a better utilization of the fish crop. The Southeastern States have led in this action. Assistance can be provided anglers in forecasting fishing conditions, advising on areas, depth of water where fish are found, lures, and other informa-

tion of value. The biologists of the TVA are now rendering this service.

3. The creation of new fish supporting waters offers an unlimited field for development. Small private ponds lessen the load on public waters but do not fill the need for more public fishing facilities. The new TVA reservoirs and some of the reservoirs built by power companies offer extensive new aquatic environments that the public is quick to use. The development and management of state-owned lakes is a young enterprise but gives much promise. More small lakes, grouped in a manageable unit, are more desirable than fewer large lakes.

The first step in a fishery program should be the completion of a basic inventory of the aquatic resources to be managed. This need not be too technical or detailed. This information makes possible the outlining of a management plan. It is important that the principal objective be clearly drawn and every effort expended in that direction.

## ACKNOWLEDGMENTS

The writer is indebted to Dr. R. W. Eschmeyer of the Tennessee Valley Authority, Biological Readjustment Division, for suggesting the basic outline of the paper. Also for supplying information on the reservoirs created by the TVA.

Letters were written to eight of the Southeastern States, asking for information which might be presented on this subject. Replies were gratefully received from G. W. Buller, Chief Division of Fish, Commission of Game and Inland Fisheries, Virginia; Charles J. Chance, Biologist, Tennessee Division of Game and Fish; Minor Clark, Superintendent of Fisheries, Division of Game and Fish, Kentucky; A. A. Richardson, Chief, Department of Game and Fish South Carolina; M. D. McRae, Chief, Division of Fish and Management, State Fish and Game Commission, Georgia; C. G. Hixon, Chief, Division of Game, Fish and Seafoods, Alabama; John L. Dequine, Fisheries Biologist, Game and Fresh Water Fish Commission, Florida.

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## DISCUSSION

MR. JOSEPH HOGAN (Arkansas): In creating these new impoundments, would it be advisable to clear the reservoirs of all timber or not? We are getting in a number of new impoundments in our state and the question has come up as to whether the reservoir should be cleared of all timber or whether timber that will be permanently submerged should be allowed to remain in the reservoir. Possibly some of the states here have had experience along that line.

DR. KING: We have had a little experience in that problem in the southeastern part of the state. Just before the war started, we completed about a dozen small lakes varying from 3 acres up to about a hundred acres. The work was done with W.P.A. and Federal Aid funds. Our big job was to get the lakes finished before the funds were exhausted.

We filled some of those lakes and left most of the stumps, logs, and about half of the tree tops. With what limited experience we had there before the war, the lake that was the best fishing lake was the one which was cleaned up thoroughly. The lake which was poorest had the stumps left in it.

DR. T. H. LANGLOIS (Ohio): One thing Dr. King mentioned that I would like to emphasize a little more is the extreme individuality of every body of water, management must not only differ on different waters—it must be altered on any one body of water from one season to the next. That means something when you attempt to manage all the waters in a state like North Carolina or Ohio, and it is pretty hard to see how we can even approach that problem without a great deal more personnel than we have at the present time.

We have seen the necessity for that in many of our fish farms where there is a series of ponds side by side, very nearly alike and yet showing great differences in the necessity of treatment throughout each season, and no generalization really is possible. You can reach a few conclusions but you just have to watch each pond as the season progresses and adjust the management to the changes that take place in that pond as the season progresses.

While it is fine to know some of the principles involved in making a body of water produce a crop of fish, by and large our most successful efforts perhaps will be to let these action programs of the conservation departments proceed and make constant check on them as to their effectiveness either for good or for evil.

# MAINTENANCE OF ANGLING IN CALIFORNIA

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Historically the official work of maintaining angling in California has passed through the following overlapping phases: 1870-90, introduction of exotic species and transplanting of native fishes; 1880-1930, mass production and planting through artificial propagation; 1900-1946, restriction of bag and other regulations. Some early successes in all three fields convinced the public that these methods were the most important and satisfactory to attain the desired objective of increasing the supply of game fish. In spite of general dissatisfaction with the eventual results, that is still their basic view today. Little or no research or investigational work was done on game fishes prior to 1930, although in the field of commercial fisheries California developed an outstanding program as early as 1917 with the establishment of the State Fisheries Laboratory. The present program of investigation is of necessity largely directed towards pointing out the limitations of the traditional methods and developing information on which to base more modern management practices. This has included the assembly of data on cost of hatchery production, and through catch records the resulting cost of fish in the creel, on the ineffectiveness of regulations based on pseudo biology, and on the necessity of maintaining natural habitats and utilizing such new ones as are created by the intensive use of water in a semi-arid state.

The principal barrier to further progress is the unreasoning and abiding faith of our customers in the planting of fish under all conditions, at all times, and in every water. We believe it can best be counteracted with adequate cost figures correlated with catches.

Fortunately, nature still provides California anglers with a generous supply of fish. I say fortunately because it costs a great deal to supply them in any other way. Our last estimate of total catch was made in 1943 and partial figures were obtained in 1944. Even though many changes have taken place since that time, the data still provide a reasonable basis for discussion. This estimate was obtained by sending postal card qustionnaires to 10 per cent of our licensed anglers of whom about 25 per cent responded. Although the data are far from perfect they supply us with some very interesting figures as to probable total catch of various species.

As is usually the case with data obtained by sampling, questions arise as to the validity of conclusions that may be drawn therefrom. The first question is as to whether our voluntary reporters as a group differ from those who fail to respond. It might very well be that the nonreporters as a group are those who are less successful as anglers. If such were the case our estimates based on the catches made by the more successful, who were interested enough to report their catches, might be too high. To determine the extent of this possible error, we sent out a second questionnaire to those who failed to respond to the first. This second request brought out the interesting fact that about 6 per cent of our licensees never even went fishing after buying their permits. These people are the true conservationists and a very satisfactory group since they have no basis for complaint as to the quality of angling. In addition there was another group making up about 11 per cent of all licensees which included those who went fishing but made no catches. This group is naturally the least satisfied of our customers. The remaining 83 per cent of anglers who caught fish have varying degrees of satisfaction, but whatever their individual luck may have been their total catch was considerable as is indicated by the following figures:

| | |
|---|---|
| Trout | 15,700,000 |
| Striped bass | 1,790,000 |
| Black bass | 1,570,000 |
| Crappie | 2,670,000 |
| Sunfish | 3,040,000 |
| Catfish | 7,060,000 |

These figures are not presented to impress you with the magnitude of the catch in California for I know that there are probably other states more advantageously supplied with water where the catches may be considerably greater.

Rainbow, steelhead, golden, and several minor species of trout were native to our state and brown and eastern brook were introduced in the 1880's. Following these introductions, work in the early years was concentrated on the planting of both native species and the new arrivals in the many barren waters of the state. This work was very successful and greatly increased the total trout supply of the state. We are still reaping the benefits today. This success naturally led to the belief that as anglers increased the supply of trout could be augmented by heavier plantings of fingerlings. There was a gradual expansion of the hatchery program and the planting of fingerlings eventually reached an annual total of about 25 million. As elsewhere, our anglers in recent years have come to the conclusion that their needs can only be met by the planting of trout of catchable size. The result has been a partial re-orientation of the hatchery program with a view to supplying larger fish.

It is probable that our present catch of nearly 16,000,000 trout is made up in large part of fish resulting from natural propagation in spite of the intensive hatchery work since 1900, and the fact that over 90 per cent of our budget is used for the hatching and rearing of trout.

Our data on the survival of trout of various sizes is entirely derived from lakes. At Castle Lake, Wales (1946) found that fingerlings 1.5 to 3 inches in length of rainbow, brown and brook trout had an average survival of 3.6 per cent, and for yearlings 6 to 7 inches survival was 37.9 per cent. At June Lake (Vestal, 1943), the survival of the larger fish was 54 per cent. In all cases survival means to time of taking by an angler, which may mean an elapsed time from one day to 6 years after planting.

At the present time our planting of trout includes 2,500,000 fish of catchable size and 18,000,000 fingerlings. On the basis of the foregoing figures as to the survival of planted trout to the time of their arrival in the angler's creel, it appears that out of the total catch of 15,700,000 trout 1,800,000 or thereabouts are fish that have been planted.

Since 1935, we have had in effect a system of hatchery accounting which is based on the determination of the size, number, and total poundage of fish produced by weighing each shipment sent out. For each hatchery a complete record is obtained of the number of pounds of food used and the cost of labor, materials, equipment, and maintenance. At the end of each season we compile and issue to each foreman, and others that may be interested, a summary showing the data for all of the 24 hatcheries in operation. This naturally provides an excellent incentive for efficient operation.

These cost figures, however, serve another very important purpose in that they are bringing home to the sportsman the fact that the artificial production of fish is an expensive luxury. Of the $2.00 he expends each year approximately $1.00 is used for the enforcement of regulations and other conservation measures such as pollution control, construction of fish ladders and screens, and research. The remaining dollar is used to provide, by artificial means, approximately 12 per cent of his total annual catch of 71 trout.

In 1945 we had in California 550,000 licensed anglers of whom about 330,000, or 60 per cent, fished for trout and in 1946 about 150,000 new customers appeared. Of these the same 60 per cent were probably trout fishermen. These 90,000 men each contributed $1.00 for the production of trout, enough to supply one limit of 15 fish. Actually, of course, they took as many additional fish as possible from the natural supply thus reducing the average number of fish available to all anglers. Having long been accustomed to an annual bag of 71 trout and more at the reasonable fee of $2.00 our older anglers are finding difficulty in understanding these new conditions. They still firmly believe that in past years the large number of fish they caught was supplied through the $2.00 paid for a license and subsequently used for law enforcement and propagation. It is little wonder that they have difficulty in abandoning those pleasant fancies for many of our predecessors had that same illusion and expounded it year after year from 1900 to 1930.

Catch and cost figures are proving extremely valuable to us in counteracting the unrealistic views of our customers, and I believe that once we develop a sound understanding of the economics of the hatchery production of fish our whole program of fishery management will go forward more rapidly and surely.

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## DISCUSSION

MR. TAFT: That completes my formal paper and as a concluding remark I would like to add this. I haven't said very much in here about our warm-water fishes. I gave the total catch, but as you might guess we have done relatively little investigation work on them, and we have done even less propagation. We are very grateful to those of you in the Middle West and the East who have so recently developed information about those fishes. It has come in very handy. We are delivering it to our anglers for their information, and we are using it to a large extent in guiding us in our own policy .

# A TEN-YEAR MANAGEMENT PROGRAM ON AN EAST TEXAS LAKE

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Management programs on fishing lakes in the State of Texas have been almost completely neglected. Since very few natural lakes exist in the state, the angler is dependent upon either streams or impounded bodies of water. Reservoirs are ordinary constructed either for pleasure, water supply, hydro-electric power, erosion control, stock water, or for other reasons. Because of the great size of Texas, fish research done in one part of the state would probably not be wholly applicable to other areas within Texas. The lake concerned in this article is situated in what is known as East Texas. It is located in Camp County, and Figure I shows its geographic position.

Ferndale Club was first organized by a group of 30 interested fishermen in 1908. In 1909, a 205-foot dam was constructed. Previous to the construction of the dam, the present floor bed of the lake was marshy and, from time to time, was subject to overflow. During the dry season the marsh contained around 100 acres of water. Approximately 70 per cent of the water volume in Ferndale originates as seepage, flowing into the lake from underground springs. Thus, 30 per cent of the total water supply to the lake comes in by way of two small creeks, Lilly Creek and Norwich Creek (Figure 2).

The soils in this area of eastern Texas are of low fertility. The surface soil is a deep phase of the Norfolk sands of the eastern cross timbers. The subsoil is gray to yellow and composed almost entirely of an acid bearing sandy-clay. The surface soil is sand, almost devoid of accumulated mineral and affords few substances that may be leached into running water to furnish fertility for impoundments. The climax vegetation is the short leaf pine (*Pinus echinata.* Mill.). Scattered among the climax vegetation, back from the water's edge, are numerous oaks largely comprised of two species, post oak (*Quercus stellta* Wang.) and blackjack oak (*Quercus marylandica* Muench). Some of the cut over areas adjacent to the lake are spotted with sweet gum (*Liquidambar styraciflua* L.). The marginal vegetation consists of impenetrable growths of marshy plants. Myrtle (*Myrica cerifera* L.), button willow (*Cephalanthus occidentalis* L.), and saw grass *Zizaniopsis miliaceae*) (Michx.) are the most evident types, although many other species occur here and there along the shore line. From 1937 through 1941, most of the surface, excepting that in deeper water, possessed evident growths of Yonquepin (*Nelumbo lutea*) (Willd)


**Figure 1**

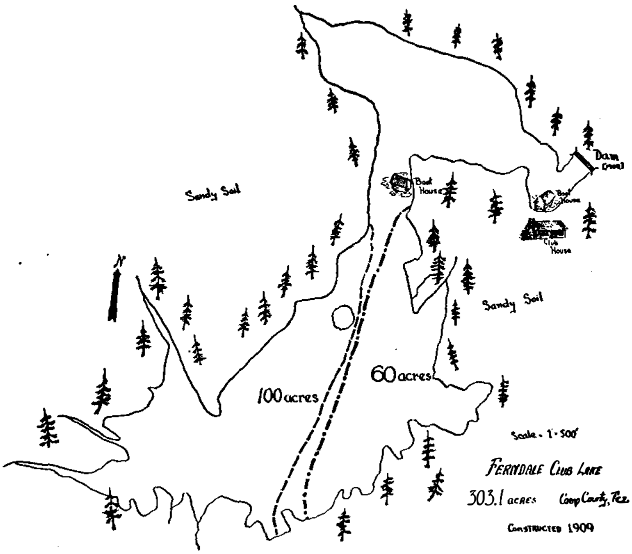


Figure 2

Pers. After 1941, this species became more of a rarity and by 1946 only one small patch remained. The most common type of water lily other than the one mentioned above, was *Nymphaea elegans* Hook. It still exists in certain shallow shoal areas, but is not nearly so prevalent as it was 10 years ago. The lack of turbidity, *Myriophyllum pinnatum* (Walt.) B. S. P. *Ceratophyllum demersum* L., and bladderwort (*Utricularia pumila* Walt.) makes possible extensive growths in practically all the water of the lake with the exception of the areas that have a 9- to 11-foot depth. Over 60 per cent of the area of the lake exhibits the above types of vegetation. Ordinarily, they do not manifest themselves in sufficient luxuriousness to present a real problem in lake management.

The basin of the lake, previous to impoundment, consisted of about 200 acres of rather heavily wooded land. This was inundated without cutting the trees. Today one must be careful in navigating the lake since the stumps of former trees interfere with the progress and safety of an outboard motor. For this reason, many areas of the lake are difficult to reach by boat. Since 1909, the tannates from partially decayed wood and plant remains have accumulated in the lake producing a coffee-brown water, U.S.G.S. color standard of 120. In winter the color may become less apparent. Although the total area of Ferndale Club Lake is variable due to high water in the spring and low water in the early fall, the average is approximately 303 acres. The average depth of the lake is 4.5 feet. The deepest area, less than one tenth of an acre, is approximately 13 feet.

As already mentioned, the club was established in 1909 with a membership of 30. By 1937, the membership of the club had expanded to 175. Although the memberships are placed in the name of the head of the family, all children under 21 are permitted fishing rights. The total number of individuals, therefore, represented by the club membership was 610. By 1946, the number had changed very little. Over 60 per cent of the membership does not average a visit to the club once a year, while 40 per cent are rather frequent visitors.

In 1937, the writers made an agreement with the directors of the club to begin a lake-improvement program with sufficient funds to cover the cost of the project. The entire program has been carried out in accordance with the original agreement; the membership has proved most cooperative and during the 10-year period, they have seen that the yield from an old lake can be definitely improved from the standpoint of pounds of fish per fisherman-day. This led to renewed vigor and interest in fishing which has not completely dwindled since the start of the program. Early in 1937, the club had no plan or program by which to measure the annual yield of fish. One could catch hundreds of small bluegills with an average length of about 2 inches. Largemouthed black bass could be taken without too much difficulty, but it was infrequent indeed when one was of legal length (11 inches). The conditions, therefore, were not conducive to great fishing interest. In order to have a measure of the total yield in fish, the directors agreed to institute a creel census established in May 1937. A printed record sheet was made so that each member could list the number and kinds of fish he caught each day. As in every club lake, a certain percentage of the membership were not cooperative; so from year to year, the creel census contained a slight error due to the few members who neglected registering their fish. We feel that the error is probably a constant one, and therefore negligible in so far as the results are concerned.

A class of graduate students spent 6 weeks at Ferndale in the summers of 1938, 1939, 1940, 1941, and 1946. The writers and certain graduate students made regular visits for the purpose of collecting data at monthly or bimonthly intervals except in 1943 and 1944. Extensive limnological data have been collected from Ferndale and will be mentioned as they appear to apply to fish management. Temperature readings of the lake water were accumulated for 5 years. Other climatic data, such as precipitation and wind velocities, were secured from the U. S. Weather Bureau at Tyler, Texas. Correlations between climatic data and fish catch were attempted, but none have proved revealing. This is attributed to the fact that the climatic conditions reduced the number of fishermen rather than the possibilities of catching fish.

The most common species of fish in Ferndale are bluegill, red-eared sunfish, green sunfish, largemouthed black bass, yellow bass, black and white crappie. Black and yellow bullheads are rather prevalent; the minnow and sucker families are well represented; but for the matter of the present paper, we will not give them individual consideration. As in all artificial lakes in the Southwest, Lake Ferndale was stocked as much as possible from as many sources as obtainable. Various members in the early days of our work told us how many thousands of fish of various species had been seined or bought from illegal sources and placed in Ferndale. No doubt, the population was tremendous; and, as exhibited by our net catches early in the work, few specimens of any species weighed over 8 ounces. It was interesting to observe that the most prevalent bass was actually the southern smallmouth which had been taken from streams and rivers and transplanted. We never did find a specimen over 3 years old and few of them ever reached a pound, although they frequently get to be larger in some of our Texas streams.

In May of 1937, we observed that from a chemical viewpoint the waters of Ferndale resembled distilled water, containing only 10 p.p.m. sodium bicarbonate and traces of other minerals. Calcium amounted to less than 1 p.p.m., and the fish exhibited poor bone formation. The water was acid, around pH 5.1; hence we introduced into the lake about 103 tons of limestone gravel. It was scattered throughout all areas into which one could navigate a small barge. In certain areas the limestone gravel was thrown out in mass and formed spawning beds for fish, which we thought at the time might be a good idea. Before 1937 ended, we placed 10,000 marked large-mouthed black bass in the lake in hopes of finally establishing this species rather than the southern smallmouth. Food studies were started and several hundred scales were collected from measured and weighed specimens of the various species. In 1937, the average bluegill caught by hook and line was 96 millimeters long and weighed 75 grams. White crappie have never experienced successful growth in Ferndale. The average specimen was 175 millimeters long and weighed 160 grams. The black crappie, on the other hand, even in 1937, was a fairly good specimen to catch; average size was 230 millimeters with weight of over 200 grams. The bass taken by the anglers were usually pitiful looking specimens, average length around 155 millimeters and weight around 87 grams. A few larger specimens were caught from time to time. The largest seen in that year was one 3-pound bass. By the end of the year 1937, we took the creel census and by analyzing it found that throughout the period under consideration, 653 fishermen had angled in the lake that year. The average catch per fisherman day was 4.5 pounds. Of this catch, 3.5 pounds was composed of bluegill and red-ear; one half pound, bass; and one half pound, crappie. This is not considered to be very productive, as will be seen in consideration of future years.

In 1938, more extensive lake improvements were undertaken. The reader should readily realize that at this time there was no dependable information concerning artificial reservoirs nor management of this type of lake. In the early part of 1938, we decided that some type of fertilizing program would enhance the food supply and consequently the fish. It occurred to us that probably a high protein content might be desirable, so with a part of our fund we purchased 20,000 pounds of cottonseed meal and scattered it in the south end of the lake. This was approximately 66 pounds of fertilizer per acre as it was dissipated over the entire lake. Limnological work followed the process of fertilization, and we observed a change in the plankton composition from zooplankton to phytoplankton. The density, of course, of the plankton crop was never sufficient to reduce the light penetration since the amount of fertilizer was not great. More limestone was added to the lake, which resulted in a calcium rise to around 25 p.p.m. and the pH rise numerically to around 7.0. For some reason the anglers were much more successful for weeks or even months after the addition of limestone, or lime. Since the submerged, floating, and emergent vegetation appeared to be copious, it was decided that part of it could be controlled by extensive cutting. A large scythe was fitted to the front of the boat and extended approximately 12 inches below the surface of the water. A powerful motor was placed on the back of the boat and employed in pushing the boat and scythe through water lilies, reeds, and sawgrass. Over a period of two or three years, cutting showed an obvious result in the reduction of vegetation in the lake. It was not our desire to remove all the water lilies since many of the fishermen assured us that this area was much more productive from the standpoint of bass, especially for the fly-fishermen and casters. Ten thousand more marked largemouth black bass were placed in the lake in 1938. Fishing intensity of the lake increased so that by the end of the year 1,335 fisherman-days were recorded. The average catch per fisherman-day was 5.5 pounds of which 3.25 pounds were bluegills and red-ears, 1½ pounds bass, and one-half pound crappie. The bass in 1938 caused the rise on pounds per fisherman-day; and the increase was in direct proportion to fishing intensity (Figure 3). Studies on the growth of the fish in 1938 indicated only a slight difference from 1937. The crappie were doing slightly better; the bluegills were approximately the same size; and the bass averaged 200 millimeters in length and 100 grams in weight. However, during 1938, several 7½ pound bass were caught. Doubtless, they were missed in 1937. The members in 1938 cooperated with the program very readily in destroying crappie or bass under legal length. At that time in Texas, 7 inches was the minimum length for crappie taken legally, and 11 inches for bass. Since fish under that size could not be kept, a part of the program was to cut them into several pieces and return them to the lake in hopes that they might act somewhat as a fertilizing medium, provided, of course, they escaped the attention of turtles. Attempts were made to obtain an idea of how many fish were destroyed. The best estimate we could obtain for the first year was 2,000 crappie and 5,000 bass. Since the bass that had been placed in the lake that year were marked, members were requested not to destroy them. Age studies instituted in 1937 and carried through 1938 indicated that the maximum age of the bass in Ferndale Lake, regardless of size, was 5 years, and incidentally, very few of these were ever found. Black crappie rarely reached 4 years of age. Four-year-old bluegills were found rather frequently as were 4-year-old red-ears, but the maximum catches of the latter two specimens made by the anglers were in the second and third years. At the time these studies were being made, we have not then shown through experimental work that the scales in this latitude are dependable. Through marked bass and other species, we were able to show that the scale method was dependable and accurate provided a sufficient number of specimens was accumulated.

In 1939, a more extensive program on Ferndale was instituted. Growth studies began to take form. The last group of marked bass

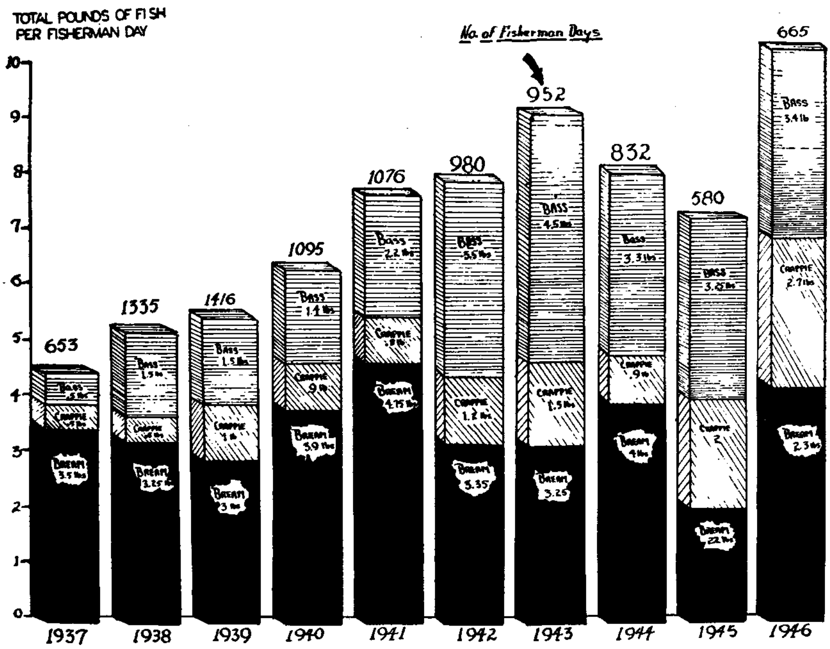


Figure 3

was introduced into the lake, and the cutting of vegetation from previous years indicated that if it was cut to sufficient depth as previously described, before it had time to flower or fruit, it would be slowly reduced in the lake. Thirty thousand pounds of cottonseed meal and an equal amount of lime were added to the lake which brought the total of each to approximately 100 pounds per acre. Effects of the fertilizer at that time were still questionable, although we shall have more to say about that in years to come. The destruction of crappie and bass under legal length was undertaken by the club members with considerably more enthusiasm. It was extended into the bluegills and red-ears. Studies of spawning activities in 1939 thoroughly demonstrated that the bluegills and red-ears began spawning in March and continued through until the early part of October. The bass and crappie did most of their spawning in April and May. Our information on catfish is still sparse. We observed with considerable interest that red-ears were highly predatory on the bass spawning beds. Observations in future years made it plain to us that the red-ear in east Texas is apparently a better species for mixing with bass than bluegills, not only because of their predatory habits when bass spawn, but because of their more rapid growth and the fact that

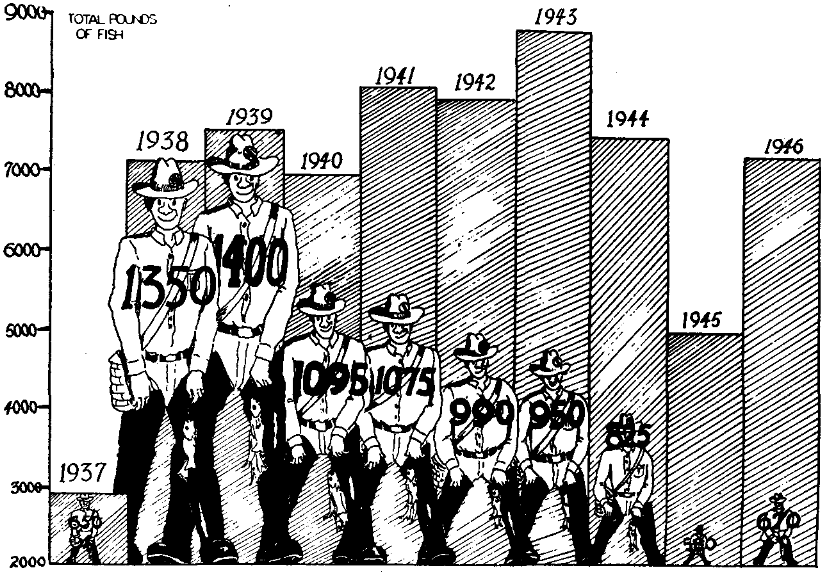


Figure 4

a bass may consume red-ears of greater length than it can bluegills due to body formation. The total number of fisherman-days in 1939 was 1,416. The average catch per fisherman-day was $5\frac{1}{2}$ pounds (Figure 3). This was composed of 3 pounds of bream, $1\frac{1}{2}$ pounds of bass, and 1 pound of crappie (Figure 3). This was the best year for fishing intensity in the entire program. The correlation between pounds per fisherman-day and fishermen is very obvious (Figure 4). The growth of the bass in 1939 was only slightly better than in 1938. The average bass taken was 240 millimeters long and weighed 180 grams; the average red-ear was 180 millimeters long and weighed 120 grams; the average bluegill taken was 165 millimeters long and weighed 80 grams; the average crappie taken was 240 millimeters long and weighed 231 grams.

In the spring of 1940, netting activities were instituted in order to determine, if possible, migration of the various species of fish in Ferndale. Marked bass caught in nets were remarked with metal tags and turned loose in specific areas of the lake. Crappie, red-ear, and Ferndale. Marked bass caught in nets were re-marked with metal tags and reintroduced into specific areas. Throughout the year 1940, about 6,000 fish were caught of various species and careful records were kept on the local distribution of the various species within the lake. It is interesting to observe, as further demonstrated in later years, that the migration of the various species in Ferndale occurs in very small areas. Our interest in fish migration was twofold: one part of the program was to retake tagged specimens and follow out the annulus formation on the scales, and the other, to find, if possible, how far any particular specimen might migrate from the original site where it was caught. In 1940, we found that the marked bass in Ferndale migrated a maximum of 200 yards from the place where they were originally planted. Naturally the migration might be in either direction, but generally it was more along the shallows parallel to the shore. Crappie migrated over less area than 2 acres; red-ears and bluegills frequently showed almost a complete lack of migration. Occasionally, during very high water, they would move up into the shoal area; and then, as the water abated, they would be observed moving out into deeper water. Never was an area of more than an acre covered by any of our marked specimens over a period of several years. By July of 1940, it appeared to us that migration of the various species was not so extensive as we had previously anticipated, so we established three areas in the lake for experimental work on the effect of fertilizer, food, and unfertilized and unfed areas. The entire north end of the lake and the north end of the channel (Figure 2) were set aside as a region where no fertilizing or feeding would be carried out. The entire east side of the channel completely up to the south end, taking in approximately 60 acres of the lake surface, was set aside for scattering cottonseed meal or other types of fertilizer. The west side of the lake south of the channel, approximately 100 acres, was used in direct feeding experiments. Direct feeding was accomplished by filling wooden troughs or feed sacks that were perforated, saturating the food over a period of 2 or 3 days, and sinking the containers in about 7 to 9 feet of water. These areas have served in experimental work for the duration of the management program on Ferndale. It was the idea of the writers that if a part of the population of crappie, red-ears, bluegills, and goggle-eyes were enjoying good growth, the productivity of Ferndale would increase. At the same time, bass should also experience better growth. In 1940, there were no obvious results demonstrated, however, in later years there was a differential growth evident in the three areas. Some of the fertilizer was carried either by wind or waterflow to the unfed area; however, this did not prove to be significant. A considerable amount of limnological data demonstrates that the organic, nitrogen, phosphorous, and bottom fauna were highest where feeding was done in containers, next in amount where food was scattered, and less in the north end of the lake. These findings are contrary to those of 1938 and 1939. Thus obvious effects were experienced 2 months after these areas had been used as described above. The total amount of food and fertilizer used was 30,000 pounds. The total pounds of fish per fisherman-day in 1940 was 6.4. The average bass taken was 300 millimeters long and weighed 300 grams. The average red-ear was 180 millimeters long and weighed 130 grams; the average bluegill was 180 millimeters long and weighed 116 grams; the average crappie was 246 millimeters long and weighed 250 grams.

In 1941, rather heavy rains started in February and continued into March. Several years previous, two 12-inch siphons had been installed over the dam in order to protect the lake against excessively high water. The siphons were started in the early part of March 1941 and continued for several weeks. An unusually early spring occurred in that area of East Texas, resulting in rather early spawning activities in all the species. The siphons continued carrying out water, apparently unnoticed by the caretaker, and about 10 days after the maximum spawning, the water was lowered to such an extent that the spawning beds were exposed. The personnel of the club in many instances was greatly disturbed. We were extremely pleased since it did give an opportunity to make practical application of our contention that overcrowding was evident in Ferndale. Probably the bass and crappie spawns suffered most, since the bluegills and red-ears continue their spawning activity throughout the year.

The same program of 1940 was carried over into 1941. Specimens tagged in 1940 were retagged in 1941. Migration over a period of more than a year could be easily studied. Growth rates became apparent in different regions of the lake and the application of the scale method to age determination was obviously facilitated. The amount of fertilizer and food used in 1941 was 40,000 pounds, and in this instance, we made use of bat guano rather than other types of organic fertilizers, although it should be pointed out that the limnological evidence demonstrated lower total quantities in nitrogen, phosphorous, bottom fauna, and plankton. Laboratory analyses of the bat guano showed that it should serve very effectively as a fertilizer and as a food, but our experience by practical application was different. By the end of 1941, 7.75 pounds of fish were taken per fisherman-day; 1,076 fisherman-days were recorded. The average growth of the various species was not altered perceptibly from that of 1940.

In 1942, with the advent of the war, we rather suspected that the fishing would drop; however, we were able to carry on our active experiments, to retake tagged specimens, and continue the study of fish distribution and growth. Food was scattered in the area of 60 acres used in the previous years. It was sunk in troughs and sacks in the 100-acre area in the southwest part of the lake, and limnological studies were carried on. The type of food used in 1942 was soybean meal and cake. This type of food is apparently about 50 per cent as productive as cottonseed products. We judge this from both limnological data and fish growth studies. We do not have a critical evaluation of the merits of cottonseed meal, guano, and soybean meal. Since cottonseed was used first, probably the most evident effects resulted. In a total picture, however, we think it appropriate from our evidence to favor cottonseed meal. Inorganic fertilizers have not been successful in any of our Ferndale work, although they were used only sparingly in small areas of the lake in various years of the program.

The summer class of 1942 did not materialize due to the lack of man power attending college, and due to the desire of students to take work that might prepare them for the armed services. Obviously, the amount of total work done on Ferndale in 1942 was not nearly so complete as in previous years. The creel census, however, was satisfactorily kept, and by the end of 1942 the total number of pounds per fisherman-day was 8.25; the number of fishermen was 980 (Figure 3). It was now apparent, and very interesting to note, that even though the number of fishermen decreased, the total pounds per fisherman-day continued to rise (Figure 4). In 1943, with the advent of gasoline rationing in Texas and other wartime activities, the program of lake management except for the creel census was completely dropped. No studies were made on Ferndale except to take an occasional limnological sample and to keep track of the average weight and length of fish taken by the fishermen. As it happened, 1943 proved to be the most productive year that far in the program. An average of 9.25 pounds of fish per fisherman-day with 952 fishing-days was recorded. It should be stated that the limnological samples showed a tremendous reduction in nitrogen and phosphorous, and bottom fauna was greatly reduced. It was the best year for bass fishing, however, so far experienced. Obviously the results of good fishing would hardly be affected by the fact that the program was stopped in that year and actually very little was done in 1943. The average lengths and weights of fish taken in 1943 were as follows: bass 335 millimeters and 450 grams; crappie, 264 millimeters, 260 grams; bluegills, 185 millimeters, 120 grams; red-ear, 184 millimeters, 140 grams.

In 1944, we followed the same pattern of management activity as 1943. The lake was visited only twice during the year and meager limnological data were accumulated. The number of fishermen was reduced and the yield was cut down considerably. The creel census was probably the only effective part of the program that was continued. Bass and crappie fishing declined while the bream fishing increased a little. Total pounds per fisherman-day was 8.25.

In 1945, the program was reinstituted in the early fall. The same regions of the lake were used for scattering food or fertilizer and sinking caches of food in the southwest area of the lake. The number of netting experiments recovered a sufficient number of the tagged specimens from which to get records of growth and distribution. When tagged specimens were taken by net or by fishermen, the tag was removed, the length and weight of the fish recorded, and scales were collected for determining the age of the specimens. For 7 years most of the bluegill catches were in the third- or fourth-year class. The black crappie were almost totally in the 3-year class, with a few in the second- and fourth-year groups. Black bass rarely obtained 5 years. Only 7 per cent of the total number of bass caught were 5 years. Since the maximum age of the fish in Ferndale is much less than in northern lakes where most of the population cycle studies have been done, it would appear that in all probability, slight effect is apparent in our lakes from variation in year groups. The tendency toward overpopulation is, of course, very apparent. This, however, does not seem to reduce the average age of the fish caught, but considerably reduces the size. Obviously, the size is dependent upon the density of population and availability of food.

In 1946, the management program was followed in more detail. Early in the spring, catches were made by net, new specimens were tagged, and migration experiments were studied. Several thousand specimens were studied for length, growth, and weight relationships. The water level of the lake was kept low in the early spring by use of the siphons. Thirty thousand pounds of cottonseed meal were used in the two different areas of the lake, one for scattering fertilizer in the 60-acre area, approximately 10,000 pounds being used, while 20,000 pounds were deposited in the feeding area in the troughs and sacks. Careful collection of limnological data preceded the addition of the fertilizer and food; and after its introduction, studies have been made regarding its effects. Ten thousand pounds of lime were scattered in the south end of the lake, and its effect was obesrved on the water. The pounds of fish per fisherman-day in 1946 was 10.3, although the number of fishermen was only 665. The average length of the bass taken in 1946 was 360 millimeters with a weight of 630 grams; the average crappie was 290 millimeters long and weighed 363 grams; the average bluegill was 186 millimeter long and weighed 130 grams; the average red-ear was 200 millimeters long and weighed 180 grams. These figures include not only those taken by the fishermen, but those taken in nets that were of sufficient size for the fishermen to keep in their creels. Nineteen hundred forty-six proved to be the most productive year in black crappie thus far experienced in the program.

## DISCUSSION

During the years that Ferndale has been established, certain fishing customs relative to seasons are firmly engendered in the minds of the membership. For example, bass and crappie fishing for many years was illegal during the months of March and April. Since much of the weather was unfavorable to fishing in January and February, the membership had developed the habit of fishing only for red-ears, bluegills, and occasionally goggle-eyes for the first 4 months of the year. Since the local Negro guides on the lake are paid frequently in proportion to their success in finding "bream beds," they would take particular cognizance of the situation and try to conduct their clientele to good "bream" zones. This resulted in extensive interest in bream fishing from January up through and including August. A few of the membership would begin bass and crappie fishing in May, but since the catch in bream was always so much better in pounds than the catch in crappie and bass, it was most frequently that the fisherman, after fishing a while for bass and crappie, in order to be certain that he had a full creel, would stop his casting or fly fishing, take up hook and line along with red worms and proceed to fill his basket with bluegills and red-ears. This obviously has reduced the interest in bass and crappie among a large portion of the membership. There are a few ardent casters or fly-fishermen who follow this type of angling on every possible occasion and who are successful throughout the year. Needless to say, these are too few in number to maintain a constantly large bass and crappie yield for the first 8 months of the year. In September, the guides have been less successful in catching bream so they have made a particular point of advising the membership that crappie and bass fishing would be more lucrative; thus the last 4 months of the year yield few bluegills and red-ears, but produce the maximum catches in crappie and bass. As a matter of fact, the maximum catch in bass occurs in August, September and October. By November, the membership finds the weather unpleasant and duck hunting or other types of sports more attractive so that much of the catch in bass must come in these 3 or 4 months. Crappie fishing has been similar up until 1945 when the law was changed in Texas permitting year-round fishing. Since the last 2 years have not been representative fishing years, we can not yet judge how much increase will be experienced during these two months in Ferndale. Obviously, the habits of the fishermen have much to do with the pounds per fisherman-day, the creel census, and most important, with the alterations in possible catches and, therefore, growth of various species. We have recently instituted a program attempting to interest club members in year-round bluegill and red-ear fishing. Most of the guides say that these two species will not bite in the winter time; however, there are two members of the club who do all of their fishing for bluegills and red-ears in December and January and they are most successful. It is interesting that they do not take guides with them and the local story is that no one knows how these men are successful in catching bluegills and red-ears in the winter. Bass and crappie fishing would doubtless be more successful if the fishermen were more persistent and would not take too much cognizance of the statements made by the guides. This is also an intricate part of a management program, especially when customs are of long standing and based on "heresay" rather than facts.

There has been a considerable amount of literature published on the effect of fertilizing ponds and lakes of various sizes, most of which is quite familiar to the reader. The series of experiments over the last 10 years in Ferndale demonstrates the usefulness of this practice in lakes of large size. Scattering of fertilizer in very large quantities may well be part of the answer to fish growth. In bodies of water of several hundreds of acres, the cost of adding sufficient amounts of fertilizer to give obvious impetus to fish growth would be almost prohibitive. In Ferndale the migration of fish was sufficiently reduced so that the lake could be divided into zones. We were able to prove to our own satisfaction that the mere scattering of fertilizer is little more effective than a total absence in so far as fish growth is concerned in this lake. On the other hand, deposition of food materials in the feeding regions of the bottom seems to be highly effective. It should be mentioned that a turtle population of great proportion may prove wholly deleterious to any feeding program. We find that in water from 7 to 9 feet in depth that the amount of food taken by turtles of various types in East Texas is not especially significant. Hundreds of trapped fish, particularly bluegills and red-ears, were studied for food habits and it was clearly demonstrated that for periods as long as 2 months, the major part of the diet was either cottonseed meal, soybean meal, or whatever type of food was deposited. The increase in bottom fauna in such an area studied over a period of 3 years showed an average increase of 108 pounds of bottom fauna per acre greater when compared with the region that was fertilized by scattering an equal amount of fertilizer. The labor involved in placing food on the bottom of the lake is obviously considerably greater than merely scattering it through vast areas. We finally, however, worked out a technique whereby we could attach our feeding boxes to poles that had been sunk in the bottom muck and could raise or lower the boxes as we desired.

In a small pond this method is especially practical. We have used direct feeding for the past 2 years in catfish raising with considerable success. Wherever food was deposited in fairly shallow waters, we employed turtle traps and examined caught specimens for consumption of the food and found that about 20 per cent of their diet was comprised of the deposited food. This, of course, is a substantial loss, but apparently they caused no reduction in the number of bottom fauna which is very important in the food cycle of Ferndale. The few times we tried inorganic fertilizers we could produce a concentrated plankton crop which resulted in a slight increase in bottom fauna, but the area of the lake was so great as to prohibit the addition of sufficiently large quantities. We have tried inorganic fertilizers in small ponds but find it much less productive than bottom feeding troughs, which are in addition less expensive to operate. It is probably worthwhile to mention that we build a number of willow shelters which were constructed by taking the boughs of green willows, submerging them around stumps, and tying them securely in place. These proved effective in attracting small bluegills, red-ears, and crappie, but the density of the groups accumulated was so great that we were never able to demonstrate any actual benefit over a 4-year period. After a willow bed had been established for a period of 10 days to 2 weeks, the phytoplankton increased perceptibly, but the bottom fauna frequently showed no effects or at most, improved as much as 10 per cent. It appeared to us that the small fish were too well protected from the larger fish to serve as items of diet and the density of population in the willow beds was too great for the specimens to experience growth. Apparently the willow beds serve somewhat the same purpose as copious growths of submerged and floating vegetation. The psychology of willow beds seems rather effective since fishermen in our area regard such sites as highly favorable to fishing. In the summer of 1946, we tried a few pole-hour counts and the observation was that fewer pounds of fish were caught per hour near the willow beds than in the more open areas. Sixty to seventy-five millimeter bluegills, crappie and red-ears could be caught, but this is not particularly satisfying to the angler, which is the program we were trying to produce.

*Vegetation control.*—In the early days of our work on Ferndale, the vegetation was very dense. Submerged, emergent, and floating types of flora covered a large portion of the lake area. A number of methods were attempted to control vegetation, as already described. We found the use of a large scythe on the front of a boat effective in controlling floating vegetation and some types of emergent, providing cutting was done in the spring or early summer before the plants had time to flower or fruit. During the first 2 years, cutting does not produce noticeable results, but the third or fourth year an observer will note that the vegetation has been reduced and by 5 years of the continuous program, a large portion of the vegetation will be killed. Probably this method is not so successful as variation in water levels In the spring of 1941 when the lake was lowered so that much of the shore line growth was permitted to dry out, many acres of water lilies disappeared. They have not returned in Ferndale, even to the present time. If the water level can be varied as much as 3 feet during the most significant part of the growing season for plants, it is apparent that this will control vegetation more effectively than cutting or, in our experience, in attempting to shade it by fertilizing or other methods. When the lake is as large as 300 acres, vegetation may be a very serious problem, particularly in a lake as shallow as Ferndale. In 1938, a plant survey was made which indicated that 60 per cent of the total area of the lake had emerged and had floating vegetation. In 1946, a like survey showed that less than 15 per cent of the total surface of the lake contained the same type of vegetation. We think this reduction is significant.

*Fish growth and migration.*—As already related, fish migration studies were carried out in considerable detail. Small monel tags placed on the back part of the dorsal fin or under parts of the caudal fin proved useful in following fish growth and migration. We also worked out a system of clipping spines from the dorsal and anal fins. The first time the fish was caught, the first two anal spines and the first three dorsal spines were clipped. When they were retaken, the fourth dorsal spine was clipped. By continuing the process of clipping spines, we could tell how many times a fish had been taken. In order to identify a specimen in a particular locality, the monel tags were necessary. We tried jaw tags for 2 years, but gave them up because of the poor growth evident in the tagged specimens. With monel tags used in the fins, we were not always successful in recovering a specimen that retained the tags, since some of them would tear out. Occasionally, the fin would slough or the tags would become so covered with algae that we would have difficulty reading the numbers. We were never able to figure what per cent of the fish lost the small tags. A sufficient number however, stayed with the fish for us to follow our investigation through to 5 years on a number of bass, 3 and 4 years on the other species. The migration of these species is most interesting to us, since we had very little information on any Texas studies and presumed that bass would migrate over a large area of the lake. However, the lack of migration in Ferndale may be due to the fact that the lake throughout its entire area is very shallow and contains a great number of stumps, thus providing a consistently homogeneous environment in all parts of the lake. Since water level never varied more than 3½ feet during the entire study, extensive migration of the different species may not have been necessary.

In 1938, many of the specimens caught by hook and line were very small but had attained their maximum age. We did not know at that time whether the scales were useful in age determination or not. The small size was due, no doubt, to a huge population and relatively poor food conditions. As the program was established the three different areas in the lake were set aside for growth studies and to determine length and weight relationships. By 1946, it was apparent that in the unfed areas of the lake, the north end, growth of the various species had improved about 15 per cent over what it was in 1938. This probably was due to cropping and the destruction of many small specimens. In the southeastern region of the lake where scattered fertilization was established, the average growth of the fish was 18 per cent greater than it was in the unfertilized or unfed region of the lake, and 33 per cent greater in 1946 than it was in 1938. In the fed region of Ferndale on the southwest side where caches of food were deposited, the increase in growth over the unfed area was 60 per cent and in 1946 was 75 per cent greater than it was in 1938. We believe these figures to be significant in illustrating what method might be employed for improvement of the entire lake.

*Factors affecting fish catches.*—A number of charts and graphs were prepared by the writers, attempting to show a correlation between precipitation, temperature, barometric pressure, and other factors which might affect fish catches. So far, our observations have been that the climatic factors affect the number of fishermen or fishing intensity much more than it affects fish catches. We have not been able to show any correlation at all on Ferndale between climatic conditions and fish catches. There are a number of members who apparently are capable of catching their limit on almost any day they visit the lake. There are many other members who never catch their limit regardless of the climatic conditions, and other factors. In between, there are members who have good days and bad days. It would seem that probably the efficiency of the angler is of greater importance than climatic factors. Since Ferndale is so shallow, temperature irregularities do not seem to be a hinderance to an angler who may fish on the bottom or on the top as he so desires without much change in his gear. Our evidence on fish catches is not conclusive.

As stated in the introduction, doubtless, the most significant part in fish management after a creel census has been established is to transmit to the membership a continuous enthusiasm toward persistent fishing. Cropping, in other words, is an essential part of the program. Frequent visits to a club lake, bimonthly or monthly written reports to the directors, the posting of interesting notices on the bulletin board, and, if possible, the creation of fishing contests seem to produce more yields in pounds per fisherman-day than purely scientific methods. To be certain, fish growth can be improved, but unless the angler is willing to cooperate in removing the production of each year's crop, the program will not long be successful. We believe Ferndale could produce 300 pounds per acre just as effectively as it is being cropped at the rate of 30 pounds per acre, if the membership had the desire to put out that much effort. Probably the same principles apply to public reservoirs that are now infrequently visited because of the poor yield of big fish and the extensive yield of very small fish.

## DISCUSSION

DR. GEORGE BENNETT (Illinois): What was the total yield of pounds per acre?

DR. SILVEY: The best yield was 37 pounds. The lowest per-acre yield was 16 pounds.

DR. T. H. LANGLOIS (Ohio): I have noticed that in fishing clubs we very often have generations of fishermen. You get a group that just starts and stays with it for several years, becoming quite expert. Have you by any chance considered the increased skill that might occur with such group?

DR. SILVEY: No. As a matter of fact, I believe that almost the same individuals fish this lake now who fished it 10 or 12 years ago.

DR. LANGLOIS: I would like to make one further comment. You mentioned the recapture of marked bass in the same area where you originally got them. A month or so ago we attended a meeting in Columbia, Missouri, and heard a paper regarding a lake in New York. The author had done a lot of fish trapping. He reported that he not only recaptured fish in the same area where they were originally taken, but that fish released elsewhere tended to return to the locality where they were originally caught.

I wonder if, in this whole question of stunting, we aren't really basically confronted with this problem of social organization of fish within a pond. Paul Errington has an approach to the problem in his paper on predation. I made a study of the social organization of bass populations several years ago.

What I think I see in your data, and the information of the author from New York, is that fish recaptured in their original areas were, in effect, individuals that had established territorial claims, and were exceedingly predaceous in these areas.

I wonder if our attempts to improve fishing by increasing the average size of the fish we catch, or the average number of big ones, should logically consist of decimating the prey group, or whether it should preferably consist of providing more outlined territories where you could have more of the predators?

# FISH MANAGEMENT—A SUBSTITUTE FOR NATURAL PREDATION

GEORGE W. BENNETT
*Illinois Natural History Survey, Urbana, Illinois*

No state or federal official can truthfully say that more than a small fraction of the fishery programs of the past 50 years has given the public a justifiable return for the amount of money expended. Fishing in inland waters has become steadily worse since about 1900 and this decline has followed closely on the heels of an expanding human population, in spite of every measure that has been taken by those entrusted with the duties of husbanding this resource.

If 50 years of an ever expanding hatchery program, plus laws to protect fish from human exploitation, plus improved law enforcement, plus the development of the "sportsman complex" have been followed by a rapid decline in the probability that the average angler will bring home fish, it seems reasonable to assume that such a program must be at fault.

But the reports of fishermen are not all bad. There are always a small number of anglers who have managed to find waters away from the "beaten paths," usually in inaccessible regions. These fortunate individuals return with photographic evidence of good fishing, even if the long route home precludes the possibility of bringing back fresh fish. If questioned, they usually will expound at length upon the abundance and variety of wildlife inhabiting these remote regions.

From nearer home come reports of unusual fishing. A new water supply reservoir completed and filled 3 years ago is producing a remarkable yield of bass and crappies of better-than-average size. Last year, anglers reported that fish were caught here in large numbers, but most of them were too small. This year, the fish are large and fishing is exceptional. Two years from now the fishing here may be very poor.

Still other reports of good fishing come from members of a fishing club who have banded together to purchase a small pond. These men are interested in fishing and do a lot of it. It is a family group affair, their water receives heavy use, and their tackle runs from fly rod to cane pole. When fish are biting everyone is out fishing, and their creel record for the year adds up to something over 100 pounds of fish per acre.

These are the bright spots in an otherwise dark picture. Can these exceptions furnish the answers to our general fishery problem?

In the summer of 1931, I was employed to make some biological investigations on the sandhill lakes of Cherry County, Nebraska, located in the north-central part of the state, 40 miles south of the town of Valentine. At that time the region was "back country" due to the fact that the sand roads were almost impassable during the fishing season. Without refrigeration, my partner and I were forced to procure fresh meat nearly every day and local possibilities were limited to fish or young jack rabbits. Often, in quest of an evening meal, we fished in Dad's Lake, because of its unusual bullhead population. Here black bullheads could be caught as fast as we could bait our hooks and all of our bullheads weighed between 1 and 2 pounds each.

Two years later, I was a member of a party that drove to Dad's Lake to hunt waterfowl. We arrived well before daylight, and we could hear the whistle of many wings as birds were startled from their feeding. When daylight came, we were greatly surprised and disappointed to find that what we had thought were ducks were American mergansers. Local residents later told us that these birds visited Dad's Lake in flocks of thousands each spring and fall.

The significance of these flights of fish-eating birds as related to the unusual bullhead population to be found in Dad's Lake was not realized for a number of years after the original observations were made. During this period, the writer had an opportunity to study a number of populations of stunted black bullheads in lakes and ponds in Illinois, but it was not until Kuhne's (1939a, 1939b) papers on Reelfoot Lake became available that I could account for the unusual fish population of Dad's Lake. Then it became clear that these mergansers were largely responsible. Each year during the period when these birds stopped at Dad's Lake they culled the fish population, removing any excess of small fish and preventing overpopulation and stunting, which are so frequently associated with these bullheads.

Kuhne's studies on Reelfoot indicate the importance of bird predators in maintenance of a fish population that has produced good fishing for many years. In 1937, the year his studies were made, anglers took 22,000 pounds of fish, commercial fishermen took 529,000 pounds, while a conservative estimate of fish taken by Ward's herons and cormorants was 400,000 pounds. The total crop of fish taken in 1937 was considered essentially the same as in other years. Yet fish-eating birds were consuming almost three fourths as many pounds of fish as were taken by commercial fishermen and anglers. Angling was considered good (1.6 fish per man-hour) and bass averaged 1.91 pounds each; crappies, 0.70 pound; sunfish, 0.37 pound, and catfish 2.39 pounds.

If the theory presented here that fish predators are essential for a well-balanced fish population, what have we, as the angling public, done to our fishing? We have declared war on fish predators, particularly fish-eating birds, until they are no longer abundant except on remote and inaccessible waters. Fish predators follow no open seasons, or bag limits and the size and kind of fish taken is limited only by the predator's ability to handle its prey, and what fish are available (Lagler, 1941). Anglers and commercial fishermen who have replaced the original predators are restricted in many states by dozens of laws of unproven value. The end result of these restrictions, coupled with the loss of most of the natural predators, which under presettlement conditions probably took more pounds of fish than are taken today by all fishermen, is overpopulation with accompanying stunting, and excessive competition between species of fish for food and space. In this competition the more desirable fishes give way to less desirable species. The fisherman is left a choice of lakes in which only stunted fish of desirable species may be caught or he may select waters in which desirable fish are so outnumbered by undesirables because of excessive competition that the odds against his filling a creel are great.

As is to be expected, natural predators are much less numerous on artificial lakes and reservoirs than in natural waters. Fishing is so poor in many of the older water supply reservoirs in Illinois that scarcely any attempt is made by the local people to catch fish. The typical fishing cycle of a water supply reservoir in Illinois is described by Bennett (1946a): "At the first spawning season (May-June) after the ......... reservoir is filled and stocked with fish, young of largemouth bass will be very abundant. These will grow rapidly to legal size and produce excellent bass fishing for about three years. Moderate numbers of young crappies, bluegills and other sunfish and bullheads may be produced during the first spawning period. These will grow rapidly to large average sizes and add to the excellence of fishing. Carp, buflaloes and suckers, as well as some other species of fish present in the stream flowing into the impoundment will move into the lake in small numbers and produce some young the first season.

"During the first few years the reservoir will be clear except immediately following heavy rains, and recreational attraction other than fishing, such as swimming and boating, will be at their maximum.

"Reduced recreational values will be apparent in about the length of time that the original spawn of bass survives (4 to 6 years). By this time the bass fishing will be largely gone. Crappies and bluegills will be present in such large populations that they will have become small, stunted, and unattractive to fishermen; carp and other rough fish will have multiplied so successfully that their bottom feeding activities will continually stir up the bottom mud. The lake will remain turbid throughout the year, regardless of periods of dry weather, and will have lost much of its attractiveness to fishermen and bathers. Many of the aesthetic values of boating will be gone. These conditions will be entirely the result of changes in the relative abundance of certain fishes, and as the primary function of the reservoir is to supply water, almost nothing can be done to bring back conditions that obtained in the early years of impoundment."

This cycle is repeated with each new reservoir that is built. The length of time required for the cycle to become complete may vary from 5 to 12 years, depending upon the length of time required for the introduced population of fishes to expand to a point where actual competition begins. The advent of competition may be delayed if the original stock of fishes contains a high per cent of carnivorous species which function with partial success as natural predators of small fish.

The theory of Ellis (1937) that high fish production in the early years of impoundment is the result of organic decay in the new lake basin is largely disproved by the fact that this cycle of production can be repeated as often as the reservoir is completely drained and restocked with small numbers of fish. Thus, it is clear that the problems involved in fish management are roughly similar to those of game management in which the well-being of certain land species become jeopardized by the loss of their natural predators. In both cases, unless measures are taken to control numerical gains made through natural reproduction, counter forces appear which largely eliminate the development of a harvestable surplus.

The amount of effort required to maintain a high rate of fish production in inland lakes and ponds (both artificial and natural) varies directly with some notable exceptions (1) with the degree to which natural predators are eliminated and (2) with the extent to which human predation varies from the original natural system of taking a fish crop. Wilderness waters largely manage themselves and frequently produce excellent fishing until their fame as fishing waters becomes too widespread. Semiwild waters, such as are found in the flood plains of the big rivers are often productive of angling and receive little or no management. At the other extreme are artificial lakes and ponds in highly developed agricultural and urban regions that require frequent attention if they are to produce a sustained fish yield.

With the loss of a natural predator-prey relationship the predator function must be assumed by an artificial human counterpart, in which the angler and commercial fisherman are predators of the larger fishes, and the fish technician assumes the nearly impossible task of holding the smaller fishes in check. In this task he begins with two strikes against him. He schemes to reduce his task by stocking new waters with simple combinations of fishes in which one or more predatory species will (he hopes) hold down the numbers of their young and the young of one or two omnivorous species (Thompson and Bennett, 1939; Swingle and Smith, 1940, and others). He may add fertilizer to smaller ponds and lakes, not so much to increase the total poundage of fish the waters support, because he probably does not need the additional poundage, but because fertilizer stimulates an algal bloom which shades out rooted aquatic plants and eliminates a hiding place for small fishes (Swingle and Smith, 1942; Smith and Swingle, 1942). He may attempt to use hybrids of such species as will hybridize, because by so doing he decreases the reproductive potential (Dr. W. E. Ricker, unpublished). He may attempt the destruction of fish nests. He may poison a part of a population (Beckman, 1943). He may sterilize the original stock to eliminate all reproduction and then resort to planting sterile fishes each year as basic stock for an annual yield some years hence. He may experiment with fish species "slightly out of habitat" with the hope of finding one or several that are able to produce just enough young to maintain a uniform population. He may attempt extreme fluctuations of water level to force small fishes into open water where larger fishes can devour them. He may use fine mesh wingnets, or seines, where their use is at all practical. He may find that one or a combination of these practices may allow him to function successfully as a predator of small fishes, but if his duties call him away from his task momentarily, he may return to find that the fish have escaped from his control.

After a few years of "doing time" as a predator of small fishes, he will begin to call for help. He will recommend that fish-eating birds be placed on the list of protected species and that the size limits, bag limits and seasons for all fishes be eliminated from the state fish code. He will make public speeches whenever he has an opportunity, calling on fishermen to fish their waters more heavily and encourage them to take everything they catch, regardless of size or species. As a last resort he will recommend draining and removing the fish population or if the lake cannot be drained he may poison the fish, restock, and bask in the warmth of the fishermen's smiles during that period when the fish are building up to the carrying capacity of the water, a period in which the fish are growing rapidly to large average sizes; a period in which the fish are readily caught. Sooner or later, the new fish population expands to the carrying capacity of the water and the process has to be repeated.

However, almost every fish technician will have noted a few exceptions to the thesis that a loss of natural predators eventually leads to a decline in fishing. Dr. David H. Thompson's unpublished study of the creel census record of the Rinaker Lake Fishing Club near Carlinville, Illinois, showed no significant reduction in the yield from this artificial lake over a 12-year period. This 12-acre pond is fished by about 100 families. It contains no rough fish and when fish are biting the caretaker makes a special effort to inform club members. The annual yield of fish is about 100 pounds per acre. No record of the intensity of fishing or the catch per man-hour is available for Rinaker Lake.

Bailey and Harrison (1945) found that small fish were scarce after midsummer in Clear Lake, Iowa, presumably because the fish population was composed of an unusual number of piscivorous species of fish. The authors do not mention the presence of any concentrations of fish-eating birds.

Black bullheads are never abundant or stunted in old strip mine ponds west of Danville, Illinois, while they are usually a dominant fish and stunted, in farm ponds. Their lack of ability to reproduce excessively in strip mine ponds may be associated with the limited area of shallow water.

There are a few lakes in Wisconsin, Michigan and Illinois that are well known for the unusual size of the bluegills they produce. Apparently, overproduction is controlled by some forces, at present unknown.

It is reasonable to assume that the states or federal service will never be in a financial condition to support a program of active fish management on more than a fraction of the waters used by anglers. This means that if the general level of fishing is to be improved, it must be brought about by the maximum use of natural forces plus the enlightened efforts of anglers and commercial fishermen.

The annual crop of fish taken from Reelfoot Lake (Kuhne, 1939a, 1939b) by birds, commercial fishermen, and anglers is indicative of the benefits to be derived by anglers from active cooperation with those natural and human forces that he usually considers detrimental to his sport. Here, in spite of an annual crop of fish of 400,000 pounds taken by birds, and the fact that commercial fishermen were allowed to take and sell all the angler's species including large-mouth bass, and further that commercial fishermen killed (1937) 95,000 additional pounds of fish (probably for the most part small game and pan fish), the ***average catch per angler was nearly 5 pounds per fisherman-day*** and the fish probably averaged as large as those taken from any other lake in the country.

In a previous paper (Bennett, 1943, p. 368) I presented a theoretical plan of cropping for small artificial lakes in which all sizes of fish are taken in proportion to their relative abundance. This plan of fish cropping might be carried on by a farmer or pond owner as a seasonal practice much as other crops are harvested (Bennett, 1946b) if minor changes were made in the Fish Code of Illinois. The same plan cannot be projected to larger waters because of the functional shortcomings of the type of gear involved and the amount of man power necessary for its execution. If most of our waters must of necessity remain unmanaged, what steps may be taken toward improving the general level of fishing?

All evidence points to the assumption that an annual removal of a substantial crop of fish from a body of water is essential to a sustained yield and for the general well-being of the fishes themselves. In spite of what the average angler believes, creel census figures indicate the relatively low efficiency of angling devices, particularly in removing a crop of fish from any water larger than a small pond. Thus, if the level of fishing is to remain high, the fisherman must take such measures as will assure that an annual crop of fish is taken.

This, first of all, requires that he reverse his own personal beliefs and fears—namely, that fish need protection, that waters may be overfished, that fish are unable to reproduce in natural waters with sufficient success to maintain their numbers. He must further be re-educated as to the true enemies of good fishing, namely, overpopulation and competition among the fishes. He must recognize his cooperators in the task of taking the essential yearly crop of fish—the natural fish predators and the commercial fishermen. Once this process of re-education has made substantial progress, attention can be directed to correcting existing legislation with the object of improving fishing. At present, current fish laws in many states are based on the following assumption:

Sufficient protection of adult game fish, with complete protection of these adults during the breeding season, followed by as nearly complete protection of young fish as is possible, will result in building up of large stocks of adult game fish.

This assumption is simple and logical, but it does not fit a group of animals that have been subjected to a high rate of natural predation since prehistoric times and have thrived because of a compensating reproductive potential.

Legislation designed to aid in a natural system of fish management should include (1) the complete protection of fish-eating birds and their nests until such time as their numbers approach their former abundance, (2) the removal of angling restrictions (except on "made" trout fishing), such as seasons, length limits and bag limits, to increase the efficiency of this method of taking fish, (3) the expansion of the commercial fishing industry to new waters not now fished commercially, and the regulation of the "take" of commercial fishermen to give assistance in harvesting a crop of such fish as are available, rather than limiting them to certain species of fish of specified lengths.

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## DISCUSSION

MR. LEE ROACH (Ohio): As some of you may know, we have nine lakes in Ohio which we consider experimental waters. They are being fished without closed season, bag limits, or length regulations. We have watched these closely during the last season. Our studies have given us no reason to return to size or bag limits or closed seasons on these experimental waters.

I know the question was raised that we are in the northern part of the country, and that northern waters might need these regulations, but on our experimental waters it hasn't panned out that way.

Commenting further on remarks a few minutes ago relative to the individual differences of various bodies of water—in the nine lakes referred to, fishing intensity varied from 5 fishermen per acre on one lake, to 57 on another. The number of fish caught per acre ranged from 7 to 253, a variation in pounds per acre from 2 to 55. The catch per hour varied from about 0.5 in one lake to 1.9 in another. Our fishing on these nine lakes (28,000 acres) totalled 612,000 man-days. The individual waters varied tremendously with respect to fishing pressure, fish removed, and catch per hour.

Relative to some of the other things which we are undertaking in Ohio, that fit right in line with the discussion here today, is a plan for undesirable fish removal. This removal must be made in the old lakes of large size by nets because they cannot be drained. Some of the smaller lakes now being built as a part of our fish-management program will be equipped with valves so they can be drained at the end of a period of time, which is variable, the undesirable fish removed, and the thing restocked with desirable fish.

I was interested in a couple of reports this afternoon, too, in regard to the age of the fish predominantly caught. Again our findings seem to coincide there. Most of the fish caught in Ohio fit within the second- and third-year class, which is predominant, that is, except in lakes where extreme overcrowding exists.

But it looks like most of our Ohio lakes go through a 5-year cycle. A new lake is built, reaches its maximum good fishing within a year, continues fair fishing for about a 3-year period, and then the fifth year begins to show a decreasing yield of fish.

DR. JAMES N. GOWANLOCH (Louisiana): I should like to express my appreciation for Dr. Bennett's excellent paper. You know very well, Dr. Eschmeyer, what experience we had down in Louisiana. It might make a rather humorous footnote to his history. Certain misled sportsmen in Louisiana perpetrated legislation that zoned the state into two zones and established a 2-month closed season on the black bass, the black crappie, and striped bass. The law was lobbied through without the Department of Conservation being asked its advice. We were against it.

What subsequently happened was rather humorous. The very legislator who introduced the bill begged for the privilege at the next legislature of introducing the bill to dispose of his earlier legislative misdemeanor, and to make the matter perfectly safe, two other legislators introduced corresponding bills under corresponding House numbers and that bill was the first bill in that session to be passed.

DR. H. S. SWINGLE (Alabama): I believe that before we follow Dr. Bennett's suggestion regarding fish-eating birds, we should do some further experimenting. I think we need to learn how to raise more predatory fish, rather than support the predatory birds with them. That may not be agreeable to folks who love birds, but I might remind you about 6 or 7 years ago we used to have Audubon folks come into the meeting and talk about the fish-eating birds.

At that time, I pointed out to them that most folks were very much interested in the birds that were rare, whereas very few of them got very much of a kick out of seeing a sparrow or a starling because they are too abundant.

We know a lot of ponds that have been in existence for 30 years which have kept a good balance without the use of fish-eating birds. We know of experimental ponds where the bass have been such good predators where we don't get enough bream survival to maintain the best bream fishing. If we eliminate the small fish from a pond, we automatically eliminate food for bass, crappie, and other fish which our sportsmen harvest..

DR. BENNETT: I admit I stuck my neck out on the fish-eating bird question. On the other hand, you must admit that we will never be able to manage most of our waters for angling, even if this might be possible in a small farm fish pond. You must also admit that the natural system of managing waters has, in the past, produced good fishing on some of them. Therefore, I am of the opinion that if we are to improve fishing generally, we must return to a natural system of fish management—with some exceptions, of course. We have an increasing number of artificial waters in which the fish managers can manipulate the populations, but on the natural, ''semiwild'' waters, a natural system of population control will be needed.

DR. SWINGLE: Our population now stands at nearly 150 million folks. We had to improve on nature in agriculture. We must do the same on our fish if we are to successfully meet the increased fishing pressure.

DR. BENNETT: You may be underestimating the fish predator. Under primitive conditions predators probably took many more pounds of fish per year than anglers and predators together take at present.

MR. JOSEPH HOGAN (Arkansas): A natural predator, in my opinion, is a big bass. He takes quite a few pounds of small fish.

DR. BENNETT: We have an experimental lake of about 18 acres that we have been studying. We have been working on it since 1941 and have had it open to public fishing since 1942. We have drained it every 2 years to census the population and have come to the conclusion that under what you would call fairly intensive fishing, say something over a hundred man-hours of fishing per acre of water in this 18-acre lake, the fishermen have never been able to crop more than a third of the available bass. Every time we have drained the lake we have taken bass out of it. The last time (1945) we took out all of the sublegal bass and put back only bass that were 10 inches or larger. The year before (1944) we had started a bluegill population against the dominant bass population which has been in there since 1941.

In 1944, we put in 129 adult bluegills. When we drained the lake in 1945 and took out the small bass, we had about 61 of those original bluegills still left. (They were marked so we could recognize them.) We had about a solid tubful of bluegills 1½ or 2 inches long. When we put back the big bass and the 61 adult bluegills, we had the best bass fishing in that lake that we have ever had.

In the fishing season following the 1945 census, instead of taking about a third of the available crop of bass, fishermen took somewhat under a half of the available crop of bass. Those 61 bluegills, under a dominant population of bass, really went to town. This year (1947) we were going to drain the lake again. Last year (1946) fishermen were catching hundreds of bluegills in that lake and there were bluegills everywhere. I am not of the opinion that the bass is a good predatory species. I wish we had some other fish more predatory by nature, something like the northern pike, perhaps, that would really go after the fish. In other lakes we have studied in Illinois, the bass, while it is a partial predator, it isn't a good enough predator to do the job—to hold the bluegills in check.

MR. M. MITCHELL: There is a lake called Lake Poplin which we started to fish in 1930. Bass were plentiful. Two persons could catch 300 bass per day, averaging 1½ pounds. Bass fishing has gone down consistently each year. You can see gars rolling, and the lake is full of mud fish. There are lots of birds. It also has plenty of protection for young fish. Where did the bass go?

On the contrary, I fished the headwaters of a Florida river a few years ago. It was hard to get to. You go down the west coast and then upstream about 42 miles. I never saw the like of bass in my life. There were plenty of predators, too. We need scientific research—we still need to find out a thing or two!

# TECHNICAL SESSION

## Tuesday Morning—February 4

*Chairman:* RUDOLF BENNITT
Rucker Professor of Zoology, University of Missouri,
Columbia, Missouri

*Vice-Chairman:* VALGENE W. LEHMANN
Game Technician, King Ranch, Kingsville, Texas

## NEW TECHNIQUES IN WILDLIFE MANAGEMENT

# GAME WATERING DEVICES FOR THE ARID SOUTHWEST

BEN GLADING
*California Division of Fish and Game, San Francisco, California*

In many parts of California and the Southwest, vast areas of range for small game exist; much of this acreage has ideal cover and food, but water is extremely limited. Concentrations of smaller game birds, such as the various species of western quail and doves, are to be found almost without exception in the immediate vicinity of available drinking water.

Many attempts have been made by sportsmen and game workers to make more water available for game in arid areas; these efforts have ranged from improvements in cover at existing watering holes through the installation of small storage tanks, windmills, and water dispensing devices, to the use of rain collecting and storage equipment. This paper will describe the construction of one of the rain collecting devices, tell of its use and development under experimental conditions, and summarize its present function in quail management in California.

At this point we wish to dispose of the academic argument regarding the necessity of water for western quail, the principal group of game to be benefited by desert water improvement. Grinnell (1927) was one of the first to point out water as being a prime limiting factor of quail in arid regions. He attributed much of the decline of quail to a general lowering of the water table and to deterioration of existing springs due to overuse by livestock. Vorhies (1928), on the other hand, cites instances where southwestern quail have been found in dry periods far removed from available water and, in general, minimizes the importance of free water.

It is true small populations of valley quail *(Lophortyx californica)* are found in summer drought periods several miles from available water. One such population investigated by Federal Aid Project California 6-R at Bitterwater, San Benito County, was located at least 2 miles from any waterhole. Investigations showed these birds were feeding on atypical foods, red berries *(Rhamnus crocea)* and the flower heads of a late summer composite. In the summer of 1941, this population was small (30 birds) for the area under study. At the same time, another population existing around a watering place in the same general locality was studied. On a similar size area, an estimated 300 birds were found. Their crops contained the usual pattern of valley quail foods for this season, primarily seeds of annual plants and domestic grain.

During the course of the FA 6-R study, in no instance were birds found existing without free water during the summer where there was not a correspondingly larger population at the nearest waterhole. In each case studied, some source of succulent vegetation was present; such vegetation is not generally found in arid areas in California at the height of the dry season.

At Bitterwater, a study of the movement of 106 birds banded at the above mentioned waterhole in the summer of 1941 revealed that much of the population moved shortly after the first fall rains from the vicinity of the summer water back to the dry area where the small summer covey was found.

Experiments were devised early in 1942 at this locality to determine what part artificial watering places might play in building up quail populations in waterless areas. The region was broken up into three experimental areas; one called the permanently watered front country, another the experimentally watered back country, and the third, the dry control back country.

Six watering devices of the vacuum type (Emlen and Glading, 1945) were scattered throughout the experimentally watered back country in the spring of 1942. These were replaced through the summer of 1942 and 1943 with self-maintaining watering units of the "gallinaceous guzzler" type (Glading, 1943). Free water has been supplied at these six sites in the experimentally watered back country from the summer of 1942 to date. During that interval the summer population has jumped from the original 30 birds to at least 348 birds in the summer of 1946. Summer populations in the permanently watered front country and the dry control area remained static. Unfortunately, a winter census was not made in the 1945-46 rainy season, nor has the one scheduled for 1946-47 been completed. We feel that we have definitely proved that these watering devices do build up summer concentration of birds in the south coast ranges of California. Whether this concentration builds up the winter (shooting season) population in the total area concerned, or whether these birds migrate to a more remote "back country," has not been definitely determined for this area.

A similar experimental installation of two "gallinaceous guzzlers" in Gambel quail (*L. gambeli*) range was started in the spring of 1945 when two units were constructed in the Mojave Desert on the slopes of the Providence Mountains, San Bernardino County. In each case these units were placed roughly 4 miles from existing springs. Cover and food for quail were present but no birds had been present in summer in the vicinity of the newly placed water. Gambel quail, however, were found here in low numbers in the winter. The guzzlers were placed in operation in February 1945; in August 1945, roughly 50 quail were observed concentrated about each of the units. About 200 birds were using each of these units in the summer of 1946.

A similar case was noted in the installation made at Cabazon in San Jacinto Pass, Riverside County, where a guzzler was constructed in February 1946. By midsummer up to 100 birds were using the device.

During the period 1942 to February 1946, 14 experimental watering devices had been constructed by the California Division of Fish and Game largely in cooperation with Federal Aid Projects 6-R and 16-R. By the summer of 1946, 13 of these had succeeded in attracting summer concentrations varying from 12 to approximately 300 birds per unit. The only unsuccessful one was installed in February 1946, and, therefore, has been in operation only one summer. Since several other of the above mentioned successful units did not attract birds the first season, this installation cannot be considered a failure as yet.

The first design of the "gallinaceous guzzler" as published in the California Fish and Game quarterly succeeded in fulfilling expectations as far as filling up from winter rainfall, storing water throughout the dry period, and attracting quail. So many quail were attracted after several years' operation in some cases, that a change in design was felt necessary in order to accommodate the hundreds that might water during a few hours of a hot, dry day. The device was radically redesigned, enlarging considerably the drinking area so that the water surface was much more available to birds. At the same time, the area of water exposed to evaporation was about the same as in the original. While this redesigning was in progress, construction methods were altered in order that all cement pouring could be accomplished in one continuous run of the cement mixer.

The so-called "gallinaceous guzzler M-2-A" that resulted is now being installed in all of our quail management projects. It is a subsurface, rectangular, concrete tank, 30 inches deep, 5 feet wide, 5 feet long, opening at one end to a sloping drinking trough or ramp which is as wide as the tank and approximately 5 feet long, sloping from the bottom of the tank up to ground level. The total capacity is about 700 gallons. A concrete partition, 3 inches thick and 30 inches high, runs the length of the tank and trough; this partition supports the roof. A baffle made of concrete slabs is placed on a plane parallel to the bottom of the ramp and about 7 inches above it; this separates the drinking ramp from the storage compartment and cuts down evaporation. Concrete roof, baffle, and shade slabs, 28 inches by 32 inches by 3 inches are poured in forms placed on nearby leveled ground immediately after the tank is poured, and, after setting, are removed from forms and mortared in place over the tank and drinking ramp. The tank is then covered with earth, leaving only the entrance to the drinking trough and the concrete shade slabs exposed (Figures 1-3). Blueprints of this device will be furnished on request.

The rain collecting apron also has undergone many changes in its development. Originally this apron was made by clearing and smoothing an adequate area uphill from the tank and covering it with a light road oil. Several years' experience with this type apron revealed that invading plants and rodents caused damage which made it necessary to repair the apron at least once a year. An oiled earth mix (California road mix) was then tried as an apron surface. This was more satisfactory but still somewhat subject to plant and animal invasion. At present, we are using a concrete apron approximately 3 inches thick. The surface of this apron is sprayed with bitumuls before it is set, thus giving adequate bond for any future necessary repairs with tar or other asphalt compounds. The apron is channeled into converging shallow troughs about 2 feet wide, running down the slope. Expansion cracks are troweled into the ridges so that cracks will not interfere with drainage to the tank. Costs are only slightly higher for the concrete apron than for the best of the oiled-earth types. The size of these aprons is calculated by dividing the

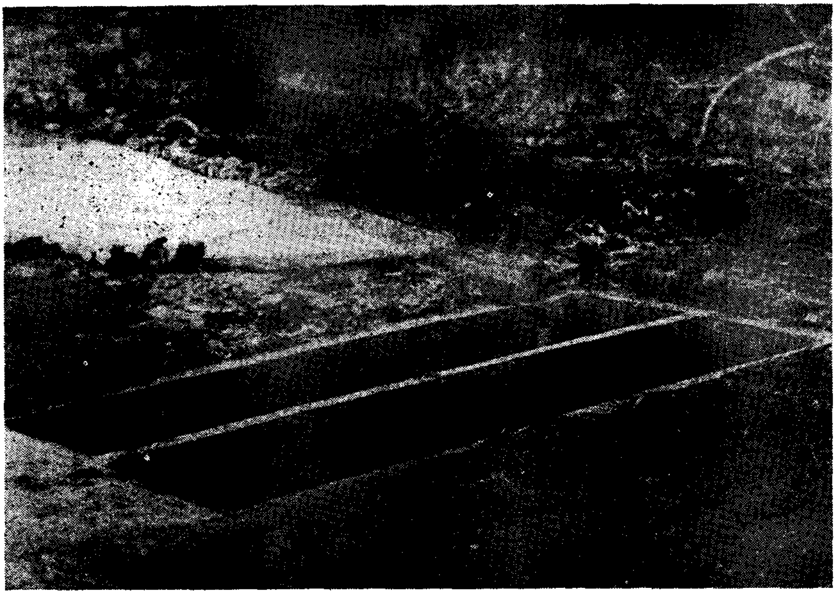

Figure 1. Completed tank and drinking ramp ("gallinaceous guzzler M-2-A"). A portion of the concrete apron is shown at upper left. Roof, baffle, and shade slabs will be installed in the next step of construction.

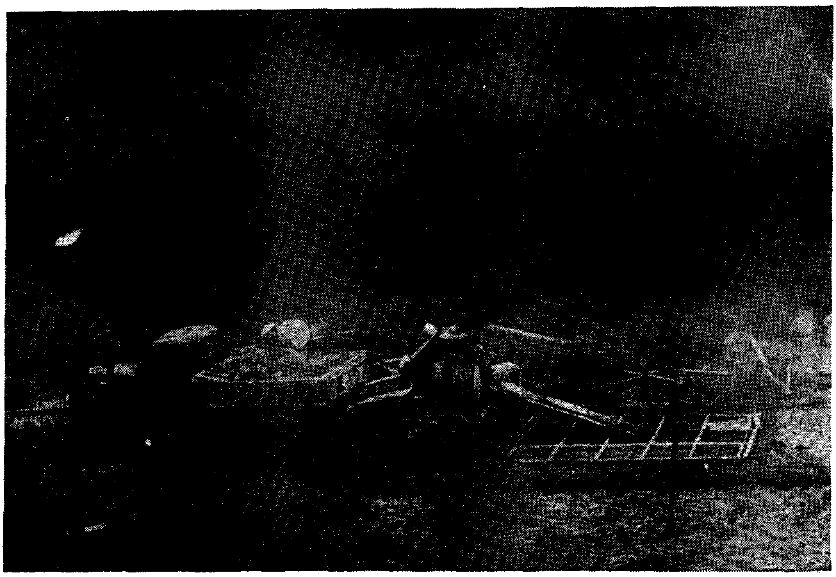

Figure 2. Pouring roof, baffle, and shade slabs. These are poured and tamped, then left to set for several days. The slabs are then removed from the wooden forms and mortared into place on the tank and ramp to form the baffle, shade, and ramp.

minimum annual rainfall by two and thus allowing sufficient area to fill the tank.

Total costs at present as determined by figures submitted by our present quail development crew (FA 26-D) are as follows on the last installation made: labor (8¾ man-days at $10 per day), $87.50; materials, including cement and fencing supplies, $23.83; equipment rentals, $18.50; totalling $129.83. Concrete aggregate in this case was creek gravel dug from a nearby river bed; its cost was included as labor and equipment rental. Roughly $15 worth of fencing and $20 worth of labor and equipment rental may be charged to fencing,

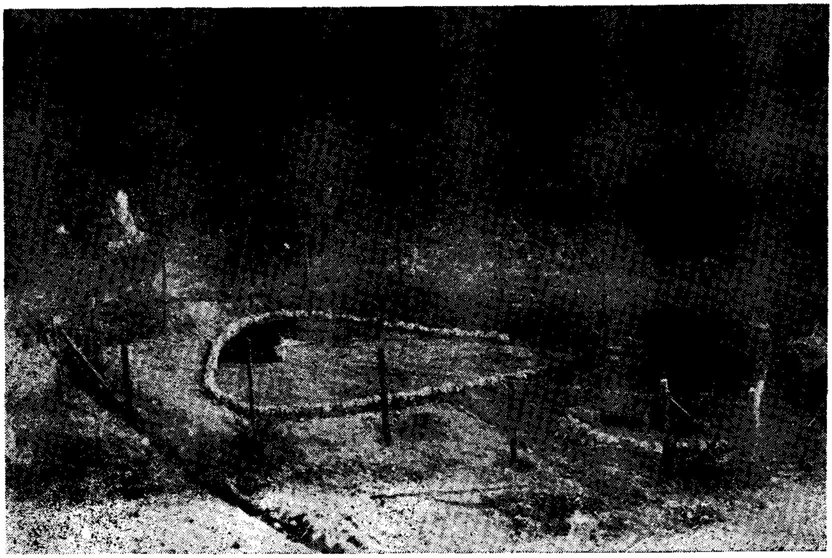

Figure 3. Completed fenced installation; rain collecting apron at left. The entrance to the drinking ramp and the shade slabs are the only parts of the unit exposed. The roof has been covered with earth.

bringing the total cost of the guzzler and apron down to about $95. In many desert areas fencing is not required and will be omitted in order that the fence structure will not attract waterhole shooters.

Experience has shown that if construction is sound, maintenance visits may be cut to about once every 5 years. Just what the life of the units will be is a matter of conjecture, but certainly 25 years is a conservative estimate. Costs per bird produced over long-time periods are certainly as low if not lower than under any other management method of which we are aware.

Since July 1946, the Division has employed one Pittman-Robertson crew (FA 26-D) to do quail management in the foothills of the area from San Francisco south to Santa Barbara and from the Pacific Ocean east to the San Joaquin Valley. Guzzlers are installed wherever their use is felt necessary at the discretion of the Project Leader. A similar project for the Sierra foothills is being planned.

We have budgeted starting July 1, 1947, two full-time Division of Fish and Game crews doing water development in southern California, largely in the Mojave Desert. The work of these crews will be almost entirely guzzler construction since there are vast areas in the Mojave which are not now supplied with water, whereas cover and food values are adequate. We feel we can get the most from our development dollar by this method.

We feel safe in recommending the guzzler as the best method for developing upland game in the southwest deserts and feel that the present model is adapted to easy construction and a minimum of maintenance.

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DISCUSSION

MR. MILO L. COX (Texas): I would like to know how far from water you feel it is necessary to install such a device for quail?

MR. GLADING: It is a matter of considerable debate and the answer will probably vary with species of quail and the locality in which they are found. At present, in the valley quail range, we feel that we can install these outfits about 1 mile from existing water or the most advantageous place. With Gambel quail, we feel that intervals of 4 miles will give us the best spotting.

MR. GEORGE A. PETRIDES (Ohio): Did you find an excessive amount of predation around these guzzlers?

MR GLADING: We found predation about the guzzlers. My answer is that before the guzzlers there were no predators and no quail. Now we have quail and predators.

MR. A. E. BORELL (New Mexico). Will one filling of the guzzler last throughout the year?

MR. GLADING: Yes. In no instance, in the 14 installations built prior to the summer of 1946, did they go down more than two thirds after the annual rainfall. As a matter of fact, if we build these things in the spring after the rains are over, we ordinarily haul water to fill them, but they have been filled in each instance by the annual rainfall. We have just gone through several very dry winters and they have still filled up, and we have been through a lot of dry summers. They maintain two thirds of the water. Maybe we have overengineered them a little bit.

# SOME NEW TECHNIQUES—HOOFED MAMMALS

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## INTRODUCTORY

The report and study of new techniques is a valuable activity in relation to game management. But it is hardly to be expected that the utmost familiarity with new or old techniques for that matter will lead to standardization. Nor would this be desirable. Treatises on methods, with their implications of standard treatments, have never overenthused the present writer. For each species and indeed each individual is unique. Conditions of climatic, soil, atmospheric, and topographic environment are never the same.

No ready program of action can be applied in a stereotyped manner, whether in research, restoration, or management. A resilience of mind and a judicious amount of scientific imagination are required on the part of the successful manager. He must be able to size up the problem under the conditions prevailing at the time and place where he is working.

The big advantage of studies of methods lies in the possible provision of additional tools for wildlife managers who have to solve a certain problem. When all is said and done, it is not so much on the tools themselves as on the use made of them that success and inspiration and effective accomplishment depend.

In an effort to turn up significant techniques, the *Wildlife Review*, *Pittman-Robertson Reports*, the *Journal of Wildlife Management*, and other periodicals, personal and official letters, and information relative to projects not as yet published on, in fact all available sources, have been drawn on.

It may be assumed that many, if not most, of these alleged new techniques date back at least to Aristotle if we had time to check the literature. There is very little really new under the sun. But, at the least, I have made an attempt to cite some recent applications which, to my mind, may well receive attention in the steadily expanding enterprise of wildlife management. My thanks to all of you who have helped.

Perforce, for lack of time, no attempt has been made to study new techniques in management of domestic livestock. A review of the literature and practice in the livestock field would undoubtedly

[1]Fish and Wildlife Service, U. S. Dept. of the Interior, Agricultural and Mechanical College of Texas, the Texas Game, Fish and Oyster Commission, and the Wildlife Management Institute cooperating.

furnish suggestions and additional tools for use with wild hoofed game, and should be provided for at the earliest possible time.

After the rapid survey of new techniques here reported on, the reviewer must express his edification in the light of progress being made. Through recent legislative and administrative developments, notably the Federal Aid to Wildlife Restoration and provision for the cooperative wildlife research units, together with other associated federal and state developments, a splendid body of energetic, intelligent, and well-trained young men is rapidly replacing opinion and superficial impression with fact and sound observation in a field where folklore has had all too large a place. The whole situation is one which should give great hope for the future of conservation in general and wildlife management in particular.

## CENSUS

### Refined Methods of White-tailed Deer Counting

#### Texas

On the extensive grazing ranges of the Edwards Plateau of Texas, where is to be found a maximum number of cows, sheep, and goats, as well as white-tailed deer, it is essential to good range management to have a knowledge of the food habits of deer and of domestic livestock as well, so as to calculate the degree of food habits overlapping or competition between the two. It is even more important to know the numbers of the deer, so as to be able to compute the respective proportions of the forage taken by deer, cows, sheep, and goats. Where range conservation depends on proper forage use as between particular numbers of livestock and particular numbers of deer, "trends" are insufficient. Thus the sufficiency of determination of population trends, as advocated by Hunter (1945b), is distinctly limited to those areas where the game populations are not occupying the same ground as livestock. Eventually the range manager, whether private or public, will have to know and regulate the numbers of his deer approximately as he does his cows, sheep, and goats.

It thus becomes of unusual importance to refine methods of deer counting.

In 1940, Halloran (1943), working under the auspices of the Texas Cooperative Wildlife Research Unit, made a tentative determination of the number of deer on the Aransas National Wildlife Refuge, using trails and fence lines as cruise routes. A comparative count by auto over an 8-mile route showed promise of becoming a good index of deer population. In this area Halloran found a direct correlation between morning temperature and number of deer seen.

In January 1942, Hahn (1945, p. 11) of the Texas Game, Fish and Oyster Commission first used a cruise census for deer based on Erickson (1940) and King. A total of 387 miles of census line was cruised and 2,149 deer observed along the census lines in a 2-year period.

Further counting was done by Texas Cooperative Wildlife Research Unit personnel on two 640-acre square deer quadrats set up in the fall of 1944. Deer numbers were determined by counting deer on strips of measured length and width. Counts made the last hour of daylight were most efficient, those made the first hour of daylight were next, and those made in full daylight were much less accurate. On one of the experimental sections counts made the last hour of daylight were 38 per cent higher, on another 96 per cent higher, than those made in hours of full daylight. Apparently one should double full daylight counts to obtain the true numbers on the counted areas.

During the last quarter of 1946, Hahn and Erlund have concentrated their attention on further refinements in deer counting. This work is being reported on by Hahn in the present Conference. Twenty-five counts on 27 consecutive days disclosed a definite correlation between deer movements, relative humidity, and overcast sky. It appears that the optimum weather for deer counting is when the relative humidity is below 70 per cent and the sky not more than 50 per cent overcast. Furthermore, they find it necessary on cruise counts of a mile in length, to make eight counts on consecutive days to obtain a fair index of deer population. On a 2-mile cruise line, on the other hand, only two counts are needed under optimum conditions.

The importance to range management of developing a simple and practical index to real deer population in a country where deer and livestock are in competition makes these rapidly developing new methods of extraordinary interest.

## South Dakota

*Pittman-Robertson Quarterly,* 6 (1):23, January 1946, refers to spotlight observations of white-tailed deer in South Dakota, the deer being identified by sex and age. It is reported (letter of January 7, 1947 from E. E. Ripper, U. S. Fish and Wildlife Service, Federal Aid) that, "These counts were made at night, by using a panel delivery truck fitted with spotlights. The current for the spotlights was furnished by a generator driven by a small gasoline powered motor. This unit was mounted in the truck. The spotlights were mounted on the roof of the cab and operated from the driver's seat. The counts of white-tailed deer were made in agricultural fields and clearings along the foot hills of the Black Hills in areas used by this species as winter range."

### Minnesota

Of four census methods tried out (pellet count, roadside track count, aerial survey, and roadside tally), the last named showed the most promise, appearing to give satisfactory information on the trend of the deer population (Schrader, 1944). At best, however, it seems to the reviewer that the roadside tally needs a good deal of support in order to be very reliable.

## Censusing a Mule Deer Herd by Sampling

### California, Oregon

Cronemiller and Fischer have developed a successful method of censusing a deer herd by sampling methods (Cronemiller and Fischer, 1946). In this instance, a single count of the whole herd had to be made within a short period in order to avoid duplicating or missing a part of the herd. Obviously, repeated counts by localities seemed to be required for determining migrations. In this migratory deer herd, the bulk of the movement was in the nature of an imperceptible drift typically 10 to 20 miles a month. Forty-nine lightly used roads and trails provided fairly good random coverage of the area. These were designated as sampling strips. For each strip an estimate was made of the area visible in which deer could be counted. Strip counts were converted into deer per square mile, and this figure applied to the area of the unit to which the strip applied. In order to keep track of deer movements and determine total use by deer of each area and type, the work was repeated at intervals of 10 days to 2 weeks. The work of two men for 10 days was required for each complete count. Thirteen counts were made in the winter of 1943-44. After the deer had reached the winter range about mid-December, it became apparent that one count (after all the deer had reached the winter range) was adequate to indicate trends and appraise the results of management.

Cronemiller's experience indicates that control has been secured of a situation which would formerly have had to be cared for under hit and miss methods without adequate supporting factual information.

## Dragging Techniques to Determine Abundance of Black-tailed Deer

### Oregon

According to Einarsen (in letter) the Big Game Management Division, Oregon Fish and Game Commission, drags the roads in the evening and makes track counts the following morning to determine abundances. In East Texas Lay used this technique in 1936 to secure quantitative figures on opossums.

Pellet Group Counts, White-tailed Deer

Oregon

Einarsen (in letter) advises that McCain is applying pellet group counts on study plots to determine degree of utilization by mule deer for the U. S. Forest Service in Oregon.

## AERIAL BIG GAME SURVEYS

### White-tailed Deer

Wisconsin

A method expected to be continuously more widely used is that of Aerial Deer Surveys used by Fenney and his associates (*Wisconsin Wildlife Res. Prog. Report,* 5 (2) : 19, September 1946). The object was to secure further information on number and yarding of deer. The work was done by trained pilots and observers in light planes of the Cub or Aeronca class cruising at 300 to 1,000 feet high and about 80 mph. If aerial survey photos were unavailable, other maps proved usable. The method used in eight northern Wisconsin counties and five central counties proved satisfactory in determining the boundaries of yarding areas, new winter concentration areas, and degree of deer concentration by tracks on the ground. But actual deer count census by airplane over forest areas in Wisconsin is not possible.

Minnesota

On the other hand, experimental work in Minnesota indicated that aerial censusing of deer in wooded terrain was entirely practicable where stands of coniferous timber comprised a relatively small percentage of the area.

Deer could be seen from altitudes of 350 to 400 feet *(Pittman-Robertson Quarterly,* 5 (3) : 105, July 1945). December or January were found to be the most favorable months for the counts depending on the character of the winter. Snow should be deep enough to increase visibility but not to force deer yarding. Frozen lakes were available for emergency landings. A Piper Cub with skis was thought to be the ideal plane.

According to Morse (1946), aerial census is accurate, timesaving, and economical. The average cost per square mile, up to date, has been $1.09, a phenomenally low figure when compared with other kinds of surveys.

In a recent letter (January 20, 1947), Paul R. Highby points out that recent experience indicates the superiority for this work of a Stinson Voyager 150 at a 500-foot altitude carrying two observers counting a quarter mile strip. The larger four-place plane permits the carrying of emergency equipment as a precaution against a forced landing.

North Dakota

According to *Pittman-Robertson Quarterly,* 6 (2) : 65, April 1946, deer have been removed from the Lower Souris National Wildlife Refuge the last three deer seasons by controlled hunting. The area of approximately 30 square miles was censused by plane the day before the opening of the season, when 850 deer were observed, and again shortly after the hunt when 368 deer were counted, 317 head were removed by hunting, and approximately 165 left the refuge temporarily during the hunt.

This is a novel but in some localities promising means of keeping track of the results of controlled hunts.

## Pronghorned Antelope

### Arizona, Texas

In order to determine fawn-doe ratio, concentration areas and numbers of antelope in northern Arizona, a Taylorcraft[2] plane was used (June 1945) with a cruising speed of 65-75 miles per hour at 150 to 200 feet altitude, observing a strip one half mile wide. Approximately 39 hours of flying time were devoted to the census. Five areas were censused and 1,157 antelope counted. The average fawn-doe ratio was 1 : 2.72 (Marvin H. Frost, Jr., *Pittman-Robertson Quarterly,* 5 (4) : 133, October 1945). Aerial census of antelope has been successfully used in the Trans-Pecos region of Texas since 1944. (O. F. Etheredge, Survey, Antelope Status (Unit G), *Pittman-Robertson Quarterly,* 5 (4) : 156, October 1945). According to the Arizona workers the aerial survey is superior to census by car (*Pittman-Robertson Quarterly,* 5 (3) : 86, July 1945).

### North Dakota

An airplane survey was conducted during the latter part of February and March. Future antelope censuses will be conducted in summer, preferably the latter half of August (*Pittman-Robertson Quarterly,* 5 (3) : 112, July 1945).

The annual antelope census (*Pittman-Robertson Quarterly,* 6 (2) : 66, April 1946) was carried out during the latter part of August

[2]Interstate planes have been used also (*Pittman-Robertson Quarterly,* 6(2) :42, April 1946).

and the early part of September, a two-plane Aeronca tandem trainer being used. Flights were made east and west following a highway as a base line. Flying time was 34 hours, cost of the plane and pilot $282.62. The plane was flown at an altitude of 700 feet, which enabled the scanning of a strip one half mile wide. Census runs were made at 3-mile intervals and a total of 347 antelopes counted.

A device was adopted by the counters which seems to have promise for similar census work elsewhere. To secure a population index the plane was flown indiscriminately over the range in loops and circles at an altitude of 300 feet, and a scanning width of one quarter mile was used, counts being made during a definite time period. Index values resulting from these flights gave 40 antelope per hour in 1943, 43 per hour in 1944, and 63 per hour in 1945. "The upward trend in the antelope population was also indicated by the regular census," it is explained.

### Montana

A state-wide aerial census was conducted in December 1943, and in January, April, and May 1944 *(Pittman-Robertson Quarterly,* 6 (2): 59-60, April 1946). Of the Aeronca Chief, Taylorcraft, and Piper Cub, the latter was found most satisfactory. Flight lines were plotted in advance. A 20 per cent coverage was deemed sufficient in areas where topography was uniform and cover similar. Approximately 121 hours of flying time were required to complete survey and 21,000 square miles were covered.

A total of 120 antelope was trapped and moved using an airplane to drive the animals to the trap.

### Oregon

In September 1945, a Piper Cruiser was found efficient for work in Oregon because of its slow flying speed and maneuverability. Twenty-nine hundred miles were flown in 32 hours flying time. Flights were made at 500 feet altitude, except when herds were sighted and when terrain permitted, when closer approach was made. A scanning width of a mile was made in the census flight. A total of 1,646 antelope was counted *(Pittman-Robertson Quarterly,* 6 (2): 67-68, April 1946).

## BIG-GAME TRENDS

### General

### Colorado

Hunter (1945b) has pointed out methods of determining big-game trends. These involve sample plots surveyed either from the air or the ground, utilization plots and maps.

The method has merit for areas where big-game problems may be cleanly set off from those of competing livestock, but it is not by any means the answer in game-livestock competition areas.

White-tailed Deer

Wisconsin

The use of balsam as an indicator of browsing by investigators in Wisconsin, (*Pittman-Robertson Quarterly,* 6 (1): 26, January 1946) suggests the desirability of recognition and classification of those plants eaten by deer on a starvation basis. In this way trends toward overpopulation can be easily recognized. But the method can only be used where deer only are responsible for the observed condition of the vegetation.

## BIG-GAME MANAGEMENT STATISTICS

General

Colorado

Hunter (1945a) has given facts regarding the hunting of big game in Colorado, which, like the material cited above, should be routine in all big-game areas. Information presented include total legal kill, head of big game estimated shot and not harvested, sex, age class, and localities involved in the kill, number of individuals killed per square mile, weights, hunting intensity, sex ratio, distributon of the kill through the season. Finally a table compares the kills for years 1934 to 1944, inclusive. Like the material presented by Robinette and Olsen, this information on hunting statistics should be in the hands of the wildlife manager in every big-game region.

Chambers Island White-tailed Deer Removal Project

Wisconsin

Since an overpopulation of deer on this 3,000-acre island in Green Bay had resulted in the serious depletion and even extermination of deer browse, an attempt was made by Feeney and his associates, through a hunt on October 18, 1945, to remove the deer (*Wisconsin Wildlife Research Progress Report,* 5 (2): 6, September 1946). The consensus of opinion prior to the hunt placed the deer population at about 200 deer. During the hunt 250 were removed and it was estimated that 50 to 200 still remained on the island.

The deer removed were carefully weighed and population ratios determined. Through this method a precise analysis was secured of such ratios as buck fawns to doe fawns (1:1.2), adult does to all fawns (1.5 : 1), adult does to all yearlings (2.5 : 1), and adult does to yearling does (4.7:1), ratios which are usually impossible of determination by field observation.

Wholesale samplings of this kind covering measured areas are of extraordinary interest and there should be more of them. Incidentally, this application is a significant example of the potential value of islands for big-game management studies as well as for upland game birds (Einarsen, 1945 and Nestler, 1946). Alert wildlife research workers should be on the lookout for suitable island experimental areas!

### Mule Deer Production

#### Utah

As pointed out by McAtee in the *Wildlife Review,* Robinette and Olsen (1944) have reported on the fawn crop of mule deer in central Utah. They give figures on fawn mortality, sex ratio of fawns, weights at birth, age classes, number of does without young, hunting wastage, winter mortality, and net increase.

Need for this kind of information is obvious in every locality in which big game exists.

## CARRYING CAPACITY, DEERYARDS, FOREST, RANGE

### Carrying Capacity of Range Lands

#### Arizona

While directed to the problem of estimating carrying capacity for livestock, Dasmann's conclusions (1945) appear to be equally applicable to big game. On ranges jointly used the problem applies to both. Dasmann points out the inadequacy of forest density measurements and palatability ratings. The former do not measure the quantity of forage, the latter vary according to livestock use and preference in different forage types. "The use of actual or estimated forage weight measurements, with allowance for metabolic reserves and livestock preferences, is basically sound, and should permit the more reliable determination of carrying capacity."

To the reviewer it appears that while forage density studies, and particularly estimates of palatability, have merit as methods in particular restricted areas, these cannot safely be generalized over large tracts of country. Undoubtedly reliance on actual or estimated forage weight measurements are much safer, whether the area is large or small.

## Experimental Feeding Pens and Carrying Capacity Yards, White-tailed Deer

### Wisconsin

According to *Wisconsin Wildlife Research Progress Report,* 5 (2): 2 (and following), September 1946, experimental feeding pens, each 66 feet by 165 feet, were installed by Feeny and his associates to appraise the good or bad effects of winter feeding. Diets included straight balsam, hemlock, and birch, alfalfa and balsam, unlimited control with hemlock, limited control with cedar, clover, alfalfa, balsam and corn, alfalfa and corn, Garver's feed. Weights of deer were checked as the experiment proceeded. Balsam proved to be a poor deer food. Several mixed browse diets failed to maintain deer weights. "Some straight diets of commercial concentrates carried deer through the test period with little or no loss in weight."

An experimental carrying capacity enclosure, made up of four 1-acre pens, was used to determine the amount of natural food required to carry deer through the year. Under the conditions prevailing it was found that one acre would not carry three deer satisfactorily—in fact, even one deer per acre through the year resulted in heavy browsing, although the area did carry one deer for one year.

These tests are noteworthy in that they are an attempt to substitute detailed facts for estimates and opinions.

### Michigan

Similar studies have been conducted in deeryards in Michigan (letter from L. A. Davenport through H. D. Ruhl; see also Davenport, Shapton and Gower, 1944, pp. 144-148). A 1-acre plot in a deeryard was fenced deer proof. Deer were introduced and the amount of browsing controlled. This gave the number of deer days of browse on an area, although not the yield in pounds, which, by the way, is highly desirable though hard to get. Davenport came closer to this objective by cutting unit areas in deeryards and feeding the resultant cuttings to captive deer. Some findings: The average coniferous yard in Michigan produced approximately 2,625 pounds of edible browse per acre cut. Since controlled feeding experiments indicated that about 450 pounds of browse are required to carry a deer through a 90-day yarding season, the cutting of one acre in a coniferous deeryard should carry approximately six deer through the average Michigan deeryarding season. Mixed swamp conifer and hardwood type produced approximately 2,300 pounds of edible browse per acre cut, or enough to carry approximately five deer through an average deeryarding season. Young hardwood reproduction, with hard maple predominating, produced less than 500 pounds per acre cut, or enough to support about one deer through an average season. But controlled experiments showed that deer are unable to survive a yarding season on hard maple browse, so, as Davenport points out, cuttings in this type would be beneficial only when other species of browse are available to supplement the hard maple. In the light of Nichol's determinations (1938, p. 38) that 2.35 pounds of food are consumed by deer per 100 pounds of deer per day, the amounts of browse required seem rather high, but other factors may well be involved. E. Swift (1946, p. 60) of Wisconsin says a mature deer requires an average of about 5 to 7 pounds of first-class browse daily per hundred weight. This is more than twice what Nichol found in Arizona by actual test.

Management of Deeryards, White-tailed Deer

Michigan

According to Ruhl and Bartlett (letter December 31, 1946):

"Where timber in deeryarding areas has grown up and self-pruned or has been overbrowsed we are cutting timber on state-owned lands on a rotation basis—one-twentieth or thirtieth of the area each year. The area is selectively logged if possible or clear-cut if necessary to prevent loss by wind throw.

"The idea is to furnish immediate food from cedar tops and additional food in later years as second growth comes in. Cutting is done only during the winter deeryarding months. Here in Michigan, with a reorganization last summer, these 'game cuttings' were integrated with 'forest cuttings.' Now all cuttings on state land, but more especially those that affect deer, must be checked by both the district forester and district game manager. Either can initiate a cutting project, but it must have the O.K. of the other before it can be put into effect.

"In relation to deeryards the procedure is this—both forester and game manager cooperating—

"1. Inventory of Yards
    *Timber*—By 40's
    Size
    Density
    Food condition
    *Deer*
    Concentrations
    Food available
"2. Management Plan
    40's to be cut, when
"3. Action Program
    Overseeing cutting operations"

This development, involving a farsighted game management technique, and depending for fullest success on integration with forest management, should be helpful in the deeryard country.

### A Deer Browse Survey Method, White-tailed Deer

### Minnesota

S. E. Aldous (1944, pp. 130-136) has developed a simple and apparently effective method of determining quantitatively the condition of winter deer range browse in Lake States deeryards. Average values are determined of density and degree of browsing on one-hundredth acre plots spaced at predetermined intervals throughout the deeryard. By multiplying the average density by the average degree of browsing values for use are obtained.

The big trouble with this method is that it is applicable only where deer alone are browsing. It is useless in an area where not only deer, but also cows, sheep, and goats, for example, are all feeding on the range, since there is a good deal of overlapping in food habits, and sometimes all the species will graze on the same browse plant.

### White-tailed Deer Damage to Forest Reproduction

### Wisconsin

Feeney and his associates (Deer Management Research Project 4-R, *Wisconsin Wildlife Research Progress Reports,* Vol. V, No. 3, November 1946) have tried three methods of survey:

1. Arbitrary sampling of 2 miles of strip (one chain wide) to each of two sections of each township. Results inconclusive.

2. Random cruise, based on percentage counts as to stocking seed trees, and damage, current and previous.

3. Survey of 161 one-hundredth-acre plots, 24 plots to a section, in forested areas. The method was suggested to get the data on a statistical basis. The figures obtained were too small to be significant; on the other hand, if used they would have been positively misleading.

Feeney feels that appraisal of damage to forest reproduction will have to be of an indirect nature, taking into account relative palatability and comparative degrees of browsing. Of the three methods tested so far, the random cruise was most satisfactory.

Incidentally, it may be noted that these methods cannot be used at all to secure, for example, information on deer damage where more than one class of game or domestic livestock is present on an area.

### Management of Elk Herds

### Colorado

According to L. Swift (1945, p. 115), "Herd control is a part of a sound big game program, and anterless as well as antlered deer should be removed." This is stated to be the present management policy of the Colorado Game and Fish Department.

The author further states that, "Some of the Hermosa elk crossed the Divide to the Dolores River drainage, where they became associated with a few native animals." Herd control had been undertaken also by open seasons including the taking of a limited number of females. "Unless hunting is sufficient to provide local control in future years, overstocking can be expected in a short time," says the author. The number of antlerless licenses has been increased considerably on all problem areas, and much progress made in suiting numbers to carrying capacity. "A further application of management principles can be expected to keep the herds in adjustment with the environment."

## FEEDS AND FEEDING

### Palatability Ratings, White-tailed Deer

### South Dakota

In a significant contribution made in 1946, Hill emphasizes the importance of palatability ratings. Calculations for white-tailed deer in the Black Hills region were based on 319 stomach samples killed from 1941 to 1944. Percentages of plant species were compared with percentages available as shown by range analyses. The ratio of utilization to availability expresses the palatability rating. Seasonal preferences varied, necessitating the selection of key species to fit the season. Since the deer did not thrive on plants of low palatability and made no use of unpalatable plants, Hill concluded that the latter should be given no weight, and those of low palatability little if any weight in calculating range carrying capacity.

One has only to state these facts to be impressed with their importance. But since the palatability of deer feeds as calculated by Hill would vary greatly from place to place and from season to season and year to year in the same place according to conditions (number of animals, weather, competition), too much reliance cannot be placed on the particular palatability determinations.

Evidences of Malnutrition, White-tailed Deer

South Dakota

Harris (1945, pp. 319-322) studied the symptoms of malnutrition in deer. Among these he lists loss of fat over the rump and saddle, gradual disappearance of the fat that lies between the hide and body cavity, loss of sleekness in appearance, loose hide, reminding one of a man in an oversized suit of clothing, fat absorption within the body cavity proper, absorption of fat around the intestines and kidneys, absorption of the spot of fat within the body cavity on the heart; rich, creamy-white color of the bone marrow due to fat cells replaced by red and jelly-like marrow which means the fat cells have been absorbed; backbone like the teeth on a buzz saw, hide susceptible to easy tearing when skinning, no fat outside the body cavity.

Although general appearances may not reveal the extent of the ravages of malnutrition, if one keeps in mind the signs listed, he can really tell the stage of undernourishment characteristic of the individual he is examining.

The Bone Marrow Test, White-tailed Deer

Michigan, Wisconsin

According to this test (E. Swift, 1946, p. 43) ". . . a deer getting sufficient food has a fatty, opaque marrow, whereas a deer which has reached the final stages of starvation has a reddish, translucent, jello-like marrow. In all cases examinations have been made on the middle bone of the hind leg."

"That rich creamy-white color of the bone marrow was due to fat cells. Now the deer begins to absorb those fat cells. Gradually the marrow turns red and finally becomes jelly-like, which means the fat cells have been absorbed" (Harris, 1945, pp. 319-322).

Winter Feeding of Mule Deer

Colorado

Carhart (1945) calls attention to some results of winter feeding in Colorado. Mortality was high, almost a third, when the animals had to depend principally on stock feeds supplied them in winter. Fawns died in highest proportion. One thousand three hundred sixty-five deer were lost at areas where winter food was furnished. On other ranges nearby where deer rustled their own browse feeds, only three carcasses were located. It is of interest that apples and peach tree trimmings added to the hay greatly reduced losses. It appears that dry alfalfa hay scratches the lining of the mouth and gullet which becomes infected and this kills many animals. The conclusion which may be logically reached by others as well is that stated by Carhart, namely, that "the feeding of deer, except in the most extreme and critical periods, and then only for a short time, is costly, unsound, and actually destructive."

### Utah

In a thoroughgoing test of winter feeding Doman and Rasmussen (1944) utilized a feed-ground localized near Logan, Utah, and in addition a four-pen corral, each pen 50 by 100 feet, equipped with feed and water troughs and facilities for trapping and weighing the deer, for particular determinations of the effect of winter feeding. It was concluded from these controlled feed experiments that none of the supplements fed, including chopped and unchopped alfalfa, native grass hay, sweet clover hay, and a considerable variety of other material appeared to replace native forages successfully. The more the deer became dependent on supplemental feeds and less on native forage, the greater were the winter losses. The entire policy of supplemental winter feeding was concluded to be impractical as a welfare program. Death losses among deer during late winter and early spring on, and adjacent to, the food-grounds resulted almost entirely from lack of sufficient available food. Autopsies showed no disease as the primary or even as an important cause of loss, although the deer were often infected with various external and internal parasites, and pneumonia frequently was found to be the immediate cause of death. At best, these investigators concluded that supplemental feeding was only partly successful, and expansion of feeding program of doubtful value. The practical management suggestions coming from this is as stated by the authors, "Removal during the regular hunting season should be heavy enough to reduce the population on all ranges where supplemental feeding has been necessary." Another important point is that "Management of the herds and planned removals during the subsequent hunt should be based more on the conditions of the forage than on the numbers of deer counted or estimated during the winter census."

### Food of the Black-tailed Deer

### British Columbia

A thoroughgoing ecological analysis of food relationships of the Columbian black-tailed was made by Cowan (1945). Topics considered included major plant communities, feeding habits of the coast deer, trees, shrubs, woody plants and ferns, and their utilization by deer, food habits as determined by stomach analysis, the coast deer and the Douglas fir, water and mineral consumption, effect of deer browsing on food plants. Milacre quadrats were used to determine utilization of the various foods. Some analyses were evidently made of deer droppings. Seeds of *Amelanchier rosa* and *Gaultheria* germinated after passage through the digestive tract. "Thus the deer may serve to distribute such forms."

Logging was found to be directly responsible for producing improved conditions for deer. However, as a deforesting agent it increases carrying capacity up to an optimum in approximately 10 or 15 years. A logging program is suggested under which clean logging of blocks of land for approximately one square mile in area be practiced, with unlogged blocks left between the logged areas. It is estimated that this arrangement would produce near optimum conditions for coast deer. Seedling with Douglas fir with approximately 1,200 per acre provides conditions under which maximum deer damage can be expected. Where seeding natural or artificial gave rise to seedling in excess of 12,000 per acre, deer damage was unimportant. Cedar was the only winter browse species found that had a palatability as great as that of Douglas fir. "Much of the logging industry of the Northwest has been built around the Douglas fir. As the stands of Douglas fir become depleted, the western hemlock, which is not eaten by deer, is coming into increasing favor as a timber tree."

### Crude Protein Determination of Black-tailed Deer Food as an Applied Management Technique

#### Oregon

Protein analysis of black-tailed deer foods was found to be a valuable aid to knowledge of food values on occupied habitat. If food deficiencies show up, the problem is to redistribute the deer to suitable habitat. Evidently this is a difficult problem, but Einarsen (1946b, p. 312) says it can be accomplished, in this instance by continued field attention and the exertion of hunter pressure where needed to force deer from poor to good habitat.

## SOIL FERTILITY AND WILDLIFE

### Work of Albrecht and Associates

#### Missouri

The work of Albrecht (1944) and his associates has attracted pointed attention at previous conferences. Probably no one has done a more convincing job in pointing out the vital role of minerals in nutrition and the importance of soil fertility in animal production.

The same principles influencing domestic livestock are effective on wildlife. With Albrecht's injunction (1944) to make wildlife natural by feeding it naturally through the soil probably all wildlife managers will heartily agree. Here again the success of the wildlife conservationist is closely linked up with accomplishments by the soil conservationist.

### An Extreme View by Denny

#### Missouri

In somewhat the same vein is a contribution by Denny (1944, p. 321) who points out that:

"1. The distribution of all species of wildlife is primarily determined by soil types and availability of the elements necessary for animal life; and only secondarily by cover and water, and climatic factors.

"2. The abundance of any species of wildlife within an occupied range is basically determined by the fertility of land, and secondarily by the type and intensity of land use, which we submit is also primarily determined by the fertility of the soil.

"3. The quality and size of the individuals of the species within the limits of its range are also fundamentally determined by the available fertility of the soil, and are only slightly affected by the intensity of land use and the scarcity of suitable habitat.

"4. Perhaps most important of all is the conclusion that wildlife production, like any other crop of the land, is in proportion to the available fertility of the soil and that land which is too infertile to produce satisfactory crops, grass, or livestock is also marginal for wildlife."

The reviewer feels that wildlife managers generally will agree particularly with Mr. Denny's statement No. 4. If wildlife is produced, it must be produced on fertile soils. With Denny's extreme view on soil fertility as the primary cause of distribution, abundance, quality, and size of individuals, wildlife managers will probably be less willing to agree. To say, for example, that climatic factors are secondary to soil types, affecting the distribution of wildlife, for example, is absurd. The best soil in the world, if covered, as in Greenland, by a thick layer of ice, would not support very much wildlife. Furthermore, work in Texas seems to show that in the range country, even a productive soil does not improve the quality and size of white-tailed deer, if the intensity of land use, through grazing by livestock, is too high. Thus in some particulars, Mr. Denny, although rightly emphasizing the importance of soil fertility, has made his presentation in so extreme a form as to be unacceptable.

## TECHNIQUES BASED ON ECOLOGICAL ANALYSIS

### Studies of White-tailed Deer on Unfenced Experimental Areas of Restricted Size

### Texas, British Columbia

In 1942-1943, Hahn (1945, p. 28) undertook to cover two census areas, each 1,280 acres in size, in Mason and Kerr Counties, Texas, respectively. Hahn was able to secure some excellent figures in numbers and mortality of deer under different conditions, but concluded that less than 50 or 60 per cent of the dead deer were found. After conference with Hahn, the Texas Cooperative Wildlife Research Unit in the fall of 1944 set up two square experimental areas in the Edwards Plateau region, each 640 acres in size, in the hope of making more accurate determinations of numbers and mortality of deer. These areas were actually measured and their outside boundary lines marked by flagging and brush-cutting. In addition, cross-lines were cut both ways, through the middle of each section. A field man spends approximately 2 weeks of each month on each one of the experimental sections, making counts of the deer, checking all dead deer found, studying deer food habits, tallying the deer population according to age and sex makeup, and recording climatic and vegetation conditions.

It is of interest that persistent search of the section in Mason County between January 5 and April 13, 1945 showed a loss of 31 deer dead and 2 deer sick. Of 48 deer found dead or sick on or near this section, 2 (4 per cent) were bucks, 13 (27 per cent) does, and 31 (66 per cent) fawns. Two (4 per cent) were not classified in the field records. Between January 7 and January 20, 1947, 96 dead deer were found on this same 640-acre experimental section. The die-off was the result of an overpopulation of deer and livestock, coupled with a cold Norther which began December 30 and which severely impaired the food supply on the range.

In one instance an aerial photo of the area, furnished through the courtesy of the Soil Conservation Service, has provided an ideal map of the section.

These deer quadrats are affording definite information of value.

In his deer studies on Vancouver Island, Cowan (1945, p. 123) also has used a representative tract of approximately 640 acres, although it has been differently handled.

The writer would like to know of any other deer quadrats of this or similar types in use in other parts of the country.

## Application of Ecological Analysis to White-tailed Deer Management

### North Carolina

The *Pittman-Robertson Quarterly,* Vol. 6, No. 1, January 1946, pages 18 and following, summarizes a report made by Dr. B. W. Wells of the Botany Department of the North Carolina State College concerning a cover type survey begun in June 1945 and completed in August. The soil and vegetation are analyzed. The ecological history of the area is summarized. A line transect method (Bauer's) was used in conducting the survey. Aerial photographs were interpreted based upon field surveys of representative sample areas. Furthermore, a series of permanent quadrats was established. Cover and frequency percentages for different plants were determined. Based on this ecological analysis some very positive recommendations relative to deer environment are made. Among these extension of the drainage system by construction of connecting ditches is recommended, with a view to improvement of drainage and lowering the water table in portions of the bog. A second suggestion is that the entire bog be black-burned at intervals of 4 to 6 years for each subdivision, the density of cover to determine the fire interval. No area should be permitted to become so dense as to interfere with movement of deer or to furnish the basis for a conflagration type of fire, it is pointed out. The bog should be burned from the center toward the edges, where possible, to minimize the possibility of fire getting out of control and burning too large an area. Third, annual burning of the savannas during midwinter when fire will not enter the bays was recommended.

Experiments under controlled conditions to test the effect of mineral supplements, especially calcium and phosphorus, on immature deer were also suggested. The small size of the deer on the area and the inferior antler development and conformation might be the result of mineral deficiencies, it is pointed out.

It is obvious that thoroughgoing ecological analyses of deer environments, and indeed game environments in general, are very much needed and afford a promising contribution to big-game and small-game management.

## Relation of Weather to White-tailed Deer Kill

### Vermont

That weather and physiography affect both the seasonal and daily legal kill of Vermont deer was asserted by Foote (1945, p. 59). Excessively warm, dry days or stormy days with deep ground snow cover, both resulted in decreased kills. An early season produced lesser kills because the better hunting weather came later. Foote goes so far as to suggest that weather conditions and time of open season might be used to secure herd reduction when this becomes necessary. If a swift reduction is needed, a late season may be most feasible. An earlier season probably would result in fewer deer being taken.

Here is a subject which should have a lot of study and which gives promise of furnishing a useful tool in one of the most difficult management problems, namely the control of deer populations.

### Maine

Like Foote, Fobes (1945) in Maine finds weather important. He points out that the deer kill is at a minimum during hunting seasons without snow and when temperatures and precipitation are below normal. Ideal hunting conditions are afforded by a damp forest floor that allows the hunter to stalk his game quietly.

## A Winter Study of Mule Deer

### Nevada

C. M. Aldous (1945) reports on a study of deer on a somewhat overpopulated area in the Nevada National Forest. Findings include information on sex ratio, utilization of browse, nutritive value of browse, removal of deer, and herd regulation. As pointed out by Aldous, this is one of the few areas occupied by mule deer in which damage to the range was discovered in time to take remedial measures before a critical stage developed. The author recommends taking a yearly local census immediately after the snow has disappeared from the flats on the winter range, and the first green grass has appeared. Sex ratio counts should be made before any bucks have shed their antlers, and should be based on at least 500 individuals. In Nevada, measurements were made of twig lengths to determine utilization of browse before the deer enter the winter range, usually in December and again just after the animals leave for the summer range. The most nutrients are shown by chemical analyses to be in the leaves and bud ends of browse plants. On ranges which are not overused, deer selectively take off only the tips or tender portions of the stems, but on overgrazed ranges they take practically everything. Management practices should be based on the deer population in relation to acreage of winter range, the winter and spring condition of the animals, the winter sex ratio, and the degree of browsing use.

## Application of Ecological Analysis to Mule Deer Management

### California

Studies of the abnormal situation surrounding the California mule deer in Sequoia (Dixon and Herman, 1945) should have a definite bearing upon problems in other areas. The Sequoia area is over-populated with deer. Mineral deficiencies are evident. Feedings by tourists is indirectly, if not directly, harmful. Parasitism is pronounced. The concentration of deer in places where they expect to be fed by tourists has caused overbrowsing in the immediate areas and constant grazing in restricted tracts. As with stomach worms in Texas, the life cycles of the stomach and intestinal worms of these Sequoia deer are direct and closely tied up with grazing by the animals. Eggs of the worms are deposited with the fecal droppings of infected animals and develop in the soil. Then immature stages of the worms crawl into blades of grass that are eaten by deer along with its food. The intensity of infection is directly proportional to the amount of grazing done by deer and also to continuous use of the same pastures by the infected deer. Some species of browse have been actually killed by overuse. This forces the deer to utilize the meadows for forage. Resulting from this is a heavier infection with parasites, such as stomach worms. Concern is not only with the increased parasites but with the reduced nutritional values of the grass forage as compared to browse which should be the normal food of the deer. Lack of mobility of the resident deer population in these areas is pointed out as one of the chief causes of present conditions.

The reviewer is impressed with the lesson repeatedly enforced, not only in Sequoia National Park but widely over the West and Southwest, that concentration of grazing as referred to here accentuates many difficulties, among them that of the big game securing proper nutrition and also the definite increase in the number and seriousness of parasites. In part, at least, the remedy is obvious, namely, to reduce the surplus populations of deer through harvesting not only bucks but also does.

## Removal of Competition from Mule Deer to Save the Bighorn

### New Mexico

Preliminary food studies based on field observations indicated competition between the bighorn and mule deer in the San Andres National Wildlife Refuge (Halloran, 1944) in New Mexico. Regulation of mule deer numbers to take the pressure off the small herd of bighorns has been arranged for in cooperation with the New Mexico State Game and Fish Commission.

## Protection of Black-tailed Deer After Forest Fires

### Oregon

Protection of a remnant stock of black-tailed deer after the Tillamook Burn in Oregon was found by Einarsen (1946a) to result in increases averaging from less than 1 to more than 15 deer per section of land. The protection was afforded by a temporary refuge. Closure to hunting was from October 1939 to October 1942.

Here is an instance where a simple management measure had far-reaching beneficial effects on deer numbers.

## Application of Range Management Concepts to Study of Pronghorned Antelope

### Texas

In Texas in 1946 Buechner (paper presented at this conference) has applied range-management methods to a practical problem in competition between the pronghorned antelope and livestock (cows, sheep). Methods of investigation include the recording of antelope-minutes (antelope feeding on a given plant for one minute is an antelope-minute's use of this plant) to determine vegetation preferences following the method used by Cory (1927) to determine preferences of cows, sheep, and goats, determination of number of antelope per animal unit, based on comparison of average weights of antelope and mature cow, close study of the vegetation to determine effect on range of use by antelope, calculation of degree of competition between antelope, cows, and sheep based on overlapping food habits, and the computation of the economic status of the antelope. Buechner's findings indicate that the antelope is an asset to the cattle ranchman rather than a liability. There is only about a 20 per cent overlap in the food habits of cattle and antelope. With sheep there is more direct and serious competition. In general, in Texas antelope restoration projects in pastures occupied by sheep have not been successful.

Only through careful and patient studies of this sort, involving a detailed knowledge of the food preferences and general ecology of the important game and livestock concerned, can the problems of competition between game and livestock be satisfactorily worked out.

The importance of proper adjustment of big game and livestock through reasonable adjustments of each to the other and especially to available natural feed on the range has been emphasized by Stoddart and Rasmussen (1945).

## Making the Elk More Secure Through Provision of Two Distinct Winter Ranges

### Wyoming

The Wyoming Game and Fish Commission (Anon., 1946), by transplanting elk, is trying to re-establish old-time desert winter range so that a larger population can be supported in the state. This is a management feature which is being widely used in other states as well and with other species of hoofed mammals. In the case of the elk in Wyoming, the animals were forced into forested areas by a combination of restricting factors. Consequently, the elk form strongly migratory habits in going from the untenable summer range to areas favorable for winter survival. Along migration routes there was great slaughter and on winter ranges high losses due to crowding and competition. Winter feeding is expensive and is accompanied by direct unfavorable results among the elk. As a system it limits their increase and spread. If the Game Commission is successful in re-establishing the old-time desert winter range, a large population should be supported in the state.

## Roosevelt Elk

### Washington

Schwartz and Mitchell (1945), have used a number of up-to-date methods to secure basic management information. Topics included in their account of the Roosevelt elk include life history, molting, herding tendencies, antler development, mating and breeding, calving, migrations and movements, seasonal migrations, movements and feeding, tagging studies, feeding habits, actions, plant utilization, stomach analyses, mineral requirements, ranges, winter ranges, westside drainages, south-side drainages, north-side drainages, summer range, forage studies, enclosures, sample plots, utilization studies, population studies, estimated elk populations, age classes and sex ratios, losses, malnutrition and disease, calf losses, predatory animals, cougar, bobcats, coyotes, black bear, elk damage, hunting season, and antler classes. It will readily be seen the study has been a comprehensive one. It was found that the elk usually returned to the same winter range each season, even when the ranges were depleted. Over a hundred different species of plants are eaten, although 25 form the main diet. Elk browse during the winter, but in the spring, summer, and autumn, grazing and browsing are about equal. Plants protected within fenced experimental exclosures, the authors point out, showed marked recovery in growth and vigor, and the comprehensive approach showed by the authors, and the insight they have exhibited toward the proper management analysis of the elk and the problems of its management are to be commended. As with so many of the hoofed mammals, overpopulation was found to be highly prejudicial to the welfare of the elk. In all, 112 elk were found dead during the study, 21 from malnutrition and disease, 10 were cougar kills, and 8 from accidents. In 1937, more than 400 elk died of malnutrition and disease. Overpopulation is a factor in increasing the incidence of parasitic infection among the animals, also.

If more wildlife managers would tackle their problems with the comprehensive point of view of these authors, we would be able to base our wildlife management enterprise on much more solid ground, than is sometimes the case.

### Grazing Management of the Tundra for Reindeer

#### Alaska

In a valuable bulletin Palmer and Rouse (1945) have reported a study of the tundra, based on 77 widely distributed quadrats clipped to simulate grazing of different intensity and observed over a period of up to 14 years. Particular attention was given to the lichen vegetation so important in winter. Sampling of numerous areas indicate a forage production of 5 to 7 tons of lichens, air dry weight, to the acre. In tundra lichen types, the range was quick to react to any disturbance. "The length of time required for its recovery is directly proportional to the degree of disturbance." So far as known to the writer this bulletin is the best available source for the direction and development of range management for reindeer. Its value is based largely on its practical ecological approach, associated with accurate, quantitative, as well as qualitative observation, over a sufficient period of time to mean something.

## TRAPPING BIG GAME

### Mule Deer

#### Montana

According to *Pittman-Robertson Quarterly,* 6 (2): 60, 61, April 1946, mule deer were trapped by two methods. One of these is of extraordinary interest. This method used on the Moiese area of the National Bison Range was as follows: The area was divided into many pastures by fences. A round-up by six riders was tried with good success, explains the report. "Two groups of three horsemen stand out behind a herd of mule deer and work them as a single group into a 600-acre pasture or holding pen. Some difficulty was experienced keeping the animals headed in the right direction. As would be expected, the animals often attempted to cut back through the line of drivers. A few escaped in this manner. By keeping the entire herd bunched as a single unit, cut-back troubles were held to a minimum. When a herd is driven into the 600-acre holding pen it is left overnight. The following day the deer were worked down the lane into cutting pens, then into loading pens for tagging and de-antlering. From there the deer were driven up a loading chute into a truck. Numerous drives over a one-month period yielded 201 mule deer."

The writer of this summary is lost in admiration of the game managers or cowboys, or whoever they were, who successfully drove mule deer. So far as known this is the only instance in which driving of mule deer has been successful. One of the most outstanding cases in the history of game management was the attempt by a man named McCormick to drive a large number of mule deer off the Kaibab Plateau during the years of congested deer populations in that area. Needless to say, the attempt, although strongly supported by large numbers of persons and given official backing, was a complete failure. The experience of the Montana boys, though, indicates that there may be something to be said for attempted drives of mule deer under certain conditions.

### Rocky Mountain Bighorn

#### Colorado

It has always been thought that the trapping and transplanting of Rocky Mountain bighorn would be one of the most difficult of big-game restoration jobs. Hunter, Swen, and Jones (1946), however, have tackled the matter and apparently with success.

In the Tarryall Mountains of Colorado the Rocky Mountain bighorn sheep comprise probably one of the best known and largest individual herds in the United States. A corral and trap were so set up that the bighorns became accustomed to using them. None of the sheep were taken until after the period of the rut, November 15 to December 20. Iodized block salt and hay were used for bait. The sheep were moved 140 miles to a liberation site. The trip took 5 hours. Thirty-three bighorns were trapped altogether. 30 of these were transplantd, 2 killed, and 1 escaped. The 30 animals trapped and transplanted cost $84.17 per head, the State share being $21.04. Details are of interest to any wildlife managers who have similar problems in their jurisdiction.

## MISCELLANEOUS

### Belling of White-tailed Deer to Determine Movements of Individuals

#### Texas

In 1942, an attempt was made to definitely determine the extent of movements of individual deer on a ranch in Mason County, Texas (Hahn, 1945, p. 25). Thirty-one deer were trapped at intervals from September 1942 to March 1943. Individuals were ear-tagged and marked with red enamel so they could be recognized at a distance. Deer were usually seen within 50 to 1,000 yards of the trapping area; and the greatest distance a marked deer was observed was 1.5 miles.

In 1945, the Texas Cooperative Wildlife Research Unit, in cooperation with Hahn, conducted a similar trapping experiment on two experimental tracts 640 acres each in size. In Mason County, 17 deer were trapped, and in Kerr County, 37. Each deer was ear-tagged and provided with a bell, does with small bells with high tinkle, bucks with a larger bell with a low tinkle. The bells enabled the observer to trace movements of the deer whether by night or day. Most of the deer remained within 1.5 miles of the trapping locality. The greatest distance covered by a belled deer was 8 miles. A number of the deer were traced to intermediate distances.

This method of trapping, marking, and belling, here used extensively for the first time, so far as known, to assist in determining individual deer movements, seems to possess merit. It will enable the field observers to substitute definite records for tentative observations or opinions on deer movements.

### Determining Age of White-tailed Deer by Measurements

#### Vermont

Refinements in age determination of deer, a highly desirable objective, were worked out by Foote (1945, pp. 43-53). "Weights and measurements taken on deer in eight counties of the state since 1937 indicate that age is the single most important factor governing size and weight of Vermont deer." In aging deer, four antler beam measurements were taken, two on each horn, at right angles to each other. These were found to be one of the most reliable indicators of age, providing a sufficiently large sample is available. A gradual, quite regular increase was found also, with advancing age in total length, shoulder height, length of tail, and hind foot. Age also was found to govern weight, general size, and antler development.

To the reviewer such measurements as total length, shoulder height, and length of tail would seem to be of little value. These are very difficult to take accurately, as compared, say, with antler beam measurements or length of hind foot. Furthermore, in the white-tailed deer there is much variation in the development of the horns, especially the number of points, with age, so much so that it is felt these also are pretty unreliable. But antler beam diameter seems to be dependable, provided a generous number of specimens is available.

### Repellents—White-tailed Deer

#### Alabama

*Pittman-Robertson Quarterly,* 6 (1): 2, January 1946, reported deer damage to net coverings of turkey traps. The deer also consumed the shelled corn bait. The difficulty was relieved by moth balls (naphthalene) scattered about the traps. These were effective as a deer repellent but apparently had no effect on turkeys.

### Blood in Urine Stains to Show Lungworms in Mountain Goats

#### South Dakota

A possibly useful point in diagnosing the status of mountain goat herds is the presence of blood in the urine stains of the animal. This indicates the presence of lungworms (Harmon, 1945: 149-151).

### Dropping Analysis for Lungworms in Bighorn

#### Montana

According to the *Pittman-Robertson Quarterly,* 5 (4) : 147, October 1945, Couey writes that the degree and seasonal variation in infestation of lungworms can be shown by dropping analysis. "The irritation and occlusion caused by heavy lungworm infestation results in verminous pneumonia," and is probably a direct cause of death.

### Mineralized Salt Blocks for Bighorn Sheep

#### Colorado

A comprehensive study of the bighorn in Rocky Mountain National Park by Packard (1946) tentatively suggests deficiency of mineral soils in granitic soils of present ranges as the cause of declines in sheep numbers. There may also be feed shortages. The stamina of sheep is reduced, and susceptibility to lungworms and coccidia increased. Further debility is associated with the incidence of pneumonic bacilli and the death of the sheep through hemorrhagic septicemia. The placing of mineralized salt blocks on the range is recommended.

### Restoration of Bison

#### Wyoming

According to Cahalane (1944), the Park Service hopes to have wild buffalo, not semidomesticated cattle, in the Yellowstone National Park. This is a key to new methods of management which are being applied to the buffalo in that important area. Unregulated increases brought about a serious condition by disease and range depletion are obvious, and artificial feeding of buffalo became necessary. New methods of management include reducing the numbers of buffalo to a level the range will easily support, and eliminating artificial feeding, cutting out all ranching operations, removing buildings, fences, irrigation ditches, and getting rid of other livestock developments in the Lamar Valley area.

In the opinion of the reviewer, this program and policy of the National Park Service in relation to the buffalo might well be considered in connection with other forms of wildlife management in other places. While artificial management of one kind or another is called for in many situations, nevertheless, it is felt that management through natural means has not been explored or tried in anything like the degree it should.

### Antelope Hunt Management

#### Texas

Ranchmen in the antelope range were visited in the spring of year, and arrangements for hunting made when desired by owners (*Pittman-Robertson Quarterly*, 6 (1) : 24-25, January 1946). Censuses were made of some ranches. Permits issued number 529 based on counts of available antelope. Twenty per cent of permits were reserved for landowners. Permit holders were assigned to specific ranches. Hunting permits cost $5.00 per hunter paid to the state, and landowners charged up to $25.00 for hunting on their ranch. The subsequent season this was increased to $40.00. Hunting was for bucks only. One hundred seventy-three animals were taken in 1944, 185, in 1945.

For further information on the controlled antelope hunt in Texas see Lay (1946).

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## DISCUSSION

CHAIRMAN BENNITT: Thank you very much, Dr. Taylor. I think I should say what we conceive to a principal value of such papers as this and the three which are to follow: When the Transactions are published, a full bibliography will, of course, appear with each paper. It seems to me that such a paper gives one an overview of a large field of research and will serve a very useful purpose both now and later.

Now, have you questions concerning any of the individual techniques which he has discussed, or have you other techniques to suggest in order that future readers of the Transactions may find the gaps filled?

DR. TRACY I. STORER (California): There is one aspect of the work on hoofed mammals that has always been neglected. Dr. Taylor mentions the belling of the white-tailed deer in Texas. There seems to be nothing, or very little, on methods of marking these animals for identification of the individual.

Now, in our work with a good many other species—upland game birds and small mammals particularly—we have paid a lot of attention to identifying the individual so that we can follow its course through life to a greater or lesser degree. We have practically nothing that has been put forth as a means of identifying the individual in deer.

Some years ago, at a conference in San Francisco, we discussed the marking of mule deer in California, and we actually got around to putting tags on a few fawns. I suggest that the big ears of the mule deer could be put to very good use. I am thinking of the practices that are used with rats, where we punch various patterns of holes; but instead of holes, I suggest that the large area of the ear in the mule deer would be very appropriate for cutting—notches, or cutting off the top of the ear, or cutting out rectangular segments—so that individuals could then be recognized at considerable distances with the naked eye or with the aid of binoculars. That was howled down by my committee associates who said that the sportsmen wouldn't stand for it. This was 10 years ago or more. I wonder if anybody has made any attempt in this direction, either with marking ears or with the use of cold brands.

There was a very stimulating paper in the *Journal of Mammalogy* last year by Mr. Chitty of the Bureau of Animal Population, Oxford, England, in which he showed that they were able to mark rats, using a cold brand and putting very conspicuous marks on the animal.

Again, I recall suggesting this practice with respect to ground squirrels. I was told that the branding material necessary to mark a ground squirrel effectively would probably kill the animal. I was howled down again; but actually Mr. Chitty and his associates have done it with rats in England, and I imagine that we could do it here. I would like to know if anybody has worked in that direction.

CHAIRMAN BENNITT: That is exactly what I mean by "filling the gaps." These are very pertinent questions. I am going to ask Dr. Taylor to comment on them.

DR. TAYLOR: I can't say much about the marking proposition in general. We have found the belling system very useful indeed. We mark deer with bells of two different kinds. On the male deer, we hang a bell that is large and has a deep tinkle; and on the does, we put bells that are small and have a high-pitched tinkle, so that we can tell the sex at any time of day or night that we hear them.

We have been able to trace the movements of deer which are trapped in localities as much as 8 miles away, and we have been able to discover such things as that most of the population—or at least 50 per cent of it—stay close to where they are trapped originally. We have been able to get together a good deal of information just by noticing that the deer whose bell you hear—a buck or a doe—was trapped at a certain place but later heard at another place. In this way you get information that is pretty hard to get otherwise.

MR. W. L. JOHNS (South Dakota): We have about 10,000 antelope in South Dakota, and for the record we would like to have the Doctor's paper include the fact that we have done a lot of work on census in South Dakota.

We also are proud to have here at this Conference a man that is a game warden. He came down here at his own expense because he is interested in this deal, and he has probably done as much as most of the folks in the United States on this deer business. I would like to have Dave Harris of our state, who has done a lot of this work, take a bow—Dave Harris from South Dakota, out in the Black Hills.

CHAIRMAN BENNITT: Stand up, Mr. Harris.

. . . Mr. Harris arose and there was applause. . .

MR. DAVE HARRIS (South Dakota): I was interested in Dr. Taylor's paper and Dr. Storer's comment on the marking of deer. I think that the belling system is something absolutely new. In regard to the branding of deer by the marking of the ears on the huge mule deer, I sometimes think that that might not work out so well, due to this fact: Oftentimes, after you mark a deer you never see that deer again until it has been killed. After a deer has been killed, you must have a definite mark that any one will notice and know that it is a mark.

In notching ears, ordinarily no one would know who put that notch on, or what it meant, except the man or his associates who did the marking. So long as you are going to catch the deer anyway, I would suggest that a metal tag be used. Perhaps you could color that tag and it would indicate to you through binoculars that that deer was tagged in a certain year.

The belling system I think is very good. It will at least call you to where the deer is, and a deer that is just marked might sneak away from you and you might never see him as long as he lives. We have experimented in South Dakota with live-trapping and tagging mule deer and white-tailed deer primarily, to study their migration routes within our state.

MR. W. C. ROCHELLE (Texas): A few years ago the State of Texas gave me three deer—a buck and two does. I still have them. They all have metal tags in their ears. However, these tags don't show the year in which they were tagged. I don't know whether it's feasible to do that or not, but I think it would have some additional advantage. The tag is about the size of a 25-cent piece, and it stays in very well.

MR. BEN GLADING: I wish to comment on Mr. Harris's remarks. In the study of herds which migrate back and forth across the Oregon line into California, the Oregon Commission, cooperating with us, has trapped a number of deer and they have used just about all the systems that have been brought up here, except notching the ears.

However, the deer that are belled are also painted on the side with a large number, and in addition there is a metal tag bearing the year and number. That holds a large red or yellow celluloid disk that flashes as the deer faces you. It's in the ear—fitted right inside so you can see these big red or yellow-eared brutes. The paint, of course, is transitory, but it lasts for as long as necessary in any one year.

DR. STORER: I just wanted to recall that in some of our work we belled individuals and this gave us useful information on migration, but I would like to ask Dr. Taylor how bells can be distinguished. Do your wildlife technicians have perfect pitch? Can they identify them?

DR. TAYLOR: All we do is tell the bells that the does and bucks wear. We can tell those, but not any others.

MR. N. E. MCEACHRON (South Dakota): One more comment relative to the notching of deer's ears. I, like Harris, came from the Black Hills originally. I found in my 30-odd years of experience with deer herds that a great deal of fighting is done among the deer in the rutting season, and it's almost impossible, in my opinion, to tell the difference between a notch from fighting and one which is put in by man. I have seen many put in by man, and I believe the idea would be far-fetched. Something different would have to be devised, I believe. The tag method is still the best.

# REVIEW OF NEW TECHNIQUES—FUR BEARERS AND OTHER SMALL MAMMALS

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Crabb and Emik have reported on "Evaluating rat baits by field acceptance trials on Guam."

Rodent control for prevention of epidemic disease, under new conditions, presented problems for investigation. Choice of the best baits within the limitations of available quartermaster supplies was imperative.

Each bait trial used a unit consisting of five feeder stations which were placed in likely cover from 30 to 200 yards apart. Each station was a boxlike covered enclosure with four entrances and contained a circular arrangement of eight feed dishes with four 4-ounce samples of bait. Opposite dishes held the two portions of each bait. Baits were rotated in a regular manner each day for a 4- or 5-day trial.

Various baits were evaluated against a standard bait of plain rolled oats, which, however, was repeatedly demonstrated to be the cereal of choice.

Three oily bases were excellent adjuvants (helpful additions) in the order—ground copra, copra oil and peanut butter.

Tables and statistical calculations are given in detail. While the specific results are only locally applicable, it is believed the method should serve anywhere.

Chitty and Shorten (of England) reported their "Techniques for the study of the Norway rat" populations, to determine efficiency of control measures. They consider (rightly, we believe) that absolute density of population is less important than the relative size of original (precontrol) and residual populations.

Their census baiting method consists in offering a surplus of food before control (census prebait) and determining the wheat consumption. Bait is then withdrawn and poisoning is done, after which a surplus is again offered (census postbait). The percentage reduction in consumption is taken to indicate the degree of success, i.e., the percentage of reduction of population. A food recording machine (the reviewer would call it a "food consumption recorder") is fully described, and graphs made with it are reproduced.

Not only is the time of day of feeding shown by this machine, but the rate of consumption is determinable. "Watching" by a concealed observer showed much individual variation in reactions, and also proved the Norway rat to be extremely suspicious of any change of position of food or apparatus.

Marking of individual rats was done by the unique method of using a depilatory. The marks thus made are easily seen, but last only 2 or 3 weeks.

Tracy I. Storer suggests, "Field rodent control by destruction of burrows." Discussing the success of controls for certain burrowing rodents, specifically the pocket gopher and the California ground squirrel, the author points out that however successful the control program may be, it does not go far enough, in that it does nothing to the habitations of the pest species. That is, the burrows or tunnel systems in which the animals live are left undisturbed. These are not only excellent protected runways for re-entry of a new population, but also are, in effect, so many furnished houses for the immigrants.

It is pointed out that where destruction of these habitations can be economically accomplished, it is probable that such a practice would greatly retard re-infestation. A subsoiler reaching to a depth of 12 to 18 inches would destroy most pocket gopher tunnels. War surplus explosives and former military personnel trained in their use are suggested as a means of destroying the deep burrows of the California ground squirrels. The reviewer would expect this plan to be of more value in ground squirrel than in gopher control.

An interestingly simple and effective technique is reported by John H. Lewis as a "Planting practice to reduce damage by jackrabbits."

On the Mathews National Wildlife Refuge, jackrabbits (*Lepus californicus*) have been a constant threat to high yields of grain, especially barley, planted for the winter feeding of waterfowl. Since rabbits do not like rye, a rod-wide strip of that grain is planted around the barley fields. This acts as a barrier, since the jackrabbits do not penetrate the rye far enough to discover the barley.

Kalmbach and Welch have continued their work on "Colored rodent baits and their value in safeguarding birds." Following the earlier experiments with nonpoison colored grains, new experiments were conducted in which poison grain, both colored and uncolored, was exposed in approved rodent control manner. Since these experiments were carried out on birds, though for a legitimate rodent control purpose, it may be questioned whether a review belongs in this paper, and we pass it with this brief mention.

While the results are encouraging and show progress in the colored bait technique, it is pointed out that further work is needed to determine hues of optimum deterrent effectiveness, economical and fast colors, without objectionable taste, and not broken down by the poison to be used. Selective use of colored poison grain is a valuable technique.

Shaler Aldous and Dave Harris reported on "Beaver management in northern Black Hills of South Dakota." This was a restoration project to be accomplished by moving beaver from populous sections to new sites. Objectives sought and accomplished were not only beaver production, but soil and water conservation, production of livestock and wildlife watering places, improved habitat for other wildlife and trout, retention of water supplies for fire control, and stabilization of stream flow.

To maintain these objectives colonies must be as permanent as possible. To attain this the harvesting practice must maintain a *minimum* number of beaver per colony in order to conserve the food supply as long as possible. Therefore, excess beaver were regularly removed by summer transplanting or by winter pelting.

Planting site selection includes not only ample available food supply and a minimum water supply equal to the flow of a 1-inch pipe, but a choice of site which will avoid flooding highways, farms, etc.

Site preparations include temporary construction of a dam below the food supply; a check dam farther down stream which seems to curb the desire to wander; temporary house (bank den), constructed by digging and covering a trench in the bank of the pond; and some aspen or willow sticks for a few days food, placed at the head of the pond.

Precautions: Herd released animals into the den entrance, if necessary; never release strange animals together at the same site—members of the same family only; plant in late summer or fall, when preparation for winter is due.

A sample beaver survey and trapping record is presented.

The *advance construction* is new to this reviewer. It seems to have paid dividends.

Shaler Aldous reports on "Live trapping and tagging muskrats" to secure needed information on winter movements of the animals. For this purpose 367 individuals were live-trapped, ear-tagged, and released. A new method of tagging was used, in which a small (2 by 7 mm.) Monel metal fingerling tag was placed on the ear. For this size tag the ears of even 4-ounce young were amply large. These tags remained in place well for several months and a dead 3-pound animal could be held suspended by the tag without its tearing out. This tag avoided all or most of the difficulties encountered in the tagging methods previously used by Errington, Cook, and Takos, such as leg injury, infections, and pelt damage.

Apples were the most attractive bait, but carrots were mainly used, because of availability.

Gibbs, Hancock, and National live traps were used, the latter proving to be the most satisfactory. Traps were staked down to prevent loss by accidental drowning in the traps.

Difficulty in holding the animals with one hand, while tagging with the other, led to development of a simple cone-like holder which proved very satisfactory. While in this cone the animal may also be conveniently sexed and weighed. Of 367 ear-tagged and released, 251 were recaptured once and 80 were retaken the second time.

This technique appears to be a considerable improvement over older methods.

Carl R. Eklund reports what we may call the administrative technique of "Fur resource management in British Columbia." All fur trapping lines must be registered with the Provincial Game Commission. Registration procedure is: application form containing a description of the desired trapping area, (and sketch map, if feasible) is submitted to local officer in desired territory; this application goes to the Divisional Game Office, where the area is mapped and forwarded to headquarters; headquarters again maps and records, and if approved issues a permit. Registration must be renewed annually.

Regulation: There is no statutory limit to take, but a seasonal report is required to record the take and furnish an estimate of fur bearers, especially beaver, on the area. Recommendations of future take are made from past records, failure to comply with which results in forfeiture of line. With approval of authority trap lines may be leased, sold, or loaned; and the trapping privilege continues for 2 years in event of sale of public land on which line is located. No two lines may lie within 1 mile of each other; each permittee is allowed to employ one licensed trapper as assistant; 6 months' residence is required before applying for a line; and failure to work a line results in its forfeiture.

All beaver pelts must be tagged before any sale can be made. A small royalty is collected by the province on each pelt.

Results have been good, each trapper having an interest in building up his line. The take has been generally uniform, with an actual increase in certain species in the last 6 years. Annual value of fur taken in the province is about $1,750,000, these figures not including the present high prices.

Viewed at this distance, this plan appears to require a minimum of enforcement effort.

C. M. Aldous describes a "Box trap for snowshoe hares and small rodents." For study of snowshoe hares in Minnesota, it was necessary to devise a box trap of sufficient size for that animal which would be at the same time compact and light enough to carry through brushy cover. It was also necessary or very desirable that all working mechanism be inside and that it give shelter from rain, snow or wind.

These requirements were successfully met in a new trap measuring only 8 by 8 by 24 inches, and adjustable to be tripped even by small mice. Hares did not die from exposure even at 35°F. when held over night. Working drawings and descriptions are part of the article.

Daniel L. Leedy and George E. Laycock, in the *Ohio Conservation Bulletin,* offer what we might call everyday or layman's "Management of Ohio cottontails." Fourteen practical suggestions, each with a corresponding illustration, are presented as follows:

1. Leave a rod-wide strip of hay around the edge of a field
2. Improve large idle fields with planted strips and patches of cover
3. Plant barren spots, fence corners and gullies with food and cover plants, from suggested list
4. Fence off heavily pastured woodlots
5. Encourage shrubs rather than trees along fencerows
6. Delay fencerow mowing and cleaning until after mid-July
7. Do not eliminate groundhogs where their presence is no menace. Their burrows are good escape shelter for rabbits
8. Build brush-pile shelters, when cut brush is available, in woodlots and untilled fields
9. Provide other similar shelters with junk, trash, boulders, etc.
10. Tiles or other artificial dens may be constructed, but are less valuable than brush piles and groundhog burrows

11. Plant food patches with recommended foods
12. Establish feeding stations near suitable cover
13. Place fruit tree prunings in piles at some distance from orchards, furnishing excellent food and drawing rabbits away from the orchards
14. Trap rabbits from areas where harmful, and distribute to more desirable areas

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DISCUSSION

DR. TRACY I. STORER (California): I would like to suggest an addition to the paper: The Public Health Report by Emlen on the use of a modified rabbit trap in the study of Norway rats, that I think has appeared within the time limit set for these reviews of new techniques.

It involves the use of a rabbit trap in which the floor has been covered with a horse-feed mixture, and they report success in taking a number of rats in a single trap. The trap has been used in the city; also it has been used in the country by David Davis on Norway rats, and it seems to me that it ought to have possibilities in the study of a wide variety of species of rodents as well—that is, in some modified form. In connection with that work, reference might be made to the so-called Emlen socket, which has been reported in the *Journal of Wildlife Management*—a device essentially a sleeve of wire rods into which a rodent may be moved for clipping or examination of the teeth, or, in the case of the work being done in Baltimore, for the administration of various materials by stomach tubes.

I think those tubes and other equipment could find a place in the handling of some of the species of wild rodents in which people are interested.

I would like to ask anybody who has his own pet devices for rodent traps to get in touch with me. I am trying to make a collection of traps or trap designs; a good many have come in, and I am also interested in the development of gas devices for fumigation of burrows. There was a small note in one of the agricultural papers of California about four different designs for the use of sulphur dioxide in killing rodents in burrows. So, if you have any gadgets, we would like to know about them; I would like to have descriptions or drawings.

# REVIEW OF NEW TECHNIQUES—GALLINACEOUS BIRDS

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The booming of the prairie chicken, the hooting of the sharp-tailed grouse, the strutting of the sage hen, and the covey gathering of bob-white quail are behaviors that help the wildlife manager determine population numbers of these gallinaceous birds. Ruffed grouse and turkey populations are more difficult to count due to their secretive nature and woodland habitat, yet King (1937) developed a sound technique for estimating ruffed grouse populations 10 years ago. Since that time wildlife technicians have been struggling to devise ways and means of censusing the ring-necked pheasant, but its furtive habits undermine practically every counting technique tested to date.

*Pheasant census and population index techniques.*—Attempts to develop both a reliable census method and a practical index for pheasant populations have been numerous. McClure (1945, p. 38) made weekly roadside counts throughout autumn and winter of 1941-43 on two 15-mile routes through a central county of Nebraska. He also studied the detonation method, the 1-minute crowing count, the scat count, and the use of a horse and of concentrated study on a limited area. He concluded that each had marked limitations, and that some had broader usage than others.

Apparently, none of these methods satisfied wildlifers who considered population measurements of paramount importance. Einarsen (1945, p. 121) says that "roadside counts and direct census drives were not practical in Oregon because of the scarcity of both roads and field investigators." Consequently, he developed the quadrat inventory which he claims "proved practical, economical, and simple, and can be used by laymen as well as game managers." During 1940-42, direct censuses were taken at Protection Island and comparisons were made on 800 quadrats. Even though "The three-year tests showed close agreement between the two methods," from 7 to 35 more pheasants per 100 acres (7 to 11 per cent) were tallied by the direct drive census than the quadrat inventory.

Census drives and winter trappings have been made at the University of Wisconsin Arboretum since 1937-38 (Leopold, et al. 1943). During two winters more hens were trapped than censused, and the 1942-43 study showed that the census was from 13 to 55 per cent low (Buss, 1946, p. 106). If the census drive was this low in Wisconsin, and if the Oregon quadrat method had been used at the University of Wisconsin Arboretum with the same degree of difference between methods, there would have been a census error not less than from 20 to 62 per cent!

Apparently, James W. Kimball of South Dakota agrees with Einarsen's statement (p. 121) that complete confidence in a census method is rare, for Kimball is now studying *Pheasant Census by Crowing Count* (unpub.). Even this method is not without limitations as pointed out by Leopold (discussion following presentation of paper) who believes density affects crowing.

It appears that the direct drive method ranks first as an actual census method, but its limitations must be recognized. The Oregon quadrat inventory probably offers the best present-day method for estimating pheasant populations, and the roadside count probably is most useful as an index to fall populations. These three methods are far from ideal, and considerable improvement is needed.

*Colored baits and their Value in safeguarding birds.*—A vastly different technique has been contributed from the laboratories of the Fish and Wildlife Service at Denver, Colorado, where Kalmbach and Welch (1946) have shown that certain birds have an aversion to unnaturally colored foods. Rodents, however, paid little or no attention to the color of food items; hence poisoned grain exposed for rodent control could be dyed to safeguard birds against accidental poisoning. This finding gained significance in northwestern Wisconsin during the summer of 1946 when sharp-tailed grouse were found dead about the edge of a newly seeded oat field. Examination of the grouse showed that they had eaten waste oats left uncovered by the grain drill. Questioning the farmer revealed that he had treated the oats for smut control. It was evident that the treatment rendered the seed oats poisonous, and the grouse were accidentally poisoned. It is fortunate that such seed treatment is not used extensively in this region, or the pathetically few Wisconsin sharp-tailed and pinnated grouse now at the bottom of their cycle would have been virtually wiped from Wisconsin's landscape. It is obvious that immediate attempts should be made to develop a smut treatment for seed grain that prevents grouse and other birds from accidental poisoning without reducing germination.

*Burning for grouse.*—This is probably the oldest wildlife technique on the continent, for the American Indian fired the prairies as a help in hunting the buffalo. His fires "pushed back" the invading forest and maintained champaign lands with herbaceous plant successions. These plants were attractive to prairie chicken and other prairie animals. After the white man routed the Indian, the prairie fires were halted and a forest protection system was developed that ended the holocausts of early settlement. After about 1900 there was a gradual increase in the forest-loving species and a simultaneous decrease in prairie-loving animals. Today the prairie chicken is surviving in small numbers on a fraction of its former range.

Anyone who witnessed the roar of grouse rising from climax stands of bluestem on our midwestern prairies and later saw these native grouse slowly plowed and shot from their haunts will agree that the most important contribution to wildlife at this critical time would be a tool to save the prairie grouse. That tool might be fire!

It is almost impossible to determine who first used fire intentionally for the benefit of wildlife. Likewise it is difficult to credit the development of this technique to one person since it is still in its infancy. Grange (1941, p. 81) probably was first to recognize the value of burning for grouse and studied the effects of fires on grouse a number of years before most people heard of his experiments. He got his cue from Stoddard (1931, pp. 401-414) who pioneered with fire for the improvement of bobwhite quail range. Today, Michigan is leading all states in its experimental burning program for sharp-tailed and pinnated grouse. Their controlled-fire plan, under Amman (1945), includes both management and research, whereas other states have set up prairie grouse projects excluding the use of known tools for management. Will enough management of the kind Michigan is demonstrating be started in time to save our prairie grouse, or are "chicken" studies destined to follow the pattern of heath hen research?

*Importance of subspecies to wildlife management.*—Transplanting upland game birds has been accepted widely as a successful technique for restoration purposes (Ligon). However, the history of many plantings shows that the innumerable factors affecting survival were not carefully studied prior to liberations. The difference between ability and inability to survive is not great. The birds that do survive are particularly suited to their environments and pass on their hereditary traits to future generations. "In successive generations the offspring better suited to the environment would be selected by nature for survival and perpetuate the species by passing on favorable characteristics to their progeny" (Aldrich, 1946, p. 87).

Aldrich (p. 90) points out that if native birds are already present as a distinct race, and foreign stock is introduced which survives to breed with the native birds, the progeny will be less well adapted to survive than offspring of pure native stock which has developed through long selective breeding under those particular conditions. A. S. Leopold (1944) concluded that wild turkeys in Missouri crossed with domestic stock produced offspring much less able to survive in natural habitats than pure native stock. Aldrich (p. 91) further states that "It seems obvious that stocking with a foreign race is a waste of time and money, at least while any of the original inhabitants of a region still survive. Instead of introducing new birds, of a strange race, the original occupants of the region should be given every encouragement to increase their population."

Stocking native prairie grouse in both Wisconsin and Michigan has proved successful, but in these cases there were no grouse residing at the release site when the stockings were made. However, when prairie chickens were transplanted from Alberta to the range of the heath hen in the Atlantic States they immediately disappeared (Phillips, 1928). The Wisconsin and Michigan chickens originated from a subspecies identical to those that formerly lived at the release site (Amman, 1945, p. 42); whereas the Alberta chickens were of a different race than once lived in the Atlantic States. Numerous other failures can be traced to the same cause (Phillips, 1928, and Bump, 1941: 412-413).

The significance of races to management might be even greater than Aldrich indicates. There are good reasons to believe that the once prosperous Hungarian partridge population of Alberta was helped into its slump by introducing Huns that were not well suited to Canadian environment (C. H. D. Clarke). It is not difficult to understand how such introductions could breed with the resident birds in the province and thereby produce inferior offspring which would not survive as well as the birds already established on this range.

The meager evidence surrounding the Alberta stockings should provoke further investigation of this important partridge population. In addition it should serve as a timely precaution. Grouse projects planning local stockings, especially in the Great Lakes region, should secure stock from races identical to those inhabiting the range on which they are to be liberated. Even if stockings from two or more races do survive on the same tract, they *might* aggravate the cycle which is very pronounced in the Midwestern States. To overlook such a possible influence on the grouse cycle is inviting disaster to our waning prairie grouse.

*Mechanics of Wisconsin quail and pheasant population studies.*—Numerous techniques have been *separately* employed in Wisconsin studies of bobwhite quail and pheasants. Nesting studies yielded important information on the phenology and success of nesting, but they raised more population questions than they answered. Studies of individual hen performance (trapping, banding, weighing, sexing, and aging) showed a high turnover rate in pheasants (Leopold, Sperry, Feeney and Catenhusen), but this technique did not show when this turnover occurred or what caused it.

Aging studies, including the use of the bursa of Fabricius for identifying adult from immature birds (Gower, Linduska, Kirkpatrick, and Buss) and the use of postjuvenile primary molt which made it possible to age immature pheasants up to 14 weeks old to the nearest week (Buss, p. 65), contributed reproductive rates and survival figures. More important, they helped narrow down the time in which typically high turnover rates occurred, but they did not show what caused them.

Application of the ovulated follicle criterion (Meyer, Kabat, and Buss) to wild pheasant populations (Kabat, Buss, and Meyer) showed that practically all hens in dense populations laid eggs, but hens at the University Arboretum in 1943 laid an average of about twice as many eggs as the hens at the University Bay area, near Madison, laid in 1946. Further study in 1946 revealed more and older broods at the University Bay area than at the University Arboretum. Neither ovulation studies of hens nor age of broods explained the difference in population behavior.

Similarly, determination of vitamin A storage and endocrine studies of quail and pheasants showed valuable findings, but none of these studies in themselves answered questions of population behavior.

Each technique and each study yielded important information, but it is probable that greater utility would be realized from application of *all* these techniques during the same year on several areas of varying population density. Such simultaneous application is now under way in Wisconsin, and it is hoped that these techniques will answer important quail and pheasant population problems.

*What is needed?*—A method to reduce research time can rightly be considered a valuable technique. Such a shortcut has been demonstrated by the use of Protection Island, off the coast of Washington, for study purposes (Einarsen, 1942). Islands of usable size for study purposes are limited in number, but where else can variables such as egress and ingress, predation, human activity, and food be controlled outside the laboratory (Nestler, 1946)? Ten-thousand-acre Pelee Island, off the southern extremity of Ontario in Lake Erie, is about 40 miles north of fabulously populated Wood County, Ohio, and in 1934 Pelee may have had 100,000 resident pheasants. The potential value of this island for research looks like a "gold mine" warranting federal (United States) consideration as an outdoor laboratory.

Errington's (1946) vertebrate population studies should serve as a challenge when planning future projects, and the quail-calling technique being studied by Bennitt (1943) and Kabat (unpub.) plus the collective techniques underway in Wisconsin should be used to test some of Errington's (1945) recent quail findings.

More practical research of the type Davison (1946, p. 298) recommends is needed. He points out that a census is sometimes unnecessary. "Research . . . of land management practices designed to produce and care for game is often stymied by nonessential steps which delay, reduce, and confuse the results." In his practical research "more dependable comparison comes from current studies of treated and untreated areas."

Finally, federal coordination of the many state pheasant projects is needed. Certain necessary, but apparently unattractive, research should be assigned to regions conducive to such studies.

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## DISCUSSION

CHAIRMAN BENNITT: Isn't it interesting how different these three papers have been, yet with only one case of duplication so far. Dr. Vorhies had a right to discuss the matter of rodents and birds in relation to colored baits, and so did Dr. Buss. I think we were benefited by both discussions. Have you comments?

MR. GEORGE A. PETRIDES (Ohio): I am interested to know Dr. Buss's comments on the value of the weakness of the lower jaw as an age indicator in pheasants.

DR. BUSS: This technique dates as one of the oldest techniques, and I believe that Linduska has aptly described its use from an appraisal of it. I would say that it has considerable value, but I believe the value hinges, at least in part, on the skill developed by the individual using it.

MR. BEN GLADING (California): We have had a little experience with the use of the lower jaw in California. It doesn't appear to be so good out there, largely because of the fact, I feel, that the nesting season is fairly well prolonged through the summer. Our hunting season was late. It was held in summer. We got tremendous variations in the ages of birds represented in the bag; and the young jaws were every bit as hard as those of the full adults.

DR. CHARLES T. VORHIES (Arizona): I would like to ask whether any one has information concerning the success or failure of various subspecies of chukars. My understanding is that several subspecies have been used in the introductions into this country, apparently with little regard to the character of the countries from which they came.

Arizona has been making some attempts to introduce the chukar. I am very sure that if they introduce a subspecies with a very different original environment there is little chance of success, when if a subspecies were introduced from the proper place there might be a greater chance of success. I wonder if anyone knows of definite work on that line.

MR. GLADING: Unfortunately, Dr. Vorhies, I don't know the subspecies that we have. I think its pretty obscure where those birds originally came from. We traced our birds back to a dealer in Singapore, I believe, and that's as far as we ever got.

However, as you probably know, there seems to be indication of chukar success in eastern California in Inyo County and in Nevada right across the line.

Mr. Colman, from Nevada, has assured me that they even have chukar damage, which indicates they they are there to stay. If you want them for Arizona, I think wild-trapped stock from either eastern California or Nevada would be your best bet.

MR. W. O. NAGLE (Missouri): As nearly as we can tell, the Missouri birds came from India, which is about the remotest connection with birds we could have gotten. What we finally had, notbody knows. They did not succeed, and there are none of them in Missouri now.

CHAIRMAN BENNITT: What other states have had experience with chukars?

DR. J. R. STURRE (Minnesota): In Minnesota they have tried over a quite a lengthy period to establish chukars. They have been very, very unsuccessful.

CHAIRMAN BENNITT: Where did they come from?

DR. STURRE: I don't know. However, these birds have been in Minnesota for a long time, and they continue to live and propagate; but when they release some in every county in the state—the progress of the birds in the counties has been watched and checked on—they just disappear.

CHAIRMAN BENNITT: This was our experience in Missouri.

MR. N. E. MCEACHRON (South Dakota): We had experience covering a period of 4 or 5 years with chukars in South Dakota. They came from the Kansas game farm. We used the prairie and the rough foothills; we also used the mountainous areas, and after about a year's time the birds became totally extinct. As far as I know, we can find only one or two pairs in the entire state today, out of several thousand pairs. What the reason is, I am unable to state. Neither do we know the origin of the birds, other than that they came from Kansas. It was very, very unsuccessful.

CHAIRMAN BENNITT: Does anyone know where the Kansas birds came from?

MR. A. E. BORELL (New Mexico): I would like to ask Ben Glading how long these populations he refers to as being established have been maintaining themselves since there were re-introductions. In a good many places they are maintained by continuous planting each year.

MR. GLADING: I can assure you, Mr. Borell, that I am just as skeptical of chukars as you are. These plantings to which I refer in Inyo and Mono Counties in California, going across into Nevada—actually there were very few plantings made in Nevada. I believe that has all resulted from our planting which was all done before the war, and the observations which I refer to were made in the summers of 1945 and 1946; so there is an interval of about 5 years from the last planting to the observations.

One of our men made the statement that he saw more chukars than he did valley quail in this particular area. There were small numbers of each, but at the same time there may be something to look out for on the other side of the picture.

I might add that this country is entirely different from anything you have in Minnesota or North Dakota, or even anything we have in the bulk of California. We have tried them all over California—much heavier plantings than in the area where they seem to show success.

MR. B. W. CARTWRIGHT (Manitoba): Canada has been equally unsuccessful in its numerous attempts to introduce the chukar, but I don't think anyone has quite realized how strange it would be for an exotic creature like that to be dumped into a strange flora. There is one suggestion that I would like to make, and I have made it in Canada: that the chukar should be released amongst as dense a population of the native sharp-tails as possible, so they could learn their customs and learn what was good to eat by precept.

Dr. Buss, do you think there would be any ill effects to the sharp-tails by such introduction? Errington had made significant findings in 1945 in regard to competition—not the kind of competition that one ordinarily refers to, but the kind wherein a high population results in a lower reproductive rate. Do you see any such possibilities?

DR. BUSS: Well, the only thing that I could point to is that the native grouse and the introduced Hungarian partridge got along very well together. There was some competition between individuals fighting, but it didn't seem to be serious. Both populations went up and down together because of factors other, I think, than competition.

MR. GLADING: I think there is one thing we can't emphasize too strongly in this matter of introduction of exotic game birds and shifting native populations around, and that is the importance that disease might possibly have.

We have just started an embryonic disease laboratory in California. It is absolutely astounding what some of the early findings are. We find that game-farm-reared birds have actually introduced tuberculosis into the wild. There are a myriad of diseases which we know little about—coccidiosis, malaria, and many, many others.

It is entirely possible that populations just over the hill have learned to get along with a disease. When you introduce it back on the other side of the hill you are working on, through the introduction of an exotic population, be it the same subspecies or another one, I feel that you are sticking your neck out in a field about which none of us knows very much.

It's quite possible that the declines of some of these populations, the crashes that have been observed, have been the direct result of the introduction of some exotic diseases. We have some reason to believe that the original introduction of chukars in California coincided with a pretty bad crash in valley quail from which they never recovered. Maybe the heath hen met with similar fate.

It's a field about which we know very little. I think we should learn much, much more before we fool around jerking populations from here to there.

MR. GILBERT M. HUNTER (Colorado): I would like to ask Mr. Glading what type of country in California the chukar has been successful in. Now, in Colorado, to give you the picture of it, we have one area which is a semidesert type—down in the delta—where we have had success. Incidentally, we have abandoned the Colorado chukar program. We feel that it can rest; if they start to come back, all right. Otherwise, we are through. I would like to know, Ben, just what is the type of country—semiarid?

MR. GLADING: Unfortunately, Mr. Hunter, I am no expert on strict ecological conditions, especially desert ones. However, the country to which I refer is extremely arid. The birds tend to concentrate about water holes, like quail in the same areas. I might say that it runs into a sagebrush type cactus, and it's fairly typical of the corner of eastern California and southwestern Nevada, running over into Arizona-type desert.

Now, it's possible that the Colorado River has acted as a barrier to the spread of populations into Arizona, but in this 5-year time they are across the line in San Bernardino County.

MR. HUNTER: From the description that you give of that land, it is quite similar; incidentally, I believe all our chukars came from California. I am sure they were purchased out there.

CHAIRMAN BENNITT: Dr. Vorhsei, do you have anything to add to this matter of chukars in Arizona?

DR. VORHIES: I am not sold on introducing chukars into Arizona. I am skeptical about all exotic introductions, but I am pretty sure that there will not be success in southern Arizona, the arid part of the state, unless the chukars come from such countries as Syria or Persia. I can't imagine chukars from the Himalayan region of India, or country of that kind, succeeding there.

Incidentally, for many years I have been telling sportsmen and game commissions that they might as well forget the introduction of pheasants in Arizona. They still believe they can establish them. I think Dr. Taylor took the same line during the many times he worked with us there. They are still trying. We still haven't any pheasants.

MR. PHIL GOODRUM (Georgia): I would like to know if anyone here has tried to estimate the turkey population by using turkey callers in the spring.

MR. M. O. STEEN (Missouri): We tried it last year. The results are insufficient, but they seem to be unsatisfactory.

MR. ADEN C. BAUMAN (Missouri): My son has been very much interested in raising chukar partridges for over 4 years now, but with all of his enthusiasm he has given it up.

# REVIEW OF NEW TECHNIQUES—WATERFOWL

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Many of the "practical" techniques to management are not published but are merely developed and used on refuges and waterfowl areas as the need arises. The lack of publication makes review of the recent waterfowl techniques difficult because of the great many which should be discussed. Developments in four phases of waterfowl work will be commented upon.

*Determination of sex and age.*—One of the most important techniques developed during the past few years has been the method of accurately determining the sex and an age criterion for waterfowl. The technique for aging and sexing waterfowl by cloacal examination has been described by Hochbaum (1942). Gower (1939) previously pointed out the importance of the bursa of Fabricius as an age criterion. Prior to this work, sex was determined only by internal examination of the birds and even internal inspection was not an accurate guide to the age of the birds. Interpretations of data and the value from studies were greatly advanced by being able to accurately distinguish male from female, adult from juvenile in all plumages and at any time during the year.

As a contribution toward further knowledge of waterfowl populations and their management, in sufficient volume and in correct distribution of the sample, sex, and age data will yield information on the following points: (1) the determination of the existence of any differential age and sex migrations; (2) the age and sex composition of the waterfowl population; (3) the vulnerability of different ages and sexes of waterfowl species to the gun, to botulism, and to other mortality causes; (4) to supplement data on sex and age classes which are obtained annually in banding operations; (5) an index to the productivity of the preceding nesting and rearing seasons.

Because of the difficulties of making nest and brood counts, an easier method was sought which would give the ratio of young to adult birds. Checking birds in hunters' bags by use of the age and sex technique is a convenient method. Disadvantages, however, are inherent in the use of the technique as an index to preceding breeding season conditions. It is a postmortem taken after the period when its use in assisting in current year's hunting regulations would be most useful. Often it is possible to secure only a sample from the fall migration because the hunting season is shorter than the fall migration season. However, it is a double check on the nesting ground surveys, and coupled with these and wintering ground surveys should prove of value in getting a more complete picture of the yearly waterfowl conditions. An adequate sample taken in each flyway and important flight lane will probably be necessary to give significance to the data. The gathering of data, first by the Delta Waterfowl Research Station workers (Hochbaum, 1942) and members of the Illinois Natural History Survey and later by other states and the U. S. Fish and Wildlife Service, has been increased in an attempt to determine whether the application of this technique can supply information on breeding ground conditions and other phases of waterfowl management. In our present state of knowledge a great deal of study yet remains before this method, simple though it seems, will yield maximum information on the complex problems of waterfowl management.

*Breeding ground survey.*—Perhaps one of the most significant concepts which has been developed in recent years in that of "territorialism" in waterfowl. Basically, this concept strikes at the very roots of waterfowl management. Habitat improvement has been concerned largely with development of nesting and rearing cover plants with the hope of increasing continuously the numbers of nesting waterfowl. However, Hochbaum (1944) states that "management of cover is but one phase of the more important manipulation of territorial terrain. Only the territorial population is constant. This, of course, is a great advantage to the marsh-manager who is studying waterfowl on a small area, or over a wide region. Determination of nesting populations by a count of nests is tedious, slow and never complete. Measurement by study of territorial pairs gives a much broader picture within a shorter period, and for one who studies behaviour characters carefully, is considerably more accurate than a nest count."

The territorialism in birds limits the number of breeding pairs for each area. Its practical application according to its proponents comes in being able with greater ease and reliability to ascertain the numbers of nesting pairs in a given area by a count of the pairs or the drakes on their territories. To arrive, however, at a final production figure it is necessary to make a sample nest count and brood count to determine success of the nesting pairs. Following this technique farther the count of territorial males on small representative areas can be projected to determine the numbers and success on large blocks of breeding grounds of the same cover type. Sowls (unpublished) at Delta, Manitoba, has been making intensive studies on the use of this technique during the past year.

Much as this method seems so applicable for appraising rapidly the nesting conditions on the northern breeding grounds, it should be said that all is not yet clearly understood. Nest densities, which in Utah marshes reach as high as 10 to the acre and three or four times as great on small areas of choice nesting cover, obscure clear-cut territorialism. Again, it is not clear how long a single drake must be watched to determine if it is a part of a productive pair or a non-breeder and how the late nesters or re-nesters can be determined accurately by rapid counts over the marshes. A goose breeding ground appraisal is being made at the present time by research personnel at Bear River Refuge. The total brood counts on the refuge each year are made and by dividing the total brood counts by the number of goslings hatched per nest on sampled units, the yearly nesting population and the success of the season is determined. Final results, however, are not yet available on this breeding ground technique.

*Botulism techniques.*—Botulism still remains a mortality factor which yearly takes a toll of thousands of ducks. Recent advances and techniques in this field involve the use of antitoxin, the manipulation of water levels for practical field control, and the development of an air-thrust boat to facilitate reaching otherwise inaccessible areas.

Botulism toxin was found by Quortrup and Sudheimer (1943) to be neutralized by botulinus antitoxin in mice and the use of the antitoxin has since been proved successful by these workers as a treatment for the duck sickness. When all sick birds were treated in 1943, 66 per cent recovered; in 1944, 79 per cent of the total sick birds, of which only the most severe were given antitoxin, recovered (Williams, et al. Unpub.). These research workers concluded that the collection of helpless botulism ducks for antitoxin treatment and hospitalization is completely justified but that the capture and treatment of ducks less severely affected does not appreciably lower the mortality since many of these birds recover without hospitalization. Bear River Refuge administration personnel who used the antitoxin on about 65 per cent of the sick birds gathered in 1946, reported a recovery of 83.3 per cent from a total of 3,254 birds. A more rapid reaction to the serum has been observed by injecting the antitoxin directly into the blood stream of the sick ducks instead of by intraperitoneal injections.

Disadvantages of the use of antitoxin, however, are that (1) the birds must be gathered for treatment, (2) the antitoxin is comparatively expensive averaging about five cents per bird, (3) labor to gather the birds is at present both scarce and expensive.

Continued investigations for a practical field control of botulism has centered upon a program of controlled water level manipulations (Williams, et al. Unpub.). In the present stage of the work the manipulation of water levels is applicable to managed shallow western marshlands. It is not a panacea for duck sickness on all areas since on many affected areas there is no adequate control of the water or land.

One of the principal advances made toward the study of botulism is the air-thrust boat. Developed in its present form by Williams and Jensen (1945), this boat has proved even more versatile than had been anticipated. This air-thrust boat consisting of an airplane motor of 40 to 60 horsepower mounted on the rear of a 14- to 16-foot duraluminum boat attains any desired speed up to 40 miles per hour and is efficient in all types of environments from a wet mud-slick to deep water. Two years of use on duck sickness studies on mud-flat and shallow marsh areas at the Bear River Refuge and on other water areas in the West have proved this boat to be a valuable tool. Versatility of the boat adapts it to numerous waterfowl uses in addition to botulism studies including (1) studies of flyway environments, (2) harvesting of aquatics, (3) trapping of waterfowl for banding and other work, (4) patrol and posting of refuge areas otherwise inaccessible, (5) sanitation work in collecting sick and dead waterfowl, (6) census work and productivity surveys on both plants and waterfowl.

*Censusing aids.*—The use of the airplane is not new in waterfowl work. It has been used successfully for years by flyway biologists and others in determining both winter and summer waterfowl conditions. Different models appear to have particular advantages for certain types of work. Types and models of planes used to date have been based largely on availability. Aircraft has advantageously been teamed with ground work in the U. S. Fish and Wildlife Service and its cooperators to give new approaches to a better understanding of breeding ground conditions.

Colorado State Fish and Game Department personnel in the 1947 winter inventory used a two passenger, side by side, Cessna, 85 horsepower plane to census waterfowl on a state-wide basis. Workers in the Illinois Natural History Survey (Bellrose, 1946) have advantageously used the Piper cub to census ducks and to take photographs as checks against estimates made from the ground. Refuge and research personnel at Bear River Refuge have been using Piper cub planes most successfully on areas otherwise difficult to census.

Recently, Spinner (1946) used an army plane to secure photographs of snow geese for comparison of flock size in subsequent censusing. Spinner believes the value of the photographs are that small flocks may be estimated readily by comparison and that for larger flocks the photographs serve as an accurately counted segment in estimating the size of the flocks. Experimentation on the use of the method may advantageously be extended as a censusing aid in other waterfowl. The use of the airplane holds great promise in waterfowl research and management as new approaches and methods for its use are developed.

New techniques too numerous to review have been made in waterfowl banding, in food habits work, in chemical and mechanical control of undesirable plants, in the uses of dynamite and machinery in marshland improvement, and in various methods of collecting and storing aquatic plants for propagation purposes.

Many techniques have, however, been designed to fulfill definite needs of the moment. Many of the techniques here mentioned are still in the experimental stage and others have yet to be put into practical use. All too few are the practical, real tools available now to assist with the necessary work of the future in conserving and in restoring the waterfowl population. Waterfowl workers cannot push too rapidly to completion these techniques now in the developmental stage and they cannot be encouraged or aided too greatly in the development of new tools with which the valuable waterfowl resources of the country can be adequately and efficiently managed. In particular, either new or improved techniques are desperately needed for (1) determining waterfowl populations on migration, wintering, and breeding grounds, (2) appraising breeding ground conditions which indicate the current years production, (3) controlling undesirable plants, (4) facilitating desirable marsh-management practices, (5) minimizing botulism outbreaks, (6) acquainting the sportsmen with the true waterfowl picture, and (7) stimulating research and administrative workers with the helpful "tools" already known both here and abroad.

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DISCUSSION

DR. W. P. TAYLOR (Texas): I would like to ask Dr. Low if the kind of work he and Bellrose did along the Illinois River is being continued. I mean the study of productive capacity in waterfowl areas. It seems to me that was promising and it looks like a lot more ought to be done. Do you know of any activities along that line, Dr. Low?

DR. LOW: I think we have Mr. Bellrose here in the audience. If he is here, he might answer that better than I. I left there a year or two ago.

MR. FRANK C. BELLROSE, JR. (Illinois): No.

DR. TAYLOR: Are any along the coast in waterfowl areas?

MR. BELLROSE: Just one down in Texas. That is the only one that I know of.

DR. TAYLOR: I wonder about anybody else.

MR. GEORGE PETRIDES (Ohio): In the marshes, I suggest that one might want to investigate the type of craft that is operated by the Army and the Navy in the Everglades area rescue work.

They took an Army "weasel" caterpillar, a small machine, fitted floats in the interior so it wouldn't sink in the marshland, and they were able to operate through the sawgrass weeds up to 30 or 35 miles per hour. It seemed like an adaptable kind of machine. They also had "alligators," which were, of course, originally created for amphibious work. This device was thought up on the spot by the men at Miami.

CHAIRMAN BENNITT: The difference between the "weasel" type and the air-thrust boat, I suppose, might be a considerable difference of expense and weight.

DR. LOW: I suspect that the boat which we have in the West is particularly adaptable to those shallow marsh areas, although it may be used out here. Other types of Army transportation might also come into use in waterfowl work. The air-thrust boat will go through marsh vegetation well. It goes through the meshed aquatics and as for as stands of the emergents; however, it's necessary to have speed to push through dense stands of emergent vegetation. Of course, it's impossible to go through the extremely dense stands of high cat-tails or bulrushes. It is particularly adaptable to shallow marsh areas which we have, growths of submerged aquatics and water shallow enough for the conventional type of transportation such as Mr. Petrides mentioned.

MR. PETRIDES: I think the air-thrust boat at the air base there is also used in the shallow water areas, particularly along canals, for rough work through swamps. Where they wanted to go over the hammocks, they used the "weasel." It seemed to be fully as fast and much more dependable where there was rough going. It seems to me that it may be applicable in the Gulf Coast area here, if not in the western marshes.

MR. H. ALBERT HOCHBAUM (Manitoba, Canada): On the general topic of Dr. Low's paper, he points out the techniques that have been accomplished, and he points more to the great things we have to do. That's what we have to do—the things we are going to do.

We should take some stock of ourselves as a wildlife group. I think there is danger that we are breaking away, perhaps unconsciously, from the parent sciences—the basic sciences from which wildlife management and wildlife research must develop. Just one example: There is a new field developing which is named "behavior." It isn't a good name, but that's what it is called. Most of us are not familiar with that field or its literature. Much of it has come from Europe; England and other countries are much in advance of us.

Our research today has asked the questions, mostly: What, how, where, and when? This new science—it is not a new science, but rather a new, modern outlook—asks the further question: Why? Why does a bird do this? Why did a mammal do that? We must think in such terms. When we do, the quail and the grouse will show many relationships with other birds—song birds, dickey birds—and there is a great field of literature that has nothing to do with game birds at all from which we can learn a great deal about pheasants or whatever it is.

MR. V. E. DAVISON (South Carolina): One of our greatest needs for waterfowl techniques in the winter range on the Atlantic Coast is a knowledge of the land-management techniques which apply to the varying soils. It's a guide we need to determine—whether it is more economical to maintain a marsh or to dig it off; and after you get the land use determined (as for ducks rather than for pasture or croplands), what do you need to do to actually produce ducks?

We are confronted, particularly on the South Carolina coast where ducks were at one time rather famous, with vegetation since cultivation was stopped—vegetation which has no value whatever. Certainly today we are not feeding ducks in the Southeast as we did 30 or 40 years ago, and the techniques by which you can bring those lands back from where they are now, from idleness to productiveness, are few. Yet we don't know how to apply them to soils, from the sands and heavy clays to the peak soils.

MR. A. E. BORELL (New Mexico): I gather from the comments that Mr. Hochbaum made last night, and the reference that was made by Dr. Low, that ducks nest in a given marsh or pothole; that their young return to that same pothole or marsh to nest; and that if the ducks that breed in that pothole or marsh are wiped out, the following year there will be no ducks returning there to nest.

I would like to ask Dr. Low if he found additional work on that. It brings up the point, then, of control relative to flyways north and south. Instead of zoning our country east and west, possibly our country should be zoned north and south corresponding with the direction of the flyways.

DR. LOW: Mr. Hochbaum mentioned last night that the marshes and potholes in the northern breeding grounds are becoming "burned out," probably because the birds are being overshot in those areas. This would indicate that the older birds nesting in those areas tend to return year after year to the general vicinity. Perhaps Mr. Hochbaum has additional comment on that.

MR. HOCHBAUM: The old hens return to pretty nearly the same general region, as far as we have been able to determine. For the young, there is a post-rearing-season movement, and they come back to the area which is familiar to them. They may not necessarily come back to the native marsh. They will come back to the general region where they were the previous year.

The river ducks, which reach a flying stage early in the summer, move more widely. The area they come back to is probably much larger than that of the diving ducks, which are late to fly and have a short period of experience before they migrate south.

MR. B. W. CARTWRIGHT (Manitoba, Canada): I can add a little to that. At Yaltan, where some 8,000 ducks were banded, we have repeatedly recaptured adult females returning to breed in the following year. In some cases, they have returned 2 or 3 years in succession. I haven't quite got the latest figures in mind, but I know of 103 returns to that Yaltan marsh; 97 of them were adult females. There have been one or two juveniles, but they seem to be more or less accidental. The adult hens tend to come back to the marsh year after year, each bringing a strange male with her.

MR. BELLROSE: In the woods where the ducks were sitting on the eggs and we were able to capture them, we found a surprisingly large number returning there in subsequent years. We raised about 500 ducks in 1944; of them, we sent 100 to Indiana and 100 to Wisconsin. In later years, some of these young birds have been recaptured at their nesting sites in Wisconsin and in Indiana, showing that the tendency of young birds is to return to their secondary home rather than their primary home. That would seem to show an association, through sight, to return to an area which they visited before migrating.

MR. GEORGE MACKENZIE (Minnesota): We have, up in our state, a marsh of about 10,000 acres. It went dry during the drought period. It used to be one of the finest wildfowl lakes in the country.

Dr. Francis Uhler of the Fish and Wildlife Service made a survey of that marsh many years ago before it went dry. It's second in size of the marshes in Minnesota, and it had more aquatic plants than any other given area in the country. It went dry and we hunted ring-necked pheasants for 13 years.

The water came back 4 years ago. Dr. Uhler said the ducks would be back. The aquatic plants came back last fall. He spent a month making a survey of that lake. He found 26 varieties of aquatic plants that had replanted themselves and the ducks were there by the thousands. They re-established our statutory game refuge in the center of the lake, 700 acres, and there will be good shooting this fall. I don't know if they are the same ducks, or if they are strange ones; but at least it is the same habitat.

# THE EFFECTS OF AMMONIUM SULFAMATE ON EMERGENT AQUATIC VEGETATION

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The problem of obnoxious emergent aquatic plants varies with many factors, the more important of which are region, soil type, species native to the region, and chemical and physical properties of the water. Throughout the country men working with the management of water are confronted with this problem.

A species may appear as a scant growth in one region, yet be obnoxious in another. Likewise, for some unexplainable reason, this species may appear as a normal growth in one pond, yet so vigorous in another nearby that the water becomes choked. When a species produces an obnoxious growth in a place not desired, it becomes a weed.

Though many species of plants may produce an undesirable growth, perhaps the nuisance quality of water lotus (*Nelumbo lutea*), cattail (*Typha* sp.), spatterdock (*Nuphar* sp.), and duckweed (*Lemna minor*) is most universally known. Other species indigenous to an area may be equally obnoxious to the point of choking an entire water area.

When emergent plants choke a water area used for the production of fish, they become a nuisance for several reasons. In these ponds the mass of vegetation offers such complete escape for forage fishes that overpopulation results, with subsequent stunting of growth (Swingle, 1942). In hatchery pools, excessive vegetation interferes with harvesting of fish. Also the cost of operation is increased, because of the expense of hand labor in controlling these growths. Weeds may be obnoxious also in areas managed for waterfowl, when undesirable vegetation crowds out food-producing plants. Often the success of shooting areas is limited by the elimination of open water by emergent growths.

Figure 1. The shallow end of this farm pond is almost completely choked by arrowhead and water primrose

In some parts of the country, removal of fringe or semiaquatic vegetation around ponds is necessary for control of mosquitoes. In fish hatcheries, control of this growth decreases losses of fish to land predators by eliminating near-water cover. For this purpose, killing of the aerial parts of the plants is preferred to killing the entire plant, because the roots remain alive to protect the banks against wave-erosion.

Though 2,4-Dichlorophenoxy Acetic Acid kills many of the obnoxious broad-leafed emergents, lotus arrowhead (*Sagittaria* sp.), and spatterdock, there is need of a chemical to supplement this by controlling sedges, grasses, and the broad-leafed plants unaffected by 2,4-D, to which nearly all of the grasses and sedges are resistant.

*Methods and applications.*—Because of the need in Missouri for the control of emergent and semiaquatic vegetation, tests were conducted with ammonium sulfamate. The chemical used was "Ammate," a chemical developed by the E. I. DuPont de Nemours Company; it contains 80 per cent ammonium sulfamate and 20 per cent inert ingredients. Throughout the tests the concentration used was one pound of Ammate to one gallon of water, with and without a wetting agent.

The wetting agent used was "Vatsol O S," a chemical developed by the American Cyanamid and Chemical Company. This wetting agent or detergent is especially recommended for use with sprays having an acid reaction, because a basic substance like soap emulsion breaks down the Ammate, releasing ammonia gas.

The highly waxed leaves of aquatic vegetation are very resistant to wetting. Most people are familiar with the appearance of drops of water rolling about on the leaves of water lotus and spatterdock. If these leaves are submerged, they return to the surface completely dry. To overcome this resistance to wetting, one part of Vatsol O S was used to 1,000 parts of spray solution. This reduced the surface tension of the spray droplets so that, instead of clinging to the leaves as tiny spheres, they flattened into thin wet spots and when sufficient spray was applied the leaves became glossy-wet.

For small pools, ponds, and shore-line infestations of obnoxious weeds, the spray is satisfactorily applied with a back-pack, garden-type sprayer from the bank, from a boat, or while wading. While applying the spray, the area covered should be beside or behind the operator, because subsequent disturbance and immersion of the leaves removes the spray. An attempt should be made to cover completely all the leaves of the entire plant with the spray because, unlike 2,4-D, partial coverage is not sufficient for killing.

In all instances with the plants herein discussed, the same methods and concentrations of solutions were used. These consisted of one pound of 80 per cent ammonium sulfamate, with 20 per cent inert ingredients, to one gallon of water, with and without one part of Vatsol O S in 1,000 parts of water. The spray was applied under high pressure from hand-operated sprayers. It was directed toward the leaves close enough for coverage, but not near enough to cause drops to form and bounce off the leaves. In the case of lotus, arrowhead, and cat-tail, an attempt was made to cover all visible leaves. In treating water primrose (*Jussiaea diffusa*), growing in dense beds with many plants from common roots or underwater stems, the aim was a general coverage of the bed.

The area covered by one gallon of spray solution varied with the species of plant, density of growth, succulence of the plant, wind velocity, humidity temperature, and the presence or absence of detergents. With cat-tails, whose erect leaves are highly resistant to wetting, the coverage was roughly 100 square feet per gallon of spray. With less-resistant plants having horiozntal and more delicate leaves, such as water primrose, the coverage was as great as 300 square feet per gallon.

After using ammonium sulfamate, it is highly important from the standpoint of care of equipment to rinse thoroughly all parts of the sprayer or any metal container with which the salt has made contact. Ammonium sulfamate is highly corrosive if it remains in contact with metal.

A discussion of the plants treated, with observations of conspicuous reactions to a ammonium sulfamate, along with observations of end results, both positive and negative, follows:

American lotus (*Nelumbo lutea* [Willd.]).—This plant was sprayed while in the succulent stage of blooming. Without the addition of a wetting agent, the spray ran off the leaves or formed small droplets along their margins. When the wetting agent or detergent was added, the leaves became glossy-wet, with a drooping appearance, and within 5 minutes showed signs of wilt. Within 2 hours the petioles of aerial leaves bowed and the wilting leaves became yellow around the point of petiole attachment. The floating leaves turned yellowish, with green blotches.

Two days later, only a slight crinkling of the margins of some aerial leaves was noticed on the plants treated without a wetting agent. Plants treated with Vatsol O S added bore dead, brown leaves on bowed but still green petioles.

Seven days after spraying, the plants treated with Ammate showed only a tinge of yellow, but with those also receiving Vatsol O S the upper halves of the petioles were dead. After 24 days, the plants receiving no wetting agent had recovered, but the others were dead above ground. At the end of 95 days, these plants were dead and the emergent parts were decomposed. The rhizomes were rotted or else the blue, molding tissue was streaked with the white of a few live fibers.

Water primrose (*Jussiaea diffusa* Forsk.).—This plant was sprayed with Ammate while in full bloom, with and without the addition of Vatsol O S. Neither solution wet the leaves, but with Vatsol O S added the drops were flatter and more irregular in shape. Within a few minutes, both treatments caused the plants to show signs of wilt. The leaves began rolling from the lateral edges and drying along the margins.

Within 2 days, all the plants treated were dead above the ground level, but the roots were still alive. In 34 days, the vines and roots were decomposing, and the internal parts were brown or black. A few living plants remained where a vine was rooted far out in the water and not affected by the death of the shoreward part.

Figure 2. Water primrose has its maximum encroachment in the shallow end of this small lake, but a 10- to 20-foot zone extended around the entire shore

Cat-tail (*Typha latifolia* L.).—While in full bloom, these plants were sprayed with Ammate with and without Vatsol O S. Without the wetting agent, drops of spray collected on the leaf margins, and at the end of 2 days only the tips were yellow. When Vatsol O S was used, however, the leaves became glossy-wet, and within 2 days the upper third of the leaves was yellow, with brown margins.

Before the next observation was made, cows and sheep breached the fence and ate the sprayed cat-tail down to ground level, leaving the unsprayed area untouched. At no time did the animals show any ill effects.

Again, beds of cat-tail were sprayed, with Vatsol O S added, and within 28 days the entire emergent parts of the plants were brown. However, the inner parts were greenish and the roots and rhizomes were alive and white. At the end of 50 days, all of the emergent parts were dead, and most of the roots and rhizomes were decaying. Still, at the end of 70 days, when the entire plant had decayed, the tips of the rhizomes bore a few live buds that might have had the ability to winter and produce a new plant.

Figure 3. This shows a section of the shore line of the lake in Figure 2 after the bed of primrose was eradicated with Ammate

Pondweeds (*Potamogeton americanus* C. and S. and *Potamogeton diversifolius* Raf.).—These two species of pondweed were treated with Ammate while in a succulent stage, with and without a wetting agent. Without the detergent the spray stood in large round drops, but with the detergent added the drops were flatter and more irregular in shape. The parts of the leaves where drops collected became dark brown.

Within 2 days the surface parts of the leaves having contact with the spray were brown, and those stranded on the bank by receding water were very dark but still alive. The edges of a few leaves protruding from the water were crisp. At the end of 24 days, all of the treated plants had recovered and seed clusters were maturing.

Black willow (*Salix nigra* Marsh.).—While in a succulent stage, the seedlings and yearling sprouts of willow were sprayed with Ammate, with and without a wetting agent. Within 5 days all plants showed identical reactions: crisp, brown leaves on green twigs. At the end of 17 days, the upper halves of all plants were dead. The dead bark was loose from the brown or brown-streaked wood. The bark on the live part was green over white wood.

After 100 days, no part of the treated plants remained alive. The internal parts of the roots and stems were brown. This was true of all sprouts treated, some of which were 8 feet high.

Water willow (*Dianthera americana* L.).—These plants were sprayed while in full bloom. Without a wetting agent, the leaves were wet momentarily; then the solution drained from the veins to the midrib to form drops. With a wetting agent added, the leaves remained glossy-wet. Within 4 hours the leaves were brown-edged and curling from the lateral margins.

Two days later, the plants remained upright with many of the upper leaves, except for their midribs, brown and crisp; the lower leaves were not affected. At the end of 24 days, the upper parts were dead, but the lower parts remained green and were sending out new branches. After 40 days, the plants had recovered and were again in flower.

Arrowhead (*Sagittaria latifolia* [Willd.]).—These plants were sprayed while in full bloom. The Ammate solution without a wetting agent wet the leaves momentarily but soon drained down the veins to form drops clinging to the lower leaf margins. With a wetting agent added, the leaves remained wet. Within 24 hours all leaves bore a brown margin about half an inch wide.

Within one week all plants showed identical reactions: the leaves were dead and brown on green upright petioles. As time progressed, the brown color advanced about halfway down the petioles, but stopped short of the water-line. A few small young plants were killed, but large plants later recovered from the treatment.

Duckweed (*Lemna minor* L.).—When the spray was applied, Ammate alone did not wet, but with Vatsol O S added the plants became shiny-wet and in a short while turned brown as did the pondweeds. A day later, no effects could be observed where plants had been treated with Ammate alone. The pond-areas where Vatsol O S had been added were white with dead plants. Within a week, however, through wind and animal disturbance, the pool was again covered with live plants. The ease with which duckweed is disturbed and moved about makes control by spraying with Ammate impracticable.

Marginal vegetation.—When marginal growths of sedges, grasses, and broad-leafed plants were sprayed, all exhibited similar reactions. Within 24 hours the sprayed area around the pond became brown, as if burned by heat. In time, some of the broad-leafed plants were killed, including their roots, but the grasses and sedges remained alive below the ground and eventually recovered.

For the control of marginal vegetation, spraying is superior to mowing in that the plants recover less quickly and the operation requires less time and effort. Since the roots of most plants remain alive, they continue to protect the banks against slippage and wave-erosion.

While eliminating emergent and marginal vegetation, no attempt was made to ascertain concentrations of Ammate that might be lethal to fish. However, during these operations, even when considerable Ammate was used in and around fish ponds, there was no evidence of deleterious effects on fish.

EARLY EFFECTS AND END RESULTS OF SPRAYING EMERGENT VEGETATION WITH AMMONIUM SULFAMATE, WITH AND WITHOUT THE ADDITION OF THE WETTING AGENT, VATSOL O S

| Vegetation treated | Ammate | | Ammate + Vatsol O S | |
|---|---|---|---|---|
| | Early effects | End results | E a yrl effects | End results |
| Arrowhead | Burned the leaf margins | Killed the leaves and upper petioles | Burned the leaf margins | Killed the leaves and upper petioles |
| American lotus | Slight yellowing of leaves | Plants recovered | Yellowing and wilting of leaves | Plants killed |
| Pondweeds | Brown spotting of leaves | Plants recovered | Brown spotting of leaves | Plants recovered |
| Cat-tail | Leaf-tips yellow, margins brown | Undetermined | Leaves burned crisp | Plants dead; live buds at tip of rhizome |
| Water primrose | Wilting and rolling of leaves | Plants killed | Wilting and rolling of leaves | Plants killed |
| Water willow | Leaves brown-edged and curled | Killed upper half of plants | Leaves brown-edged and rolled | Killed upper half of plants |
| Duckweed | Plants became brown-spotted | Plants recovered | Plants turned brown | Plants killed |
| Black willow | Leaves burned brown; lower stems green | Plants killed | Leaves burned brown; lower stems green | Plants killed |
| Sedges and grasses | Upper parts of leaves brown | Above-ground parts dead | Upper parts of leaves brown | Above-ground parts dead |

## SUMMARY

Of the eight species of emergent and floating types of vegetation treated with one pound of Ammate to one gallon of water, two species were killed—black willow and water primrose.

When the wetting agent Vatsol O S was added, two additional species—cat-tail and water lotus—were killed.

Ammate successfully controlled the above-ground parts of marginal vegetation. The time required for recovery varied according to the species, but in all instances was of much longer duration than the time required for recovery from mowing.

Plants sprayed with Ammate appeared to be nontoxic to sheep and cattle. I should like to add that we found no ill effects on cattle and sheep which reached one area and ate an area dead of cat-tails approximately 8 feet wide and 100 feet long. They seemed to relish these plants, ate them down to the very ground, and seemed even to grope for the remainder under the ground.

With the concentration of Ammate used, no deleterious effects on fish were noted though large areas within ponds and the entire marginal zones were treated.

Pondweeds with floating leaves were highly resistant, and water primrose was extremely susceptible to Ammate.

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### DISCUSSION

MR. R. W. FAUTIN (Wyoming): I would like to ask Mr. Bauman if he has made any observations of the effect on aquatic invertebrates.

MR. BAUMAN: No, sir, I can't say what the effects on aquatic invertebrates would be. However, I will state this: Frogs living in the vegetation were blinded when the spray was put on them, but after spraying the vegetation in the water the invertebrates remained apparently in normal quantities. So I don't think it's too strong even for the tender skins of invertebrates.

MR. B. W. CARTWRIGHT (Manitoba, Canada): I would like to ask Mr. Bauman if he has had any experience with the treatment of Elodea. I am very much interested in the eradication of that weed if possible.

MR. BAUMAN: I have used the 2,4-D spray in waters where Elodea occurs in abundance. I have seen no effects whatsoever. However, should there be a method of carrying the 2,4-D spray to the plant, it might be successful.

MR. CARTWRIGHT: Do you know of any way of tackling the Elodea?

MR. BAUMAN: We have been working on it for several years in several ponds. In one pond we have been nearly successful.

MR. RICHARD M. BOND (Oregon): We have had a little experience with Elodea, using benochlore in drainage and irrigation ditches, and have gotten a very effective killdown to the surface of the mud; but I don't know whether that is a permanent kill yet or not. It seems to be much more effective on *Anacharis canadensis* than on *densa* which has been brought from South America to the West Coast.

I wanted to ask Mr. Bauman at what stage of growth the cat-tails were sprayed and whether they were narrow-leafed or broad-leafed cat-tails.

MR. BAUMAN: In all cases these plants are sprayed in the succulent stage. We get them before the bloom or while they are blooming. It is then much more effective. After they have blossomed, it takes much longer for the poison to be effective.

MR. PHIL GOODRUM (Georgia): There have been other experiments with this chemical in Florida on obnoxious trees. At the Southern Experiment Station, Fred Kelley since 1944 has conducted an experiment trying to kill blackjack oak. In parts of the Southeast blackjack oak is considered a pest. That's to me a more or less controversial question. They think it provides more pasturage for cattle if they kill some of the blackjack oak. They have written the results up just recently. They make two chips at the base of the tree and put two tablespoonfuls of Ammate in each chip: it completely kills the tree, with no sprouts They are still carrying on the experiment. I believe, too, that they are using it on other trees.

MR. FRED A. GLOVER (West Virginia): Along that same line of controlling obnoxious trees and weeds—if Mr. Handley is in the audience, I think he can enlighten you quite a bit with what he has done in Virginia. I have seen some of the experiments they have done there.

MR. C. O. HANDLEY (Virginia): We have pastures where the Ammate was sprayed on mountain laurel and that type of vegetation. We got a very good kill, and it did not adversely affect the rest which we wanted to bring out.

MR. BAUMAN: There seems to be no limit to what you can do with chemicals like this.

MR. EDWARD K. LOVE (Missouri): What about smartweed? That is one of the big growths we have in St. Charles County, Missouri. The smartweed is prolific and terrific.

MR. BAUMAN: My observations haven't been sufficient to answer that positively; but I would say, from what I know of the use of it, that it would probably kill smartweed if used while the plant is succulent.

MR. A. E. BORELL (New Mexico): Mr. Bauman, you refer to cat-tails killing to the ground. What happens when they are growing in water?

MR. BAUMAN: When they grew in the water it took a little longer for the lethal effects to get down to the roots, but eventually they did. However, I suspect that if any of them recovered, those in the water had a better chance than the others. They were the ones that bore live tips—the live buds at the tips of the dead, decayed stems.

MR. O. A. FRYE (Florida): Do you have any idea what possible effect this chemical might have on sawgrass formations, in a semidead state and a dense stand?

MR. BAUMAN: My only familiarity with your sawgrass is from fishing down in your part of the country. From what I remember of it, I would say it probably would resist the Ammate except that the leaves would probably be burned if you used a wetting agent along with it. They are waxy, and I think the spray probably would make no contact unless you used the wetting agent.

MR. FRYE: If you burned the sawgrass first, then applied this chemical to the new growth, do you think that would do any good?

MR. BAUMAN: By mowing and burning it, yes. Then you would spray the new shoots. It would take several applications. By continuing that, the plant would undoubtedly die.

MR. DAVISON (Georgia): Have any of you had any experience with this chemical on the alligator weed or the parrot's feather?

MR. BAUMAN: No sir.

# TECHNICAL SESSION

## Tuesday Morning—February 4

*Chairman:* Oscar E. Sette[1]
In Charge, South Pacific Fishery Investigations, U. S. Fish and Wildlife Service, Palo Alto, California

*Vice-Chairman:* Lionel A. Walford
Assistant Chief, Division of Information, U. S. Fish and Wildlife Service, Washington, D. C.

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## MARINE FISHERIES AND OCEAN AREAS

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# ON THE FISHERIES RESOURCES OF THE CENTRAL PACIFIC

Wilbert McLeod Chapman
*California Academy of Science, San Francisco, California*

In the first half of the nineteenth century the central Pacific was very nearly as well known to the men of the New England fishing ports as the neighboring North Atlantic. The whalers criss-crossed the vast expanse of the Pacific and to them may be attributed the discovery of many of the atolls, reefs, and islets that stud the area. Before the turn of the century, the great American whale fishery had died and in the succeeding 75 years Americans very nearly forgot these rich hunting grounds.

During the recent hostilities, upwards of a million Americans went again into the area. None of the points of land in it escaped their attention and there was scarcely a square mile of its enormous water surface that was not crossed by an American vessel. Included in this horde of invaders were several hundred seamen which the war had taken from the West Coast fisheries. To them the riches of the area

[1]In the absence of Mr. Sette, Dr. Walford presided as chairman.

were apparent. It was full of the same kinds of fish from which they had made a living at home.

It is the purpose of this presentation to discuss the fishery resources of the central Pacific and to point out a few of the fields of information on this subject upon which we have insufficient knowledge to enable us to play an intelligent role in the development of these resources.

*The fishes.*—The fishes of central Pacific form a portion of a fish fauna which extends in unbroken array from the Red Sea and East Africa in the west to the Marquesas and other islands in eastern Polynesia to the east, and from southern Japan on the north to central Australia on the south. Within this considerable section of the earth's surface, the fish fauna maintain a remarkable homogeneity not only among the large kinds, but among the tiny forms as well. It is the largest fish fauna in the world from the standpoint of the numbers of families, genera, and species it contains as well as from the area it covers. It contains perhaps the largest virgin supply of protein food which remains to be exploited by mankind.

In spite of these superlatives it remains among the most poorly known of fish faunas. The taxonomy of its forms is extremely confused, scarcely anything is known about the life histories of the species in it, the depths have scarcely begun to be explored, the general economy of the seas is poorly understood, and the knowledge about the abundance, seasonal occurrence, and distribution of even the presently important large food species is fragmentary.

For the purpose of our consideration the fauna of the central Pacific can be conveniently divided into three categories: the inhabitants of the depths; the shore dwellers, who are tied by their habits to the land; and the pelagic species which roam the open sea and stay clear of the land.

*The bathypelagic fauna.*—From the standpoint of the professional ichthyologist, the bathypelagic portion of the fauna holds an overwhelming fascination because it would be impossible to undertake any serious work upon it that would not yield a wealth of new information. The subsurface section of the Pacific, which occupies a greater area than all of the land of the earth, is virtually virgin territory to the explorer. Most of the specimens which the *Challenger* and *Albatross* brought to the surface were new to science and a large number of these species have never been seen again, for there has been no deep-sea exploration in this region in recent years.

What is known of the inhabitants of the deep in the central Pacific is limited very largely to the information that these two vessels brought back. Neither was equipped with adequate gear for exploring the intermediate depths; both were preliminary reconnaisance expeditions, standing in relation to modern exploratory missions in about the same relation as the voyage of Magellan stands to the present Navy-Byrd expedition to the Antarctica.

Besides a general ignorance of the bathybial dwellers of the open central Pacific there are great deeps and trenches in the southwest Pacific, which are isolated from each other and from the main Pacific basin by broad expanses of shallower area into which a net has never been lowered. Because of their ancient isolation it is to be expected that the unknown faunas of these deeps would be quite distinctive and very largely new to science.

The reason for this lack of exploration is simple. Such expeditions can be conducted only on large vessels which can stand any weather, have winch capacity for five or six thousand fathom of wire cable, and can remain away from port for a considerable length of time. Such expeditions are so expensive as to be beyond the financial capabilities of private research organizations. It is the hope of professional zoologists that the American government will accept a responsible role in the development of this field of exploration and that one or more vessels will be equipped for this type of work and put into service.

*The reef and lagoon fishes.*—It is in the shallow waters around coral reefs that the tremendous variety of Pacific fishes is found. The richly colored and bizarrely shaped fishes are such a prominent feature of the coral country that they have caught the interest of zoologists since the earliest exploratory voyages. English, French, Dutch, Australian, Indian, German, Japanese, Philippine, American, and Siamese fish students have worked enthusiastically in their own sections of the fauna, often under the mistaken impression that their section was somewhat different than others, usually without adequate reference collections of specimens and without sufficient library facilities to discover what those before them had done.

The result of this work has been a plethora of uncorrelated literature in many languages, species described over and over again, no proper information as to the interrelationships of the groups in the fauna, and a degree of confusion that cannot be appreciated by anyone who has not become entangled.

The very vastness of the fauna has served to multiply the difficulties of working with it. There are a little more than 500 species of fish in the entire northeast Pacific; over 8,000 species have been described in the Dutch East Indies and adjacent areas. Recent ichthyologists seem to have almost abandoned trying to untangle the literature and as a result layer upon layer of new confusion continues to be added.

It is necessary that a drastic change be made in the nature of the systematic work on this fauna. The first step should be the compilation of a complete bibliography of the entire Indo-Pacific faunal area. The second step should be the compilation of a checklist of the fishes of the entire faunal area. From these basic reference points each group of fishes should be taken up separately, the synonym of its taxonomic units worked out and the distributional pictures corrected and amplified for the group through the entire faunal area.

*Practic aspects.*—This section of the fauna, the inshore fishes, have considerable practical as well as scientific interest.

In the southwest Pacific the Japanese, before the war, developed fisheries for these kinds of fishes which yielded poundages which were important in terms of even their huge fisheries. I question, however, that fisheries for these types of fishes in the central Pacific will ever amount to much in terms of our, or the world's, economy. The spots of land in the central Pacific, while numerous, are so small and isolated, and provide such proportionably minor sources of food for the inshore fish populations that it is to be questioned that the stocks could stand a very intensive fishery. The history of the inshore fisheries of Hawaii indicate that the stocks are exhausted by fisheries of relatively small size, and it was my impression at atolls elsewhere in the Pacific that similar conditions existed.

These fish populations are of the greatest importance, however, to the native peoples. It is upon them that the natives place their principal day to day dependence for protein food. The exhaustion of the reef and lagoon fisheries would quickly bring suflering and hardship to them. It is suggested that no fisheries for this kind of fishes should be permitted by white men until mature studies have shown that such fisheries will not work to the hardship of the natives.

The problems of exploiting new kinds of fisheries is continually arising in our maritime states. Here we have, and are continually augmenting, a backlog of knowledge concerning the life history of the different kinds of fish which are not presently, but may become, commercially important. Thus the administrators of our fishery resources can draw upon a mass of that basic information which is essential to the rational management of fisheries.

The administrators of island affairs in the Pacific have no such backlog of information to draw upon. In view of the importance of fish to the welfare of the natives it is suggested that the agency of government which is going to adminster the American Islands in the Pacific should include a branch concerned with research upon the practical aspects of the reef and lagoon fishes.

*The pelagic fishes.*—Unlike the bathybial and the reef and lagoon fishes, the pelagic fishes of the tropical Pacific are of considerable importance to our own and the world's economy. It is not unlikely that their exploitation will have inportant repercussions in world politics before it becomes stabilized.

For pelagic fishes the word tuna can be substituted without much loss of scope, for it is the tuna which are so overwhelmingly abundant throughout the tropical Pacific. They are true fish of the open sea; they ordinarily do not even come in over shallow areas. Wherever I was in the central Pacific I found tuna in abundance out in the blue water offshore—in such abundance that it was quite impressive. A comparison of notes with other men who had been at other islands in the Pacific indicated the tuna were spread uniformly across the Pacific, and seemed to be in commercial abundance nearly everywhere.

These impressions were confirmed by the results of subsistence fisheries begun by the Navy in the Marianas during the war, by the results of the field work at Bikini during the atom bomb tests, and through the discovery by the Navy of the statistics of the Japanese prewar tuna fisheries in the mandated islands.

About one third of the fish landed in the United States and its possessions is landed in the State of California. Some 55 per cent of the value of the annual landings of fish in California is tuna. The California tuna fisheries rank second in importance to us only to the Alaska salmon fisheries, and they are continuing to expand rapidly. The vessels now fishing out of San Diego and San Pedro cover the entire ocean south to the equator in their search for fish. It is not unusual for one of the clippers to cruise as much as 8,000 miles before returning home (this is about the round trip distance from Seattle to Tokyo).

While our tuna fisheries are of great importance to us, they landed only about one third as much tuna per year before the war as did the Japanese fisheries. Such statistics as are available now show that the Japanese were taking about as many tuna from the mandated islands alone as we were taking in the California fishery.

Thus the proven productive capacity of the central Pacific is of the first magnitude. Since it is known that the Japanese were still expanding their fishery in the mandated area before the war, and that the tuna resources of Polynesia (with the exception of Hawaii) has never been tapped by anyone, it is suspected that the tunas of the Pacific will come to a much greater point of importance in years to come than they have in the past.

The possession of island bases in the heart of tuna country does not necessarily guarantee a tuna fishery or an overwhelming advantage over other nations in the development of the fisheries.

No way is seen by which the methods which are presently in use by Americans for capture of tuna can be used profitably on a large scale in the central Pacific. The distances between fishing grounds and market are so great, the known bait resources so small, the price structure of our fishery so high, etc., that new methods will need to be applied.

One such method is available: the mothership, which is a large freighter made into a mobile, self-powered, self-contained supply base for a fleet of smaller fishing vessels. Such vessels and their fishing fleets can stay out of port continually for as much as 9 months at a time. They can actually, and practically, operate out of their home base to any corner of their world. Their development and use has outmoded the former practise of high-seas fisheries and the regulation and conservation of such fisheries for the reason that fishermen no longer are confined to operations within a few hundred miles of home.

The capital investment for beginning such an enterprise is considerable. American firms are hesitant to plunge into the development of the central Pacific fisheries on the basis of the present fragmentary information as to seasonal and geographical occurrences of the fish. What is needed is a thorough and practical exploration of the area designed to supply this necessary information to the industry. Such an exploration will be costly for the area to be covered is huge and the work will have to be done on a scale large enough that the results can be applied directly to the commercial fishery. The value of the resource is great enough to justify considerable expenses.

*Economic aspects.*—One may be inclined to wonder why the United States should be so interested in expanding her fisheries into the area. Several reasons can be suggested:

1. The area is considerably essential to our national defense. We have assumed large responsibilities on behalf of the native peoples. Both of these factors will result in large expenditures by this country in the central Pacific. It is reasonable to attempt to recover as much of this money as possible from the area. There are no other resources of consequence in the area. There is no labor that can be drawn upon. There are no considerable mineral or timber resources. There is scarcely enough agricultural land to support the natives. While the total area of the mandated islands is larger than that of the United States, it is nearly all water. The land is only about the size of the State of Delaware, and most of that is poor. There is no other important source of wealth in the area besides the fishes of the sea.

2. The tuna represent an important need in our own economy.

Our domestic demand for tuna continues to expand rapidly. It is questionable whether the area of the present California tuna fishery will produce a greatly expanded catch. This year the number of vessels fishing that area has been increased sharply without a proportionately sharp increase in production.

3. It is pointed out that our needs for protein food may be considerably increased in 50 or 100 years from now as our population increases. Recent developments in the interpretation of international laws on the conservation and regulation of high-seas fisheries indicate that it is desirable for us to stake out in the next few years those areas of the ocean whose produce we will need in the future. It would appear that these next few years may be times for decision in regard to the water surfaces of the earth as the last century was for the land surfaces.

## CONCLUSION

In this brief examination of the fishery resources of the central Pacific it has been indicated that:

1. Exploration of the subsurface layers of the Pacific would yield a wealth of material new to science such as could scarcely be expected from the same expenditure of effort elsewhere on earth.

2. There exists considerable confusion in the systematics of the littoral fish fauna of the Indo-Pacific area. To remedy the defects in this field of knowledge, certain steps have been recommended: (1) The preparation of a bibliography on the fauna; (2) the preparation of a checklist of the fauna; (3) the systematic revision group by group of the families and genera on a faunal wide basis.

3. The inshore fisheries are of primary importance to the native peoples and should be reserved to their use except where exportable surpluses can be demonstrated. The administrators of the islands will need a considerable body of information about the life histories and habits of these fishes which is not available. Provision should be made to begin the gathering of this information.

4. The pelagic fishes, in particular the tunas, present a food resource of the first magnitude. A large scale investigation of this resource should be initiated in the immediate future designed to provide information for the development, management, and perpetuation of American fisheries in the area.

## DISCUSSION

MR. E. W. ALLEN (Washington): What is the prospect of securing interest on the part of the government in doing this exploratory work?

DR. CHAPMAN: There is a bill before the Congress at the present time, H. R. 859, introduced by Delegate Farrington from Hawaii which is designed to accomplish the objectives I have spoken of: to provide funds for the investigation and the exploratory work I have indicated.

MR. MILTON C. JAMES (District of Columbia): The Secretary of the Interior has made a recommendation to Congress for undertaking a program of this kind. That might be considered as supporting the Farrington bill; and in any case it is a recommendation for an all-out attempt to secure the information which you pointed out so clearly is necessary. I would like to ask if in your consideration of the matter you had visualized the possibility that the stocks which are supporting the present commercial fishery in California might be identical with those in the western Pacific? In other words, the tunas may be so far ranging that we are already drawing from that resource without knowing it.

DR. CHAPMAN: There is that possibility, but we just don't have enough information about tunas to say one way or the other. There is one interesting point along that line. When the magnets were put in sardine reduction plants to recover sardine tags in California, they recovered from tuna offal (which was also run through the same plants) some hooks which were obviously of Japanese origin. The Japanese did fish albacore continually from their own shores out to the longitude of Midway and we don't know whether the recovered hooks indicate our albacore belong to the same stocks as are fished by the Japanese in the western Pacific, or whether they may have originated from fish taken by Japanese operating near our shores.

CHAIRMAN WALFORD: Some evidence pertinent to that point was found by Brock who studied the albacore in Oregon. According to an age analysis of the stock taken by the commercial fishery, there appears to be only 2- or 3-year classes of albacore that come within range of our fishery. Very young ones, i.e., "fish of the year" are never found. But on the western side of the Pacific younger and older age classes are taken. This suggests that albacore originate somewhere in the western Pacific and visit our shores during a relatively small segment of their life cycle.

MR. J. L. BAUGHMAN (Texas): Is there any reason to believe that the tunas of the Atlantic are distinct from those of the Pacific?

DR. CHAPMAN: I wish I could answer that question. The taxonomy of tunas is very confused, because they are such large fish that a sufficient number of them can't be kept in museums to make collections for studies. I have examined tunas from the Caribbean and from the eastern Pacific and I am not able to distinguish the species myself.

MR. BAUGHMAN: Assuming that there is no difference, is there any reason why tuna investigations should not be extended to cover the Atlantic as well as the Pacific? There are blue fin in some quantities off Nova Scotia, which presumably migrate northward from the Bermudas and Cape Cabron; but we do not know anything about their point of origin or about the course of their migrations. Furthermore, at times there are very large tuna runs in the Gulf of Mexico off south Texas down towards the Cape of Yucatan. Anglers, fishing in that area as far offshore as a hundred miles, have reported many times seeing tuna there larger than 200 pounds running in aggregations that "turned the top of the Gulf white for miles."

If there is to be a tuna investigation, it seems well to me that it should take in the tuna throughout the world.

# THE LAGUNA MADRE OF TEXAS

JOEL W. HEDGPETH
*Texas Game, Fish and Oyster Commission, Austin, Texas*

The Laguna Madre of Texas is a long, narrow coastal lagoon, extending from the Rio Grande to Corpus Christi in a broad arc in a northerly to northeasterly direction (Figure 1). It is separated from the Gulf of Mexico by Padre Island, a long sliver of sand which is less than a mile wide in many places. The Laguna Madre is about 130 miles long and from 3 to 5 miles wide, but nowhere is it more than 9 feet deep. Over most of its area it is very shallow, and many parts of it are but a few inches deep at normal stages of the tide. Nevertheless, this narrow coastal bay is now the most important source of commercial fish on the Texas Coast. During the last several years, it has supplied from 40 to 51 per cent of the entire fish catch taken from all bay areas of Texas, although its area is only about 20 per cent of the total bay area.

The leading commercial fish taken from Texas waters are the redfish or red drum (*Sciaenops ocellata*), the black drum (*Pogonias chromis*), and the speckled trout (*Cynoscion nebulosus*). These three fish together comprise more than 86 per cent of the total catch of all fish reported in Texas, exclusive of the red snapper, which is caught outside the territorial waters of the state (Figure 2a). During the last 5 fiscal years (Sept. 1 to Aug. 31), the combined catch of these three leading fish was 16,174,335 pounds, of which 9,658,561 pounds were taken from the Laguna Madre. The yearly average catch of these three species from the Laguna Madre during this period (1941-42—1945-46) was 1,931,312 pounds. The yearly average catch of the same three fish for the entire coast during this period was 3,234,867 pounds. Thus the average production of the Laguna Madre for the last 5 years has been roughly 60 per cent of the total Texas production of redfish, drum and trout (Figure 2b).

How much of this productivity is due to the peculiar salinity conditions of the Laguna Madre and how much is due to the relatively unchanged environment, as compared with extensive changes made in the other coastal waters of Texas by industrial developments, ship channels and abnormal silting from poor agricultural practices, is hard to determine. Fifty years ago, the bulk of the commercial fish catch came from Galveston Bay, and the contribution of the Laguna was negligible. Today the situation is reversed, although the total catch is not greatly changed. The production from the central area has remained about the same.

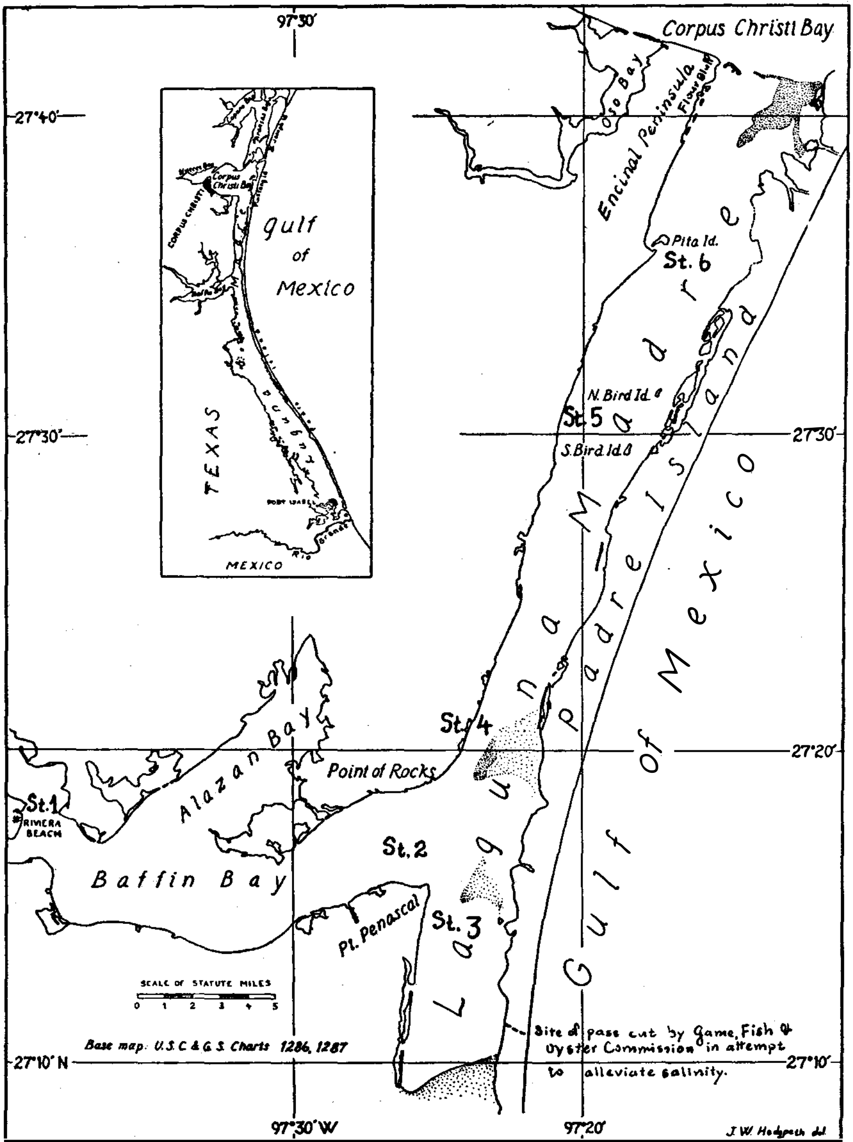


Figure 1. Upper part of the Laguna Madre of Texas

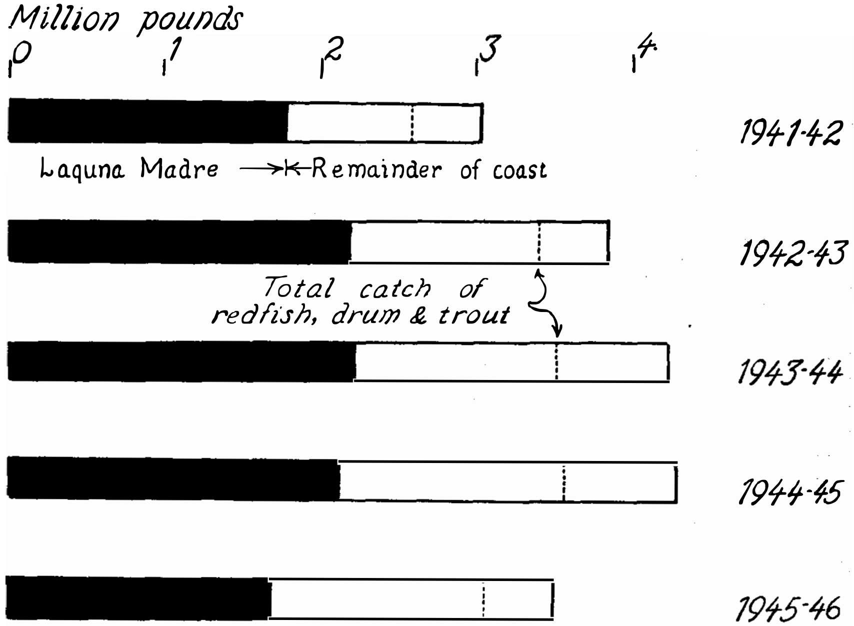


Figure 2a. Total fish catch in Texas coastal waters for last 5 fiscal years

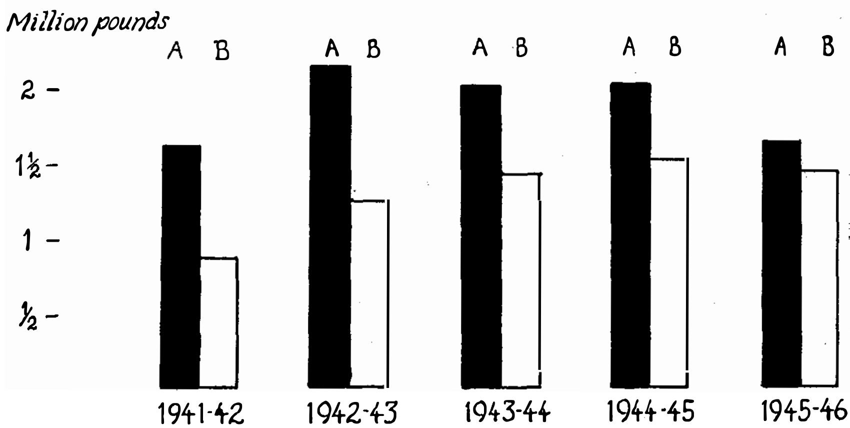


Figure 2b. Catch of redfish, trout and drum from Texas coastal waters for the last 5 fiscal years. A: Laguna Madre; B: Remainder of coast

TABLE 1. TEXAS COMMERCIAL FISH PRODUCTION, BY FISCAL YEARS
(All figures in pounds)

1941-42

| | Laguna Madre | Remainder of coast | Total |
|---|---|---|---|
| Redfish | 517,806 | 242,075 | 759,881 |
| Trout | 577,953 | 504,698 | 1,082,651 |
| Drum | 627,844 | 116,430 | 744,274 |
| Totals | 1,723,603 | 863,203 | 2,586,806 |

Total Laguna Madre production (all species) 1,741,954
Total coast production (all species) 2,939,980

1942-43

| | Laguna Madre | Remainder of coast | Total |
|---|---|---|---|
| Redfish | 598,708 | 408,796 | 1,007,504 |
| Trout | 597,782 | 667,274 | 1,265,056 |
| Drum | 963,779 | 162,105 | 1,125,884 |
| Totals | 2,160,269 | 1,238,175 | 3,398,444 |

Total Laguna Madre production (all species) 2,181,736
Total coast production (all species) 3,766,126

1943-44

| | Laguna Madre | Remainder of coast | Total |
|---|---|---|---|
| Redfish | 382,033 | 546,290 | 928,323 |
| Trout | 888,294 | 745,456 | 1,633,750 |
| Drum | 786,578 | 163,247 | 949,825 |
| Totals | 2,056,905 | 1,454,993 | 3,511,898 |

Total Laguna Madre production (all species) 2,137,877
Total coast production (all species) 4,215,841

1944-45

| | Laguna Madre | Remainder of coast | Total |
|---|---|---|---|
| Redfish | 432.120 | 554.365 | 986.485 |
| Trout | 843,892 | 737,788 | 1,581.680 |
| Drum | 783,299 | 229,483 | 1,022,782 |
| Totals | 2,059,311 | 1,521,636 | 3,580,847 |

Total Laguna Madre production (all species) 2,131,137
Total coast production (all species) 4,250,207

1945-46

| | Laguna Madre | Remainder of coast | Total |
|---|---|---|---|
| Redfish | 314,553 | 363,314 | 677,867 |
| Trout | 654,303 | 548,101 | 1,202,404 |
| Drum | 689,617 | 526,452 | 1,206,069 |
| Totals | 1,658,473 | 1,437,867 | 3,096,340 |

Total Laguna Madre production (all species) 1,714,419
Total coast production (all species) 3,472,041

It is important to remember that redfish and drum do not spawn in the bays, but in the passes to the Gulf of Mexico and along the Gulf beach near the passes. (Pearson, 1929; Gunter, 1945a). After hatching, the young migrate into the bays and grow there. As far as these species, and many others, are concerned, the bays are nursery grounds.

In the case of the trout, (*Cynoscion nebulosus*), however, the situation is different. This fish spawns in the bays, possibly in less saline bay areas. There is no good evidence that it spawns in the more saline parts of the Laguna Madre, at least in the northern half. However, the life histories of the fish in this area are incompletely understood. It does seem that the Laguna Madre is somehow more favorable for the growth of fishes than some less saline areas. There are indications that a correlation between size and salinity exists, that the larger individuals of a euryhaline species will be found in the water of greater salinity (Gunter, 1945a, pp. 114-116).

The stock of a bay can be almost exterminated by a hard freeze, or as in the case of the Laguna Madre, by excessive summer salinities, but will be replenished from the breeding stock 2 or 3 years after such a catastrophe. (Gunter, 1945a, pp. 103-108). Suc hrecovery from wholesale reduction would indicate that overfishing in Texas bays is not as great a danger as the deterioration of the natural environment of the bays. During the first 2 weeks of January 1947, a severe cold spell along the Texas coast, in combination with a period of low tides, resulted in extensive mortality to fish, especially in the Laguna Madre and the back bays. Of the commercially important fishes, the greatest loss was inflicted on the trout. Many large female trout were seen dead along the shores of Copano Bay and in the Laguna Madre. Redfish were severely affected, and many dead drum were also observed. This loss does not seem to be as extensive as that of January 1940, at least along the central coast, although it may have amounted to several million pounds along the entire coast. Nevertheless, it is quite probable that this loss of 1947 exceeded the commercial fish catch for the previous fiscal year. Because of the very shallow water of the Laguna Madre and the inadequate connection with Corpus Christi Bay, which made it impossible for the fish to escape to warmer water, the loss was apparently greatest in the Laguna.

The loss of marine resources through industrialization, pollution and physical alteration by the construction of channels, causeways, jetties, and other projects is irreversible, whereas mortality caused by cold spells and high salinities can be overcome in an unspoiled environment. The decline of the marine environment on the Texas

Coast has been well outlined by Dr. Gordon Gunter in a recent article in *Texas Game and Fish* (Gunter, 1946).

The Laguna Madre is one of the world's more peculiar bodies of water. It lies across two climatic areas, the subhumid in the north and the semiarid in the south. The line of demarcation between these regions lies roughly at Baffin Bay. Above that line precipitation and evaporation are in balance, and below it there is more evaporation than precipitation. Before the hurricane of 1919 the Laguna Madre was a continuous body of water, but at that time it was divided by the movement of sand from Padre Island into two parts about 10 miles below Baffin Bay. This dry land area is about 35 miles long and is covered only by extreme high tides. The upper end of the Laguna Madre is now about 35 miles long and from 3 to 5 miles wide. At its lower end is Baffin Bay, which extends some 15 miles westward at a right angle to the axis of the Laguna. Just above the confluence with Baffin Bay, in the area known as Point of Rocks, there is extensive shoaling, which has reduced the width of the Laguna at this point to less than a mile except during the high tides of the fall and spring months.

The greater part of the Laguna Madre is very shallow. Large areas along the Gulf side adjacent to Padre Island are less than a foot in depth. Along the mainland side the depths range from 3 or 4 to 5 or 6 feet with an occasional hole 7 or 8 feet deep. The entire bottom of the Laguna rises northward toward Corpus Christi Bay, forming an extensive bar which blocks the water from Corpus Christi Bay during periods of low tide.

About every 10 years or so the salinity of the upper part of the Laguna becomes so high that there is heavy fish mortality, and most of the fish population is wiped out at such times. Even under conditions of favorable salinity exchange, the salinity of the upper part of the Laguna is often more than twice that of normal sea water. After the concentration has passed 72°/oo, the fish begin to die, so there is always some fish mortality in the Laguna. The normal concentration of salts in the sea is 35°/oo. Of course, salinity is not the only factor affecting fish in the Laguna Madre. The summer water temperatures are very high; surface temperatures of 33° to 35°C are not rare. The oxygen content at such high salinities and temperatures was not determined as the facilities were not available. However, the main cause of fish mortality is mechanical. If the fish could escape the Laguna "death trap" (as the press calls it) during the summer, mortality would not be as high as it is.

These periods of high salinity are the result of the shoaling at the northern end of the Laguna Madre where it connects with Corpus

Christi Bay across a high threshold, the constriction at Point of Rocks, and the lack of adequate precipitation or fresh-water drainage. It is possible that what water does drain into the Laguna carries salt with it from old deposits.

Although several miles wide in most places, the Laguna Madre is in effect a long channel, and the fact that it has shoaled at the northern end is an indication of what can be expected of any channel dug along its axis, whether as an aid to navigation or for salinity exchange. At the present time the Intracoastal Waterway is being extended from Corpus Christi to Port Isabel through the Laguna Madre, and the hope has been expressed that this channel will alleviate the excessive salinity conditions which now occur. This channel will be 130 miles long and only 200 feet wide, and since there will be no adequate source of water at either end to set up a current, it is difficult to understand how it will be of much benefit to salinity exchange. In all probability the water will rock back and forth in this channel without getting anywhere, and its 15-foot depth may serve as a trap for the denser water of high salinity.

Salinity exchange is a lateral and laminar process, and is not affected in or through narrow channels. It is true of course that there is limited interchange of salinities between bodies of water connected by narrow channels, but the adjacent bodies nevertheless retain their distinctive characteristics.[1] A typical example on the Texas coast is that of Copano and Aransas Bays, which are connected by a channel about 2½ miles wide. The yearly average salinity of Copano Bay is 9.1°/oo, whereas that of Aransas Bay is 20.5°/oo (Gunter, 1945a). In the Laguna Madre the salinity is so much greater than that of Corpus Christi Bay that the situation is exaggerated.

For several years the Game, Fish and Oyster Commission tried to alleviate conditions in the upper Laguna Madre by cutting an artificial pass to the Gulf just above the filled part of the Laguna at Murdoch's Landing. This effort was unsuccessful because of its small scale in comparison with the total area of water to be affected. Such a pass could not be kept open because there is no influx of water into the Laguna from a river to maintain a head of water sufficient to prevent the filling up of the channel by the action of the wind. A pass adequate enough to effect even a moderate exchange of salinities would cost millions of dollars, for it would have to be several miles wide. The story of the Commission's effort to maintain passes

[1]This property of oceanic waters is the basis of modern dynamical oceanography (McEwen, 1932). If sea water mixed rapidly, it would be impossible to determine ocean currents by mathematical analysis, as is now done. The best known example of a current in mid-ocean retaining its own characteristic salinity and temperature is the Gulf Stream (Marmer, 1929).

into the Laguna Madre has been told in some detail by Gunter (1945a).

In a recent study of the interchange of water between the Black Sea, the Sea of Marmora and the Sea of Azov, it was demonstrated that the denser, more saline water is not disposed of by flowing into a deeper basin, but "by mixing with a surface current of less density flowing in the opposite direction." (Ullyot and Ilgaz, 1946). The Bosporus, the channel between the Black Sea and the Sea of Marmora, serves as a trap for the more saline water of the Sea of Marmora, so that it never mixes with that of the Black Sea, but is turned back on itself by the frictional action of the lighter surface layer. In order to be effective, even within the limits of hydrographic conditions, a channel must slope in the direction of the less saline body of water, so that the denser water will flow into the less saline basin. If the channel bottom is level or has a higher threshold at the end nearest the lighter water, the denser water will not move out. Even under optimum conditions the incoming current of lighter water in the upper layer will pick up some of the heavier water below it and, therefore, be of higher salinity than the water from which it originated. This is exactly what happens to the water exchange between Corpus Christi Bay and the Laguna Madre at the present time (Figure 5).

Beginning on July 19, 1946, a series of weekly salinity samples has been taken at six selected surface stations in the Laguna Madre by airplane (Figure 1). Usually the samples are all taken within a period of 2 hours, which is as nearly simultaneous as feasible. Salinities are determined from hydrometer readings, which are accurate enough in view of the very high salinities involved.

It is apparent that this series of samples (Table 2) records the conditions in the Laguna at the critical period of the fall overturn caused by the equinoctial tide. A comparison between the tide at Corpus Christi and the fluctuation of salinity in the Laguna (Figures 3 and 4) illustrates clearly how the salinity falls after each successive tidal rise, as the tide proceeds down the Laguna.[2] Between July 19 and 25 the salinity dropped at Station 6 (nearest Corpus Christi Bay), and with a further tidal rise the salinity of Station 5 fell the next week. On the third week the effect became noticeable at Station 4, the narrow constriction near Point of Rocks. However, there were no pronounced tidal increases for nearly 2 weeks, during which time the salinity at Station 4 increased. Finally, with the high September tides, the entire salinity of the Laguna began to fall.

[2]The tides of this part of the Gulf of Mexico are somewhat peculiar, as can be seen from the tidal graph in Figure 3. (Marmer, 1926, pp. 57-59.)

The most conspicuous thing about this exchange is the oscillation at Station 4. Carrying out this picture of salinity exchange into the winter stabilization period (Figure 6), it can be seen that the Laguna divides in two parts, the southern end and Baffin Bay assuming a

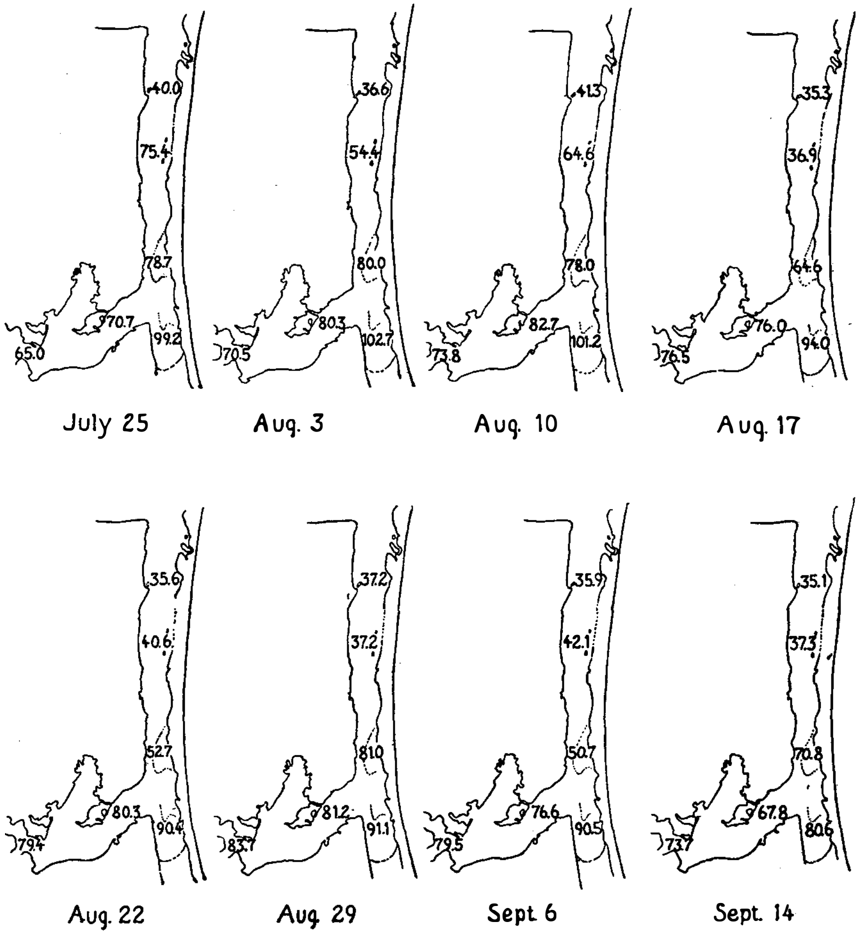


Figure 3. Pattern of surface salinities in the Laguna Madre during the critical period of fall tides, 1946

concentration of around 50°/oo, while the more open end levels off at about 35°/oo and then gradually falls toward the salinity of Corpus Christi Bay. It is evident from the graph (Figure 6), that complete exchange of the more saline water of the Laguna Madre as a

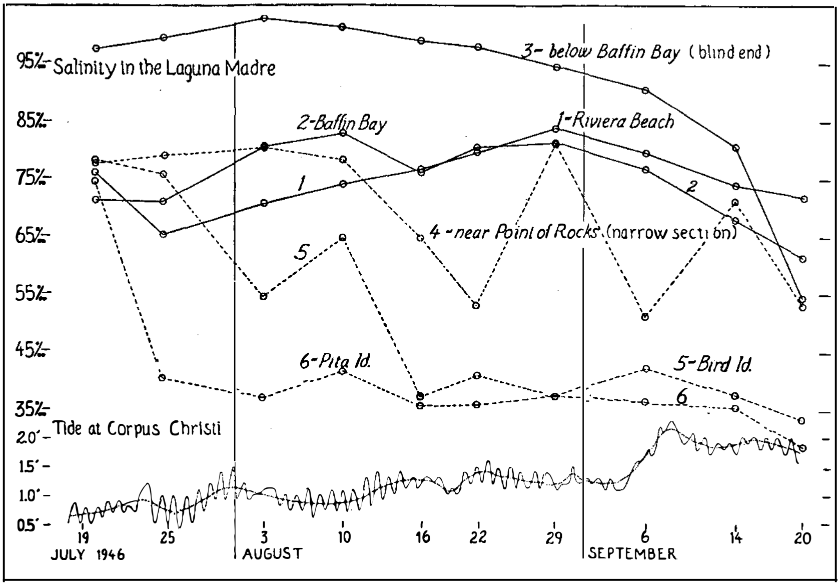


Figure 4. Relationship of tide and salinity exchange, Corpus Christi Bay and the Laguna Madre

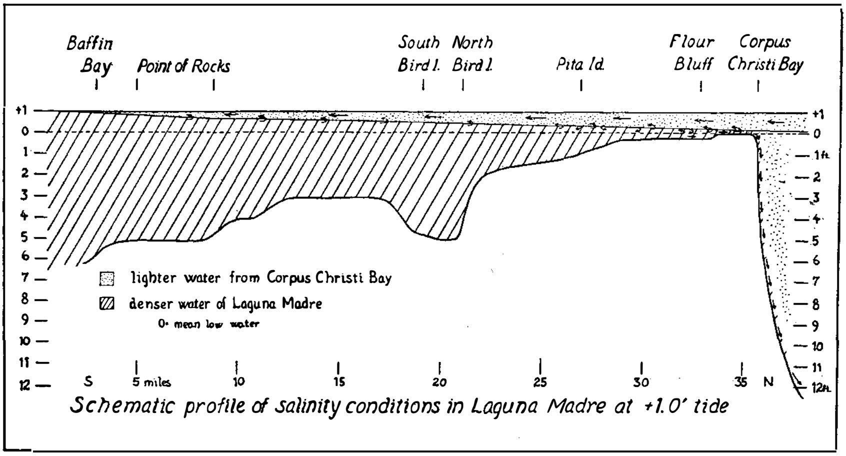


Figure 5. Diagram showing layering of salt water of different densities in the Laguna Madre

whole and the water of Corpus Christi Bay seldom occurs, and that the waters within the Laguna are stabilized during the summer period of high salinities, only to become separated during the period of high fall tides into two salinity groupings. This break occurs at Station 4, which is at that part of the Laguna where the width has been constricted by a large bar. This constriction is almost a mile wide, but, nevertheless, it effectively splits the Laguna into two hydrographic units, and furthermore, the water in this constriction remains with the higher salinity group of the stations south of it. Later on, as the low tides of December set in, the back part of the Laguna remains little affected, but the oscillation which occured at Station 4 during August and September moved northward to Stations 5 and 6, im-

TABLE 2. SALINITY DETERMINATIONS IN THE LAGUNA MADRE, 1946-47
(by hydrometers)

| Date / Station No. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1946 | | | | | | |
| July 19 | 75.6 | 71.0 | 97.2 | 77.4 | 77.9 | 74.3 |
| July 25 | 65.0 | 70.7 | 99.2 | 78.7 | 75.4 | 40.0 |
| August 3 | 70.5 | 80.3 | 102.7 | 80.0 | 54.4 | 36.6 |
| August 10 | 73.8 | 82.7 | 101.2 | 78.0 | 64.6 | 41.3 |
| August 16 | 76.5 | 76.0 | 94.0 | 64.6 | 36.9 | 35.3 |
| August 22 | 79.4 | 80.3 | 90.4 | 52.7 | 40.6 | 35.6 |
| August 29 | 83.7 | 81.2 | 91.1 | 81.0 | 37.2 | 37.2 |
| September 6 | 79.5 | 76.6 | 90.5 | 50.7 | 42.1 | 35.9 |
| September 14 | 73.7 | 67.8 | 80.6 | 70.8 | 37.3 | 35.1 |
| September 20 | 72.0 | 61.4 | 54.4 | 53.0 | 33.1 | 28.3 |
| October 2 | 68.5 | 64.4 | 36.0 | 33.8 | 24.2 | 24.9 |
| October 17 | 55.1 | 58.4 | 55.1 | 52.8 | 39.9 | 32.7 |
| November 7 | 47.2 | 58.4 | 61.2 | 52.5 | 22.5 | 17.5 |
| November 29 | 53.5 | 52.8 | 52.8 | 50.7 | 23.7 | 23.2 |
| December 5 | 52.7 | 50.0 | 45.8 | 48.9 | 27.6 | 28.7 |
| December 12 | 50.8 | 49.6 | 51.2 | 51.7 | 44.3 | 35.5 |
| December 20 | 51.5 | 52.1 | 50.0 | 46.8 | 31.2 | 22.1 |
| December 27 | 54.8 | 52.1 | 54.2 | 51.0 | 46.3 | 41.7 |
| 1947 | | | | | | |
| January 6 | 56.8 | 48.9 | 46.8 | 50.6 | 24.1 | 24.1 |
| January 19 | 54.8 | 52.8 | 49.1 | 51.9 | 36.7 | 29.4 |

mediately below Corpus Christi Bay. This would appear to indicate that this section of the Laguna is already becoming more saline at this time. The affect of the high spring tides is yet to be observed.

The oscillation at these stations also indicates the laminar behavior of waters of different density. The salinity of this area rises, when there is no effective tidal action, at the same time the salinity of the stations near Corpus Christi Bay are stable or declining, which means that water of greater density is being exposed by the recession of the tide and the consequent withdrawal of lighter, less saline water, and that mixing of water masses lags behind the tidal action. A schematic diagram of this action is represented in Figure 5. This is also indicated in the salinity graph for the entire period (Figure 6). Therefore, any interference with the tidal action, such as blocking the upper end of the Laguna by hydraulic fill causeways from the mainland to the Gulf barrier islands, as has been proposed by development interests, will eventually result in converting the Laguna Madre into a brine pool.

There are several other examples of salinity exchange on the Texas Coast which illustrate the difficulties of ensuring exchange through comparatively narrow channels. Although the opening between Aransas and Copano Bays is relatively wide in comparison with the size of Copano Bay, it takes at least a year for Copano Bay to return to normal salinity conditions after a period of unusually heavy rainfall,

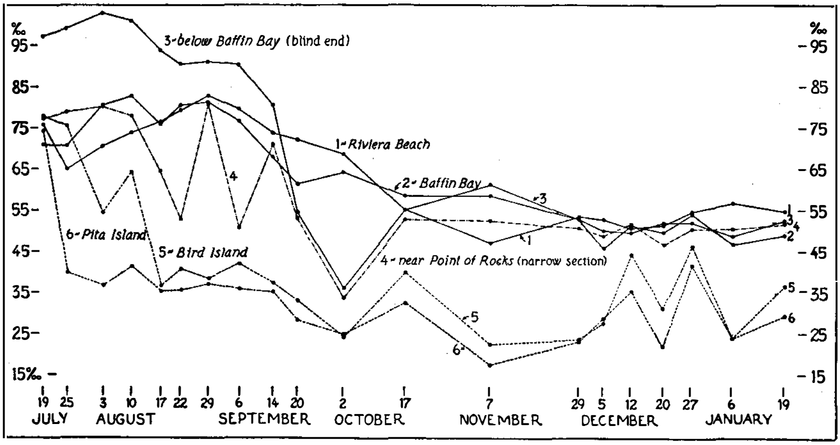


Figure 6. Salinity g aph for the upper Laguna Madre, July 19, 1946, to Jan. 19, 1947. Location of the stations is indicated in Figure 1

such as occured during the fall of 1946. During average years the salinity does not return to its former level for 4 or 5 months (Collier, 1938, Figure 6b), after a heavy influx of fresh water. In Offats Bayou, a deep arm of West Galveston Bay, the salinity is often higher than that of the adjacent bay because of inadequate circulation between the bayou and the bay. Fish occasionally concentrate in its more saline waters, driven there by freshening of the bay after periods of heavy rains. Offats Bayou is also an example of another type of inadequate circulation, when excessive pollution in the blind end brings about a lethal condition resulting in severe fish mortality (Gunter, 1942).

The failure of channels to permit adequate circulation is well known to oceanographers, and there are several notable examples. The most famous of these is that of the Straits of Gibraltar, which effectively block interchange between the Mediterranean and the North Atlantic, so that the salinity of the Mediterranean is 38°/oo, whereas that of the adjacent Atlantic is 35 to 36°/oo (Murray and Hjort, pp. 291-295, Figure 199; and Sverdrup, Johnson and Fleming, pp. 646-666). Exchange of Mediterranean and Atlantic waters takes place in the Gulf of Spain outside the Straits of Gibraltar. A situation similar to that of the Laguna Madre, although on a larger scale, is found in the Gulf of Kara-Bugaz, which connects with the Caspian Sea across a 60-mile bar. The salinity of this gulf is 164°/oo, whereas that of the Caspian Sea is 12.7°/oo. (Sverdrup, Johnson and Fleming, pp. 146-150, Figure 37).

In the spring of 1945 application was made to the U. S. District Engineer office at Galveston for a permit to construct a hydraulic fill causeway across the northern end of the Laguna Madre between Flour Bluff and Mustang Island. The plans for this causeway leave less than 2,500 feet of opening between the solid fill sections. Although it was protested at the time that such a structure would inhibit salinity exchange between the Laguna Madre and Corpus Christi Bay, and although the Game, Fish and Oyster Commission addressed a resolution to the District Engineer requesting that this permit be denied in the public interest, the permit was granted, since at that time the only objections considered were those based on the effects of such a project on navigation. Another application for a similar causeway, with 1,435 feet of opening, was heard by the U. S. Engineers in Corpus Christi on December 17, 1946. At this time the situation was somewhat changed, inasmuch as H.R. 6097, amending 48 Stat. 401, is now in effect. This Act requires the U. S. Engineers to consider other objections than those based on navigation. At this second hearing the Game, Fish and Oyster Commission filed a protest, supported by a detailed brief, and the Fish and Wildlife Service requested a delay in approval of the permit pending an investigation of the probable effects of the causeway. Protests were also filed by the National Audubon Society, which maintains bird sanctuaries in the Laguna Madre, and by the Izaak Walton League. This second application is now under review by the U. S. Engineer Office. Nevertheless, the former permit is still in effect. For the time being, however, the two rival parties are engaged in a court fight and the projects may be delayed for some time. The purpose of these causeways is to provide ready access to the barrier islands for recreational and development purposes.

At the present time, definite plans have been made only for causeways across the northern part of the Laguna. It is inevitable that upsetting the equilibrium of this part of the Laguna will in time affect the lower part, especially if the two parts of the Laguna are to be joined by a ship channel. In any event, a causeway across the upper Laguna would turn that region into a brine pool within a few years, and rapid sedimentation will also set in. During the last fiscal year slightly more than half of the Laguna catch came from the upper part of the Laguna, and in previous years the catch of the upper Laguna has been around 8 to 15 per cent of the entire bay catch. But the construction of a causeway across the northern end of the Laguna is only the beginning of the development plans for the beach of Padre Island, for interested groups in the lower Rio Grande region plan a causeway across the lower end of the Laguna at Port Isabel. If this is also a dirt fill structure, the damage to the fishery of the Laguna will be irreparable.

Several of the parties interested in this development either do not understand, or prefer to ignore, the dangers of the type of structures proposed to the biological and hydrographical economy of the Laguna Madre. It is true that the recreational development of the Gulf beaches will be of tremendous value to south Texas, and especially to the City of Corpus Christi, but it would appear that too many interested parties are concerned with the immediate prospects of gain at the expense of the long term effects of that development, and prefer to lay down a less expensive but highly injurious structure rather than incur the greater expense of a structure which would be of less damage to the Laguna Madre.

The issue posed by these projects transcends the fate of the Laguna Madre. It is simply this: which is more valuable, the renewable, fishery resources of the coastal waters, or their immediate, non-renewable resources, such as oil and mudshell, and their commercial development? This issue concerns not only Texas, but all areas with productive coastal bays. The Texas Coast is peculiarly vulnerable to these developments, since it is an intricate system of inner bays, and outer coastal lagoons connected to the Gulf of Mexico by narrow passes, with a complex salinity gradient from fresh to purely oceanic water. It has been shown that these bays are in a natural state of equilibrium which has been upset by the dredging of old oyster reefs for mudshell and the cutting of ship channels. (Price, 1933, and MS). A hydraulic fill causeway across a bay, in particular across the Laguna Madre, would upset the dynamic equilibrium of the bay and cause it to fill up in a matter of years instead of centuries.

It is not generally realized by the public how precarious the balance is on the Texas Coast. Even under natural conditions these bays have undergone a gradual change on the south Texas Coast towards a drier, less productive, environment (Price and Gunter, 1942). The Laguna Madre has been the particular victim of these changes, and in terms of geological time, is already dying. Although the factors have, up to the present time, been natural ones, they are being reproduced artificially on the rest of the coast through the appropriation of water from the rivers, uncontrolled silting and indiscriminate dredging. Thus the Laguna can be considered an object lesson of what is to come for the entire Texas Coast unless there is a radical change in the activities of man.[3]

The destruction of the bay environment would mean not only the loss of the fish and oyster resources, but also of the shrimp fishery, with its annual production of around 14,000,000 pounds, for the shrimp require a favorable bay environment in which to grow to maturity. It is probable that the shrimp fishery of the Texas Coast has reached its maximum, and possibly it may be maintained at the present level. However, any further changes in the bay environment will probably be immediately apparent in this fishery. As for the oysters, it is later than most people think, and large scale oyster production can only be regained by heroic measures. The balance between sustained yield and rapid decline is very close in the case of fish, since the Laguna Madre is the last major producing area. Because of its high salinities, the Laguna Madre is an unfavorable environment for shrimp and oysters, and its contribution of these elements to the fishery of Texas is negligible. There are a few oysters at the extreme southern end of the Laguna, but they are mere survivors of the past when the Rio Grande emptied into the Laguna and freshened its waters in that vicinity.

The fact that the Laguna Madre is in the final stages of its geological history should not, however, be considered an argument in favor of hastening its end through the construction of causeways and other engineering projects. Its natural life may still be measured in centuries, and its present fish production, as reflected in the catch records, is far less than its actual production. Most of the Laguna Madre is closed to net fishing, and much of the catch is unreported, for obvious reasons. On the basis of observations made during the recent cold spell, Mr. J. L. Baughman, Marine Biologist for the Game, Fish and Oyster Commission, estimated that the number of fish killed in the entire Laguna Madre by this cold spell was about three times a normal year's catch. If nothing else, this indicates that the present

[3]There have recently appeared two fine articles in *Harper's Magazine* indicating that an interest in conservation of natural environments is being brought more to public notice. These are: Bergen Evans, "Don't Monkey with the Platypus" (December 1946), and Bernard DeVoto, "The West Against Itself" (January 1947). It is to be hoped, however, that these articles are not symptoms of a merely fashionable revival of interest in conservation.

fishery in the Laguna Madre is something like one fourth of the fish population, and since the population will recover from this loss by cold in 2 or 3 years, it means that the Laguna Madre could support an even larger fishery than it does at the present time, when it supplies slightly more than half of the total fish catch of Texas coastal waters.

## SUMMARY

The Laguna Madre, a long narrow coastal lagoon on the south Texas Coast, is the major remaining source of commercial fish in Texas coastal waters. During the last 5 years it has supplied 60 per cent of the entire coast production of redfish, drum, and trout. These three fish comprise 86 per cent of the total Texas production for the same period. This production is maintained in spite of adverse salinity conditions, which result in periodical mortality to fishes during extremely dry years when the salinity becomes too high, and in spite of the closing of large areas of the Laguna Madre to net fishing.

A study of salinity conditions, carried out since July 19, 1945, indicates that the salinity exchange between the Laguna Madre and Corpus Christi Bay is a tidal action, depending on a wide lateral surface for adequate mixing, and that a natural constriction in the Laguna to the width of about a mile blocks exchange at that point and divides the waters into two different salinity groupings. This study, instigated by the proposal to construct a hydraulic fill causeway across the Laguna Madre just below Corpus Christi Bay, indicates that any artificial constriction in the width of the upper Laguna Madre will upset the dynamic equilibrium of this body of water and destroy its value as a source of fish. Such constriction would be inevitable if the type of structure now proposed is built, since the plans of one project call for residual openings of less than 2,500 feet and the other project allows but 1,435 feet of openings. These projects would not only impair salinity exchange, but would also cause abnormal sedimentation in the Laguna Madre.

Although the benefits of a causeway between the City of Corpus Christi and the Gulf beach would be considerable in so far as recreation and development are concerned, it is questionable whether such benefits outweigh the irrevocable destruction of the last major fishing area of the Texas Coast, especially when the danger would be much less if an open, piling type structure were to be built.

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## DISCUSSION

MR. J. L. BAUGHMAN (Texas): Just one remark. Mr. Hedgpeth told you the mortality of the fish in that area. It might be of interest at this time to give you a very few words on that mortality. Last week, I made the trip from one end of the Laguna to the other. For every foot of beach in the Laguna I estimated there were between 20 and 30 pounds of fish killed. Some of the *Cynoscion nebulosus* ran up to about a foot long. *Pogonias chromis* to about 15 inches long, and redfish or channel bass to about 4 feet long.

DR. JAMES N. GOWANLOCH (Louisiana): I would like to mention an incident in reverse of Joel Hedpeth's experience that we had in Louisiana. As you may know, in 1944 we experienced a severe flood and it became necssary to open the spillway above the City of New Orleans for the protection of the city and flow a spillage of 290,000 feet per second. This destroyed $3,000,000 worth of oysters. We are presently in litigation with the Federal Government, through, chiefly, the Corps of Engineers who disclaim any responsibility.

The interesting thing there is exactly what Joel Hedgpeth has said. There are three factors involved: the change in salinity, the time of exposure, and most of all the speed of change. The same spillway was opened in 1937 without any damage.

# SOME PROBLEMS OF MARINE FISHERY BIOLOGY

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In this age of comic strip literature, most of us have become more or less familiar with the character known as superman. This remarkable person is endowed with extraordinary powers. He is gifted with X-ray vision, and is omniscient. He flies through the air with lightning speed, and he descends into the depths of the ocean as competently as a submarine. Very clearly this is the kind of man we desperately need to carry on ocean fishery studies. It is a pity he is only a fiction. However as long as the human brain can imagine such a character, we may as well go a little farther and consider what he would behold with his all-encompassing eyes during one of his submarine excursions.

No doubt different people would produce different images for this fantasy, depending on what detail of the marine world they had been in the habit of focusing their attention upon. Oceanographers would tend to have our superman observe the intricate movements of masses of water and the various cycles of chemical and physical changes in them. Students of plankton might have him notice in particular the successive flowerings of different species of drifting plants and animals. Fishery biologists would perhaps have him notice the changing abundance of fish populations.

I suggest that he be a very super superman, that he take in these things all together, and that he have the ability to integrate their very intricate interrelations. What he would perceive, then, might be likened to a vast and infinitely complicated organism, with every population of animals and plants a separate organ affected by every other one, and affected too by the continually changing environment.

Unfortunately we have no superman, and no magical instruments for taking in the anatomy of the marine organism at a glance. We ordinary mortals employed in ocean studies very rarely see what goes on beneath the surface, and when we do, we get only the most fleeting, localized glimpses. Most of the important things that we have learned about the sea have come to us by indirect methods, not through such homely senses as sight and touch, but through tools by which we get *numbers* of various degrees of accuracy, which must be *interpreted,* and from which patterns must be deduced.

Now there are many tools for studying the sea and its contents, including some rather remarkable ones developed during the war years. For a long time we have been able to sample the water and take temperature readings at whatever depth we choose, from surface to very deep sea. Thus we get the material needed for studying ocean currents. A most valuable improvement on this laborious method has been the bathythermograph, which can be lowered while the ship is under way to make a record of subsurface temperatures against depth, and thus provide infinitely more detailed material than was formerly attainable. There are the ordinary tow nets, which can be lowered closed and made to open at any depth where we wish to sample plankton. A current meter can be attached to these nets to measure the amount of water which they strain and so give us a basis for quantitative studies of the sea's drifting life. There is the Hardy sampler, which quantitatively collects plankton continuously. With echo ranging apparatus we can locate and measure the size of masses of schooling pelagic fishes, and with the hydrophone, we can hear the sounds made by certain sea animals that have sound-producing apparatus. If we wish to know what the bottom actually looks like, there is a submarine camera which can be lowered to the bottom where it takes excellent photographs.

All these are very important aids to learning the mechanics of our marine organism. As various as their uses may be, however, they have one thing in common: they are tools that can be used only at sea, and they must be operated from a ship. Now it is a peculiar thing that though our fishery biologists are expected to learn all that is important about the great sea fisheries so as to develop intelligent programs of conservation, they have for many years been expected to carry on the greater part of their studies without ships; therefore the various instruments that I have been talking about, for studying the marine environment have not been available to them, except for very brief periods. At the present moment, for example, the United States government has only the part-time use of one vessel for fishery studies. And there are 80,000 miles of shore line around the United States and Alaska, not to mention the vast distances in the Pacific traveled by our fishing fleets. Compare this with the 95 research vessels Japan operated before the war; or the five that Russia operates now in the Sea of Azov.

Occasionally in response to the protests of American fishery biologists, ships have been made available to them. There have been times (very rare times, though) when these ships have been especially designed for marine research; usually they have been converted from some alien use into something not very serviceable for delicate scientific work. Whatever they were, they have always eventually been diverted to other purposes for one reason or another. Speaking only for the U. S. Fish and Wildlife Service and its precursor, the Bureau of Fisheries, and this is the largest agency carrying on research in fishery biology in this country, we have nowhere had the continuous use of a vessel over the last 30 years. We have had them for seasonal use, and occasionally for short periods to work on special problems. From time to time we have acquired a boat which we were led to believe was for permanent use. We have always had these bright hopes just long enough to get started programs that gave promise of fine and valuable results, and these programs have always been broken off after a few years for want of funds. Unfortunately, studies in marine fishery biology do not usually get very far or very deep in a few years, for a single generation of fish may last 5 to 10 years or more and many generations must be followed if our results are to be conclusive. Furthermore, it takes long series of observations to detect significant associations among elements of the marine environment. The most promising series of correlations have the most disturbing way of breaking down quite suddenly when some new, unknown factor becomes dominant, and it takes another long period of years to discover such a factor and see how it fits into the ecological system. Thus sea work must be continuous and long lasting to be effectual.

Even during those brief periods that a research ship is made available to marine biologists, its use must often be spread very thin among several independent "investigations." This tends to make the work diffuse and incoherent.

The failure to supply ocean going equipment has tended to cause marine fishery work to evolve into a dry land science. It has forced the biologists to make the most of what data they could collect ashore, which is to say, samples of the commercial catch and catch statistics. Thus they have been driven to overwork a small assortment of techniques like scale reading, analysis of length-frequency curves and boat catch statistics. Useful though these processes may be, they have not yielded a very rich ore during the last 20 years. Indeed, if we examine several issues of any of the scientific journals or government bulletins containing articles reporting the results of fishery studies, we are apt to get the impression that techniques are the goal of fishery work, rather than aids to reaching a goal, so frequently are they the chief subject of articles that seem to point neither to new principles of science or to useful applications in fishery management, or even to further work remaining to be done.

It is owing partly to our lack of boats for studying ocean fishery problems that we take these problems up by species. Thus we have a rosefish investigation, a haddock investigation, a shrimp investigation, a pilchard investigation. We must work that way because the data we can get on dry land are assorted by species; we get them from the commercial fisheries, which are specialized and more or less independent of each other. How productive this piecemeal fashion of studying the ocean fishery resources has been can be judged by the record of published literature. There are in the United States and Alaska about 70 categories of marine fishes, each of which either yields to commercial fishermen at least two million pounds of fish or has considerable recreational value. Very intensive and detailed studies have been made on only about eight of these species, or less than 12 per cent of the total. Briefer, much less profound studies have been made on about two dozen others; and we know virtually nothing at all about the remaining 35 to 40 species. Among these are some of our most valuable fishery resources, like menhaden, tuna, and the Florida game fishes. New studies are not begun very often. During the past 10 years the Fish and Wildlife Service has started only one major fishery investigation. They are generally not started until some crisis has aroused an interested part of the public to demand it. Thus progress in learning about the whole of our fishery resources has been slow, and there is no promise of its speeding up in the immediate future.

Besides trying to carry on ocean fishery studies without benefit of ships, we must also operate with very small scientific staffs. Thus in the United States and Alaska, among all the maritime state governments, the Federal Government, and three or four universities that carry on fishery research programs, there are only about 80 marine fishery biologists of all grades. One- or two-man fishery investigations are very common in this country. Of course these can not go much farther than the assembling of the most elementary facts about distribution, growth, spawning, and catch statistics. Even our very best equipped and largest staffed laboratories are very badly equipped, and understaffed. Not one of them is able to cover whole fishery populations in their studies, because the geographic ranges of these populations are invariably far beyond their scope. So what they generally do is study segments of the population which the fisheries draw from, or which is within reach of their meager facilities, and to assume or hope that their observations represent the entire populations. Unfortunately, they rarely do.

Even if they could study whole populations, that is still not enough; for it is a fallacious approach to the analysis of marine biology to study it bit by bit, attempting to isolate each population from its ecological system and ignore all the other populations that must profoundly affect it. Still, that is the way we try to do it, and the consequence is that we have an extensive knowledge about a shamefully small fragment of our fishery resources, and we know almost nothing at all about ocean ecology. We have carried on investigations of bank fishes species by species for at least 20 years. We know something about a few of our bank fish but we know nothing of their interrelations and nothing about the way in which the environment affects them, because we have never made a study of bank ecology. I think when we do, we will learn a very great deal more about the fishes. The same is true of our pelagic species. We are examining a very large picture through a very small hand lens. We never see the picture, and we suppose the little patches of color that come to our eyes have some independent significance.

If we are to see the whole picture with understanding and I believe we must if our ocean fishery studies are ever to have the practical conservation value that we like to claim for them, we will have to study whole populations and their environment *in situ*. Perhaps we would find it profitable to stop investigating species entirely, and to concentrate our attention instead on ecological systems. I think if we did that our eventual knowledge of the biology of the species would be very much broader and deeper than it ever will be the way we go at it now.

This is asking for a great deal, though not, I believe, too much when we consider the value of the ocean fishery resources. It means first of all, very careful planning with a long range view, and with proper consideration to what we need to know about all our fishes. It means clarifying our ideas of what we are after and of why we carry on ocean studies. As for the work itself, it means continuous oceanographic observations to determine the water movements and their relation to the sea's productivity. It means meteorological observations to determine the relation between winds and currents. It means studies of the abundance, dispersal and general biology of the many organisms of the plankton, and their relation to the biology of fishes. It means studying the interactions among the many populations of fishes; and of course the effect of man on these populations and on the environment.

As far as I know, no such program has been tried anywhere in this country, because nowhere are there adequate facilities in one place. I come back again to the fictional character I started with—superman, because that is the kind of person we would need, even to carry on the ordinary work. A fishery biologist can not also be a meteorologist, an oceanographer, a chemist, a bacteriologist, a planktonologist. And the kind of ecological studies that would be required to make the most practical contributions to our knowledge of the fishery resources would necessitate specialists in each of these fields. Yet no fishery biology laboratory in this country has such a staff. The Fish and Wildlife Service, for example, employs no oceanographer, and no meteorologist anywhere.

There seems very little likelihood that these conditions will suddenly change for the better. So what can we do? There is one thing, which for some reason has not yet been tried on a thorough-going scale. Those engaged in ocean studies can work together, exchange plans, ideas, facilities, information, much more than they have in the past. There is so much to do, so very much, that questions of credit—who does what, what agency or what man is mentioned on the cover of a paper—should be secondary: the important thing is the knowledge that is developed. And state and federal fishery agencies, university seaside laboratories, oceanographic institutions, and any other organization studying the sea and its life, should seek each other out, pool their slender little resources, and work together in closest harmony and with resolute purpose to produce an integrated knowledge about the undersea world.

## DISCUSSION

DR. W. M. CHAPMAN (California): You referred to the 95 research vessels that Japan had. I might also point out the difference in their catch and ours. They caught approximately one third of all the fish caught in the world. They expanded all through the Pacific into the Indian Ocean and into the south Atlantic and they were making plans to establish commercial fisheries in the Mediterranean. They traveled nearly every place and knew what they were doing wherever they went. They landed about four times the fish we did and we are the second largest fishing country in the world.

CHAIRMAN WALFORD: The fisheries of Japan landed more than half of the volume of the entire meat production of the United States.

DR. THOMAS H. LANGLOIS (Ohio): I should like to invite you to visit the Stone Laboratory. I think you might find there an approximation to the idea that you have outlined. We have not a large staff but we are tackling the problem of the fisheries of Lake Erie from most of the angles that you have indicated, including such things as meteorology and the discharges of the streams into the west ends of the lake. The measurement of currents, the determination of light penetration, the sampling of the bottom, the determination of life histories of the organisms present in the bottom and the type of thing that ties in with the studies of commercial fisheries are all being done.

MR. JOEL W. HEDGPETH (Texas): I might mention that the fact that the United States has no research vessel now is rather strange since the first research vessel particularly built for the purpose was the *Albatross* by the United States.

It was designed on the advice of Captain Tanner of the *Fish Hawk* and it was entirely for the purpose of the Bureau of Fisheries at the start.

# PRESENT EELGRASS CONDITION AND PROBLEMS ON THE ATLANTIC COST OF NORTH AMERICA

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Prior to 1931 eelgrass (*Zostera marina*) was by far the most abundant plant species found in the brackish-water bays and estuaries along the Atlantic Coast from North Carolina to southern Labrador and Greenland. Until nearly all the thousands of acres of this marine pondweed disappeared during 1931 and 1932, its ecological importance was not fully appreciated.

In the years preceding 1931, eelgrass was the dominant stabilizing influence in the biology of these tidal waters. Canada geese (*Branta canadensis*) and some species of ducks fed heavily on the seeds, roots, and leaves. Many waterfowl thrived on the abundance of small organisms associated with eelgrass. Before the blight of 1931, heavy stands of eelgrass provided protective cover for the small motile seed of the common, commercial scallop (*Pecten irradians*). Heavy growths also protected the adult of this shellfish during low-tide periods, when flats were exposed. The spat of other shellfish utilized eelgrass as a place of anchorage, attaching themselves to the narrow leaves by means of a byssus. Many other forms of shellfish, as well as a host of crabs, scuds, and other crustaceans, were harbored by the patches of eelgrass. The young of many species of fish found escape cover in the dense, ribbonlike leaves.

The sudden disappearance of this plant upset intimate ecological associations and made necessary a great many radical readjustments. The diminution of eelgrass undoubtedly influenced in a subtle or obscure fashion the feeding habits, movements, and general well-being of most of the coastal waterfowl population. The adverse effect upon certain species of waterfowl, notably the Atlantic brant (*Branta bernicla hrota*), was alarmingly apparent within a relatively short time. Perhaps the scallop industry was the commercial activity most severely affected by the widespread destruction of eelgrass.

For several years after the destruction of eelgrass along the Atlantic Coast the authors and numerous other investigators inspected many thousands of acres of mud flats that had formerly been covered with eelgrass. In only a few areas (particularly in Rhode Island and Pamlico Sound, North Carolina) were small, sickly colonies found. As the years passed, observers reported limited recoveries of eelgrass in scattered localities, but some of these beds disappeared the year after apparent recovery. Not until the early 1940's did eelgrass appear to be definitely on the upgrade. In 1941, Cottam reported general improvement along most of the Atlantic Coast. Addy and Aylward (1944) reported the presence of many fine beds—some of them more than 100 acres in extent—in Massachusetts waters in 1943. Late in the summer of 1944, the wasting disease attacked the Massachusetts areas again and eelgrass experienced a severe setback, but the species made a recovery during the next year. In 1945, Cottam reported again on the condition of eelgrass along the entire Atlantic seaboard, pointing out a trend toward recovery in favorable areas. During the past season (1946), the plant continued its growth and spread all along the coast.

The authors have tabulated information contributed by more than 50 people who observed the location and condition of eelgrass beds during 1946. Significant data have been submitted by a number of the U. S. Game-Management Agents and by various state fish and game officers and administrators. The authors are particularly indebted to Dr. Harrison F. Lewis, Superintendent of Wildlife Protection for the National Parks Bureau, Department of Mines and Resources, Ottawa, Canada, for a summary of conditions along the Atlantic Coast of Canada and Newfoundland during the summer of 1946 and to Dr. Neil E. Stevens, Professor of Botany at the University of Illinois, Urbana, Illinois, for a detailed and critical report on the status of eelgrass in upper Buzzards Bay, Massachusetts, as observed during the same year.

## PRESENT STATUS

The reports received by the authors have given assurance of marked improvement in the eelgrass beds during the past few years. Many observers reported healthy, vigorous beds that covered sufficient areas to be of value to waterfowl and shellfish. Eelgrass is known to have reappeared in small, scattered patches at many points. Because of limitation of time and space, the authors have included here references to only a few of the well established areas.

*Canadian Atlantic Coast*—Dr. Lewis, summarizing (August 10, 1946) information received in his office, wrote:

> On both sides of the mouth of the Bay of Fundy, that is, at Grand Manan, New Brunswick, and along the coast of Yarmouth County, Nova Scotia, eelgrass shows little or no improvement.

Farther east, along the south shore of Nova Scotia, in Shelburne and Queens Counties, the eelgrass shows marked improvement, though it is not yet back to normal. In this region it is again being used commercially.

In Northumberland Strait, between Prince Edward Island and neighboring provinces, the eelgrass situation is improving. The mainland shore of the strait reports that the growth of eelgrass has been gaining steadily for the past three years. It now provides improved feeding for geese and brant and is being used, as it was before the "eelgrass disaster," for the banking of houses for the winter. On the south coast of the east end of Prince Edward Island the average condition of the eelgrass stands is now about 50% of normal.

In the great salt-water lagoons of the Magdalen Islands, in the Gulf of St. Lawrence, the eelgrass continues to grow afresh each spring and to die back later in each year.

On the south shore of the estuary of the St. Lawrence River some improvement in eelgrass stands is reported, but it is very local. Along some parts of this shore no eelgrass can be found.

On December 11, 1946, Dr. Lewis continued his summary:

At the mouth of the Tidnish River on the Nova Scotia side of Baie de Verte there is no increase in the growth of eelgrass since 1945.

A report received from the Magdalen Islands since my letter of August 10, 1946, indicates that during the autumn of 1946, the eelgrass in that area did not die back as it has done during several previous years.

Eelgrass in the bays and harbours of Yarmouth County, N. S., is reported to be in a healthy condition.

The condition of the eelgrass beds along approximately 35 miles of shoreline of East Pictou County, N. S., has shown a progressive improvement during the past three years.

The eelgrass in the coastal waters of the Counties of Temiscouata and Kamouraska, Province of Quebec, shows no improvement over past years.

Good recovery of eelgrass has been reported in the southern part of the Gulf of St. Lawrence, about Prince Edward Island and on the Nova Scotia and New Brunswick coast south of the Bay of Chaleur. In these areas, the use of eelgrass in banking houses in winter is again becoming common. The recovery has not been uniform in all localities but has been best in sheltered situations. Exposed areas where the former mat of eelgrass roots has been washed away to leave shifting sand have had very slow recovery, although even there areas of new growth are appearing.

There is still evidence of the disease in a number of localities, sections of leaves being blackened and the grass breaking more readily into small pieces before being washed ashore.

*Maine*—Excellent stands have been reported in Casco Bay and vicinity, Mill Cove of Boothbay Harbor, Taunton River, Egypt Bay, Penobscot Bay and vicinity, Saco Bay and vicinity, and at Kittery.

*New Hampshire*—Moderate to heavy growths have been reported in Great Bay.

*Massachusetts*—Heavy growths of eelgrass have been reported in Newburyport Harbor, Ipswich River, Barnstable Harbor, and Waquoit Bay, as well as in bays on the islands on Nantucket, Muskeget, and Marthas Vineyard. Dr. Stevens has described (unpublished, 1946) the situation in the upper Buzzards Bay region:

> . . . the return of eelgrass has been slow and irregular. A surprising number of men who are commercially engaged in the shellfish industry estimate the present stand as not over 1 per cent of the stand in 1930, that is, previous to the outbreak of the wasting disease. My own judgment as to its abundance agrees with theirs. On the other hand, there is certainly more than a hundred times as much eelgrass in this area as there was 10 or 12 years ago. If these estimates have any validity whatever, at the "low point" there could not have been more than 1/100 of 1 per cent of the amount of eelgrass which was present before the onset of the disease.

Cape Cod Bay and Pleasant Bay have excellent stands, some of them almost comparable to the growths present in 1930 and with this improvement, scallops have shown a substantial increase. These beds supply the principal winter food of Canada geese and brant. The luscious rhizomes have a prominent part in the diet of black ducks, scaup, and many other species of coastal waterfowl.

*Rhode Island*—Many of the tidal bays or ponds have vigorous beds of eelgrass. The waters reported to have particularly heavy stands include: Point Judith and adjacent ponds, Brightman Pond, Winnepaug Pond, Ninigret Pond, Green Hill Pond, Trustom Pond, Card Ponds, and the Pattaquamscott River.

*Connecticut*—Limited data available indicate but slight improvement along the coast of Connecticut.

*New York*—Most of the eelgrass found on Long Island is in the bays along the southern edge. Excellent stands — several miles in length—have been reported for Great South Bay, and moderate stands have been reported elsewhere in the state.

*New Jersey*—The eastern shore of Barnegat Bay has produced one of the heaviest growths of eelgrass, but there is only a scattering of the plant elsewhere in the state.

*Delaware*—The authors have received no reports of important stands of eelgrass along this portion of the coast.

*Maryland and Virginia*—Eelgrass beds in the Chesapeake Bay area of Maryland and Virginia are too numerous to be listed here. Undoubtedly, the most extensive stands anywhere along the coast are located in Chesapeake Bay. Reports indicate that sizable beds of eelgrass may be seen in most of the rivers entering the bay and in numerous cove and island areas. Mr. F. M. Uhler, biologist of the Fish and Wildlife Service, who completed an extensive survey of the area January 27, 1947 states that since last April (1946) the recovery throughout the bay has been widespread and in many of the estuaries and shoals this has been almost as spectacular as was the destruction of the plant in 1931. The plant seems to be returning wherever conditions are favorable and extends from the lowest limits of salinity tolerance in upper Chesapeake Bay where the water ranges from 25 to 35 per cent of ocean salinity throughout the bay to where nearly full ocean salinity occurs. Luxuriant growths of eelgrass containing many hundreds of acres may be found near St. George, Tilghman, Taylor's and Hooper's Islands in the lower Patuxent, Potomac, James, Honga, Chester, and Choptank Rivers and in Tarr, Tangier and Pocomoke Bays. Only a scattering of eelgrass has been observed in Chincoteague Bay and in other areas on the ocean side of the Delmarva peninsula.

*North Carolina*—Eelgrass is making a comeback in these waters. Dr. Lewis G. Williams of Duke University Marine Laboratory, Beaufort, North Carolina, has reported (August 24, 1946) a good growth in Pamlico Sound near Ocracoke Island and a scattering of plants as far south as Beaufort.

A report just received from Mr. William P. Baldwin, biologist of the Fish and Wildlife Service, indicates that during the summer and fall of 1946 eelgrass increased very satisfactorily in Pamlico Sound, being substantially more abundant there than in 1945. He and Mr. Willie G. Cahoon, refuge manager of the Swanquarter National Wildlife Refuge, state that this plant has increased materially on suitable shoals throughout Swanquarter Refuge. In the fall rather large windrows of apparently healthy plants washed ashore as it did before the great catastrophe of 1931. A most satisfactory recovery was also noted at the mouth of Pamlico River. On the eastern edge of Pamlico Sound, from Oregon Inlet to Cape Hatteras, the shoals exhibited an increased growth and in many of these areas and also near Kitty Hawk, a near maximum growth has appeared. It may be significant that scallops have also increased throughout the Pamlico Sound area. Improvement over past conditions, but less satisfactory growth, is recorded at the junction of Albemarle and Currituck Sounds. Bogue Sound represents the southern limit of the eelgrass range. In this area and in the adjacent Core Sound only moderate recovery is reported. Many shoals are still bare of the plant. In general, however, the plants are now healthy wherever they occur.

## THE DISEASE

Many theories have been advanced in the effort to determine the probable cause for the abrupt destruction of eelgrass. The evidence accumulated to date points to the mycetozoan *Labyrinthula,* a low form of fungus. Renn (1936) demonstrated the ability of this organism to reproduce rapidly, to spread from leaf to leaf, and to produce the characteristic streaking and blackening of the leaf.

For a picture of the recent recovery of eelgrass—or perhaps the abatement of the disease—it may be helpful to review briefly the progress noted on Massachusetts areas, where the activity of *Labyrinthula,* in the leaves of eelgrass has been observed by Addy and Aylward since 1944. During the spring (May) of 1944 the beds at Newburyport were healthy and vigorous. Only a few streaked leaves were observed; microscopic examination of the leaves revealed only scattered, inactive *Labyrinthula.* By the latter part of July and August, however, the beds at Newburyport were degenerating rapidly, most of the older leaves were blackened, and much of the new growth was streaked. The wasting disease was exacting a heavy toll, and it appeared that a major part of the eelgrass then present would be destroyed. Microscopic examination of the leaves revealed myriads of active *Labyrinthula.* In August 1944, a survey of the extensive beds at Cape Cod and Marthas Vineyard presented the same situation: the leaves were being destroyed by *Labyrinthula.* In October 1944, after the waters had cooled considerably, the beds at Newburyport were examined again. At this time the eelgrass was healthy, green, showing little of the black streak; microscopic examination of leaves revealed only a few scattered, inactive spindle cells of *Labyrinthula.* Unfortunately, the size of the area covered with eelgrass had been reduced by about 25 per cent.

The beds at Newburyport were examined again in April, May, and June 1945. The eelgrass was healthy, but the beds were smaller than they had been the year before. It was difficult to find examples of the diseased condition, and only an occasional leaf section showed a few inactive *Labyrinthula.* Examination of specimens taken at Newburyport in September 1945 failed to reveal the presence of any *Labyrinthula* although some of these organisms must have been in the beds.

During 1946, the eelgrass along the coast grew vigorously. In Massachusetts, Addy found the plant in excellent condition during late July and August, a period when he had expected to find the beds diseased. The health, vigor, and density of the beds were in striking contrast to the degenerate appearance of those beds in 1944. On July 25 and 26, 1946, beds at Cape Cod and Buzzards Bay were observed and specimens were studied; on August 5 and 8, beds at Newburyport and Ipswich were observed and specimens were studied. Examination of many leaf sections taken from these areas revealed only an occasional inactive *Labyrinthula.* This seemed remarkable when it was recalled that at the same period in 1944 the cells and intercellular spaces were teeming with *Labyrinthula.* The rich, green, vigorous growth, containing scarcely a darkened leaf, was a decided contrast to the wasted growth of previous seasons. During the 1946 season, it was difficult to find single leaves that showed the streaking typical of *Labyrinthula* activity.

Is this seeming loss of virulence on the part of the disease organism a temporary phenomenon? Is a more resistant strain of eelgrass developing, or is the disease organism becoming less virulent? Are ecological and other factors unfavorable to the disease organism at this time? Will the disease return in cycles? What may we expect next year? Since the first appearance of the disease in 1931 we have many times observed partial recovery, which then has been overtaken by partial decline. It is unfortunate that in recent times there has been no comprehensive study of eelgrass and the factors affecting its abundance. If we possessed the information to be obtained from such a study, we could answer some of these questions and act intelligently on proposed management programs.

Apparently the destruction of eelgrass has been caused by *Labyrinthula,* but apparently this organism has always been associated intimately with eelgrass in the past. Is some cosmic or other force responsible for stimulating *Labyrinthula* to such highly destructive activity? There have been other periods of eelgrass decline (Cottam, 1934, 1935), and, as pointed out by Stevens (1936, 1939), those periods have followed solar cycles rather closely. Whatever the agent or agents responsible for the decline, the fact that the plant disappeared abruptly and is returning slowly in about the same proportion throughout most of its range, points to a force of hemispheric scope—whether it has been of direct or indirect influence. Perhaps a study of the changes in ocean currents, temperature, salinity, and similar conditions during the past 30 years might shed some light on the problem. Temperature changes certainly exert a profound influence upon the activity of the disease organism and probably upon the plant itself. During July and August the organism is in greatest abundance and activity; as soon as cool weather begins, the activity of *Labyrinthula* drops rapidly until the organism is nearly dormant and much reduced in number during the winter. The complete life history of this organism, including its intermediate host (if any) and its dormant stages, is not known to the authors.

## MANAGEMENT

Natural reproduction from seed is taking place on a wide scale in the vicinity of established beds. Stevens noted that the present beds in the upper Buzzards Bay region have developed from seed of plants that survived the disease. He based his conclusion upon the location of the beds and the distribution of plants within the beds. Of the new beds on Hog Island Dike, he wrote (unpublished, 1946):

> . . . In the course of rebuilding the Cape Cod Canal, the Buzzards Bay entrance to the canal was relocated. A part of Hog Island was cut away, and a dike was built to connect Mashnee and Hog Islands with each other and with the mainland. This dike was built with sand pumped from the bottom of Buzzards Bay. Work on this dike was begun in June 1936 and finished in February 1937. The dike thus consists of new sand, that is, sand which has not been in shallow water for many years, probably in historic times. Yet on both the north and south sides of this dike are healthy stands of eelgrass, stands which are among the best which I saw during the entire summer. These stands could have come only from seed, probably from seed recently ripened on plants which had survived the epidemic, far less probably from seed that had lain on the bottom of the bay for years.

Commenting further upon the prospects for natural reproduction, Stevens wrote:

> . . . Throughout the season it was evident that on all beds *Zostera marina* was blooming and fruiting abundantly and that there would be adequate seed for a new season.

> A perhaps significant fact about this interesting plant is that although it is structurally monoecious, it is functionally dioecious; that is, although both staminate and pistillate flowers occur on the same plant, the stigmata drop off before the anthers on the same spadix open. It is thus extremely unlikely that self-pollination will occur. Thus what we are apparently seeing on our Atlantic-seaboard is the re-establishment from seed of a freely cross-pollinating species.

It appears that fairly quiet water and freedom from deep mud and silt are major factors in the re-establishment of eelgrass. These requirements are emphasized in Stevens' report of his 1946 studies in Massachusetts areas:

> In the upper Buzzards Bay region there are certain coves in which eelgrass was known to be very abundant prior to the outbreak of the wasting disease yet on which the plant has not succeeded in re-establishing itself. Conspicuous examples of this are Little Buttermilk Bay and Back River. The most obvious difference between such areas and those in which the eelgrass is now established or re-established is the difference in the bottom. In the areas where there is no eelgrass the bottom is covered with a rather deep layer of silt and fine mud, quite in contrast to the condition, for example, on Hog Island Dike, where there is abundant, clean sand.
>
> . . . eelgrass beds in good condition are found in a number of places in which eelgrass was abundant before the outbreak of the wasting disease. The observations of the past summer lead to the belief that these beds have been re-established because these areas furnished good seed beds; that is, reasonably quiet water and sufficient freedom from deep mud and silt to allow the seedlings to become established. Careful search on the long dike south of Stony Point fails to show any significant stands of eelgrass. This dike is also new, having been built when the entrance to the Cape Cod Canal was relocated. An obvious explanation is that here wave action was too severe to permit the establishment of seedlings.

Although eelgrass is gradually reoccupying former areas and the wasting disease appears to be on the decline, it would seem that the process of recovery might be hastened and the productive areas greatly expanded. There are many local areas where eelgrass was once abundant but where there is no new growth now. This seems to be a logical time to begin seeding and transplanting operations—on areas where the environment appears favorable—to facilitate the spread of the plant.

Recent observations indicate that with further investigation the harvest and sowing of seed may be a profitable method of propagation. Experiments are now under way to determine the time of year to plant and the proper method of handling eelgrass seed.

Among other methods tried, eelgrass seed was harvested by pulling up fruit stems that had numerous spathes or capsules containing the seeds. These stems were placed in a strong, copper-screened (16 meshes to the inch) box, which was then anchored to the bottom of a small salt creek. In this container (which allowed circulation of the water but prevented loss of seed) the spathes decomposed and then released the mature seeds for winter storage and spring planting. Removal of the spathes and stems was necessary in order that the seeds could sink when sown, and the procedure reduced the bulk to be stratified for winter storage.

At Newburyport seeds harvested in August and held in a wire box in a tidal creek until the latter part of October, germinated and produced seedlings. From this the authors assume that some seeds dropped during the summer may be expected to produce seedlings before the advent of cold weather. This might indicate a preference for fall planting.

After the disaster on the Atlantic seaboard, Cottam and others of the Federal Service made a number of transplants, but these attempts to produce a growth of eelgrass were unsuccessful. Live rhizomes and plant seeds were shipped from the West Coast (where eelgrass had been relatively unaffected by the wasting disease), but these also failed to survive. Limited experiments with transplants at Newburyport in 1943 showed an encouraging degree of success, but most of these transplants were destroyed by the disease in August 1944. Plantings made during the summer of 1946 in turbid Chincoteague Bay and its clearer coves apparently have not taken hold.

Though there is much to be learned in the propagation of eelgrass, the authors feel that a program of transplanting eelgrass sods or rootstocks on a limited scale would meet with reasonable success. A program of this nature is now under way as a cooperative undertaking of Ducks Unlimited, Inc., the Wildlife Management Institute, various state fish and game departments, and the Fish and Wildlife Service. Mr. Philip Barney of the Connecticut Board of Fisheries and Game is chairman of a committee known as the Joint Black Duck Committee (composed of representatives from these organizations) and is directing the program. A planting guide has been prepared, and crews of men and equipment for transplanting are being organized.

The transplanting of eelgrass is primarily a program for the improvement of winter feeding conditions for waterfowl along the Atlantic Coast, although shellfish and other marine animals will also benefit. It is recommended that all transplanting be restricted to bays and estuaries that remain open during most of the winter and where waterfowl may be expected to feed.

It is hoped that experiments on propagation with seed will show results by the fall of 1947. If good beds can be developed by the harvesting and sowing of seed, the expense involved in propagation will be materially reduced.

## SUMMARY

Observations reported for 1946 indicate the continued growth and spread of eelgrass in many areas. Study of *Labyrinthula* activity on Massachusetts areas has further established the association of that organism with the wasting disease, but the force that stimulated the organism to epidemic proportions is still unknown. Whether *Labyrinthula* is becoming less virulent or the eelgrass strain is more resistant, is still unknown. In favorable areas eelgrass is now developing by natural reproduction. To speed up the development of eelgrass beds and facilitate the spread of the plant, experiments are being made with seeding and planting operations.

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## DISCUSSION

MR. S. H. HOPKINS (Texas): I just want to say that the eelgrass very definitely is important to the fishery problem in the Chesapeake area. It is very important in the life history of crab and it is also important as a harboring place for the young of many species of commercial fish. When the eelgrass is gone, the scallops entirely disappear from the coast.

DR. COTTAM: I might state that I have quite a good many samples of the plant to see what organisms were attached to the leaves. I have found that almost microscopic forms of *Mya* seem to be attached almost all the way up and down the coast. I might mention the pecten and *Mya*. Their abundance, I am quite sure, had some very close, either direct or indirect, relationships to the abundance of the eelgrass.

MR. CHARLES E. JACKSON (District of Columbia): Has the absence of eelgrass got anything to do with the production of scallops?

DR. COTTAM: In my opinion, it has a good deal to do with it.

If you look at past records of 1931, 1932, 1933, and 1934, you will see there was a great decline in scallop production on the East Coast just as soon as eelgrass went out.

MR. BRUCE S. WRIGHT (New Brunswick, Canada): What is the reaction of the fisherman on the coast to the appearance of eelgrass? I know in the Maritimes they deliberately dig it out when it comes back. They don't want it back.

DR. COTTAM: Eelgrass forms a dense mass in areas where it does occur in good abundance. The plant leaf comes to the surface and forms slicks so that the water is smooth and glassy. When you travel over that with an outboard motor, your propeller gets caught in the leaves of the plant to such an extent that any person traveling in an outboard motor soon finds himself in sore difficulty. I think it was largely for that reason that the Wigley's propeller was developed to cut the grass and keep it from stopping the propeller. I suspect there was no plant cut quite so much as eelgrass before it disappeared. When the plant almost completely died out, fishermen prayed for its return. Now it is coming back just too much. It is either a feast or a famine. When you have too much of the stuff it is too hard to get through. When there isn't any, the fish or organisms that go with it suffer.

# SALINITY AS A FACTOR IN ATLANTIC COAST TIDEWATER MUSKRAT PRODUCTION

HERBERT L. DOZIER
*U. S. Fur Animal Field Station, Cambridge, Maryland*

According to Cottam (1938) there are approximately 625,000 acres of tidal marsh, both fresh and salt, on the Atlantic Coast from Maine to Virginia. These have long formed a valuable part of our great natural wildlife resource. Over a great part of this area muskrats occur in varying numbers.

The race known as the Virginia or coastal muskrat (*Ondatra z. macrodon*) is distributed over the Middle Atlantic Coast region from upper Delaware Bay to Pamilco Sound, North Carolina, being found in greatest numbers over the Delmarva or Eastern Shore Peninsula.

The purpose of this paper is to present a brief analysis of the data accumulated to date at this station, covering various aspects of the salinity on tidal marshes and muskrat production in the eastern coastal region. It is intended merely as a progress report to show the way the evidence is pointing for the region under consideration. Apparently, the more the salt content increases the less productive of muskrats a marsh becomes. A rather complete and detailed discussion is given on fluctuations in the marsh vegetation and correlated

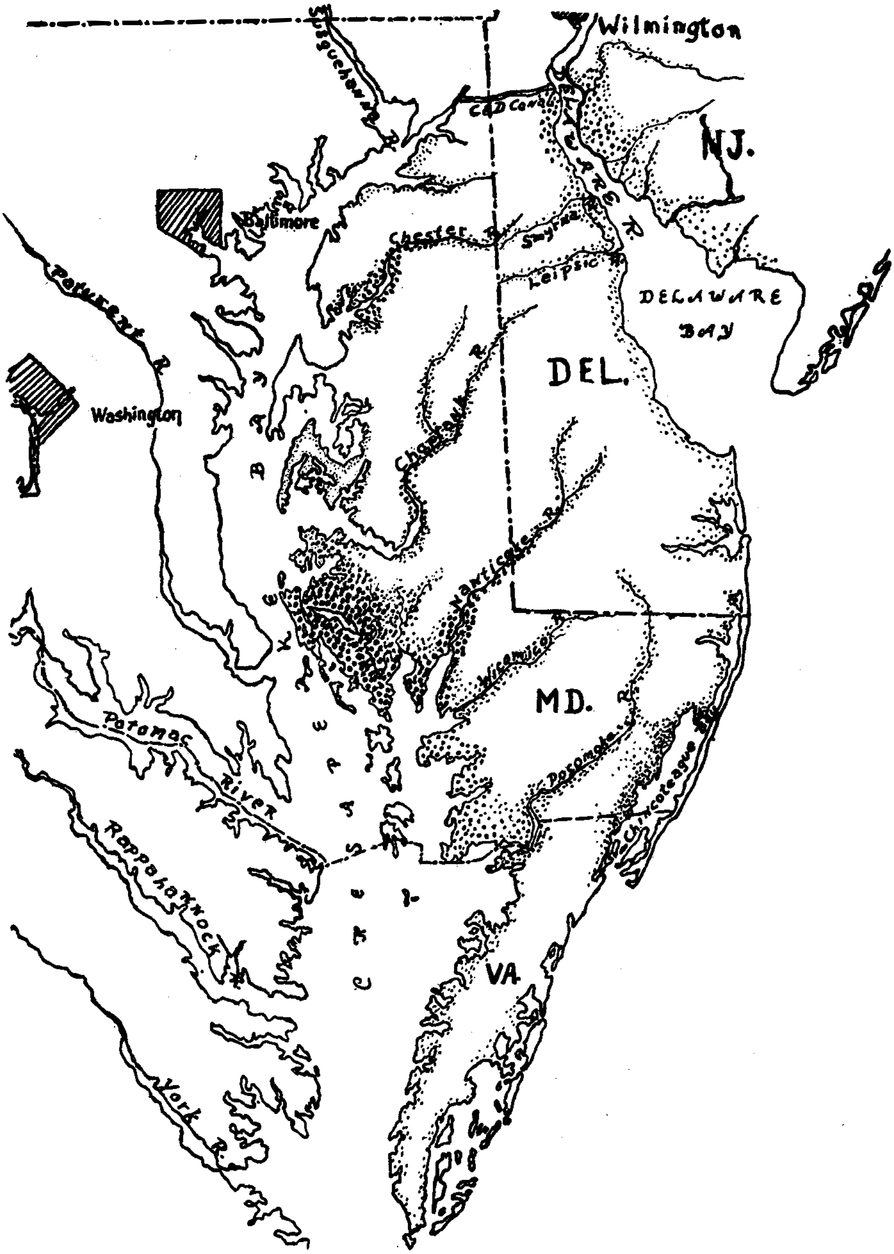


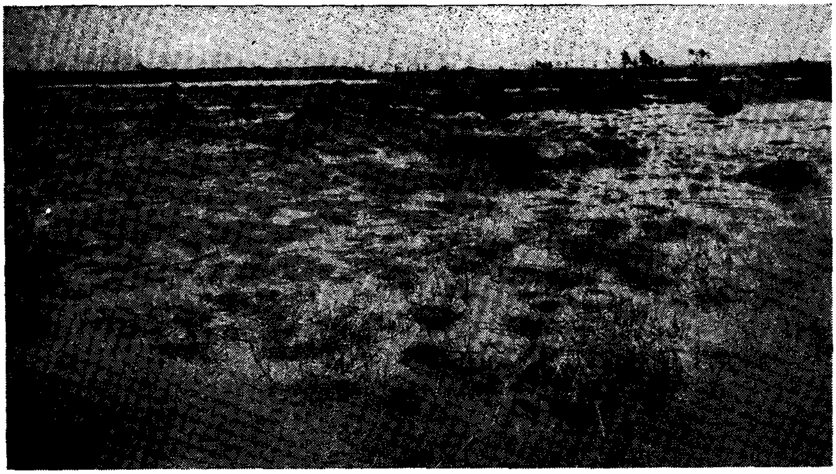

Figure 1. Distribution and relative abundance of the coastal muskrat on the Delmarva Peninsula.

muskrat population on the Blackwater National Wildlife Refuge in Maryland as a basis for a better understanding of the entire salinity problem, from both an economic and a wildlife conservation standpoint.

The author is indebted to the following for their kind and valued assistance: Frank G. Ashbrook and Charles E. Kellogg, Fish and Wildlife Service, Chicago, Ill., for helpful direction, initiation of the annual muskrat house count on the Refuge, and especially for data accumulated on this phase prior to 1937; Merle H. Markley, U. S. Fur Animal Field Station, for preparation of graphs, chloride determinations covering the period January 1, 1946 to the present, and conduction of the 1946 annual house count; William S. Holt, Robert W. Allen, Leonard M. Llewellyn, Carl Rossy and Solomon R. Willey, former assistants, for securing desired house count data; Arnold L. Nelson, Ray Treichler and Francis M. Uhler, Economic Investigations Laboratory, Bowie, Md., for suggestions and chloride determinations prior to the date mentioned above; Peter J. Van Huizen, David V. Black, and Cornelius W. Wallace, past and present managers of the Blackwater Refuge, for cooperation and assistance in obtaining trapping data and annual house counts; George P. Spinner, Bombay Hook Refuge, Smyrna, Del., for securing historical data on marsh habitat changes in his region; and John Lehn, Animal Trap Company of America, Lititz, Pa., for additional data on mustrat distribution.

*Natural and man-made changes affecting muskrat production.*—Over the long period of years since the coastal country was first settled there have occurred many changes, both natural and man-made, that have influenced and affected muskrat abundance. Chief among these, perhaps, has been the effect left by occasional hurricanes and storms of unusual violence. These have caused profound changes in the character of the vegetation which in turn has been reflected by fluctuations in the muskrat population.

Excellent examples of the latter are the so-called "break-throughs" that have occurred along the Delaware Coast, where tidal ingress of salt water through new breaks along the coast line, has greatly affected marsh vegetation types and muskrat production. One of the more important of these breaks took place in the Woodland Beach area just above the Bombay Hook National Wildlife Refuge, near Smyrna, Delaware, during the record-breaking storm of October 1878. Prior to this, much of this area is said to have consisted of excellent cat-tail and *Scirpus olneyi*. Through a period of years, as this break enlarged, the marsh changed slowly from fresh to a more brackish water condition. This was hastened by the digging of Sluice Ditch at the southern end of the area about 1890. Today, most of the muskrats taken



A

B

Figure 2. A.—View on still-water Deadwoods marsh of the Blackwater National Wildlife Refuge, Maryland, showing density of muskrat houses at the peak, March 9, 1938; note badly eaten condition as result of overpopulation

B. View of the same area, showing scarcity of houses at the low, April 14, 1944 in this area come from the upland borders where the freshest water is present.

The inherent fertility of much of this coastal land has led to many man-made efforts at reclamation for agricultural development. Warren (1911) states that "the reclaiming of tidal marshes extends back about 150 years, but the results obtained have not been wholly satisfactory. The comparatively few permanent successes have been accompanied by so many failures that many people have become discouraged and skeptical as to the practicability of such reclamations." Some of these reclamation projects have seriously affected wildlife populations. The construction of dikes, roads, and canals have also in many cases brought about great changes in our coastal areas.

Attempts to straighten navigation channels have been rather frequent. For example, two canals have been made in the course of the Leipsic River in Delaware, one prior to 1900 and the second in that year. The canal built prior to 1900 had little effect on the vegetation in the marshes bordering the river as this was over 2 miles from the trapping areas. The more recent canal was located immediately below the trapping marshes and had a great effect on these. The vegetation changed from a fresh and brackish ecological type, being altered from cat-tail along the upland marsh border and *Scirpus olneyi* along the river, into a more brackish salt marsh of *Spartina alterniflora* and *S. patens.* Consensus among trappers who have trapped these marshes before and after these changes state that trapping yields of muskrats have been greatly reduced.

Drainage of wet areas along the coast to eliminate pest mosquito breeding areas has been very extensive and has greatly altered the low marsh country along the New Jersey and Delaware coasts in particular. Cottam and Bourn (1938) in discussing ditching and wildlife have shown that "a large percentage of mosquito control projects as hitherto conducted in this country undoubtedly has been unnecessarily destructive to wildlife. Much of this destruction can be attributed to ill-advised and woefully misdirected programs and to the employment of control methods that are particularly injurious either to wildlife or to its habitat. There is nothing wrong with mosquito control as such, but some of the methods, abuses, and common improper practices employed are open to serious and warranted condemnation because of their needless detrimental effect on wildlife."

*Muskrat population fluctuations on the Blackwater National Wildlife Refuge.*—The Blackwater National Wildlife Refuge is located on the Eastern Shore of Delmarva Peninsula about 10 miles southwest of Cambridge, Maryland. It consists of 8,168 acres of cultivated land, timber, marshes, and open water, 5,233 acres of which are trappable marsh during normal years. This has been staked out into 27 "hunts" or trapping units, the boundaries of which are to each remain intact over a long period of years for maintaining accurate records. Title to this excellent tidewater muskrat producing area was vested in the United States on January 23, 1933, subject, however, to trapping reservations by the private corporation for a period of 8 years. Since expiration of these rights on April 15, 1940, trapping has been conducted by Fish and Wildlife personnel.

During the period 1933-37, the number of muskrat houses on the refuge was counted by the manager annually in November as a basis

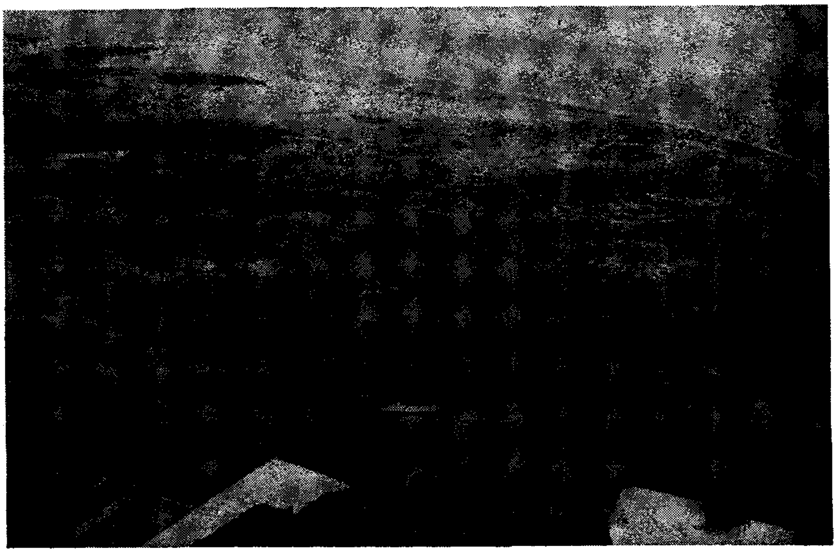


Figure 3. Aerial view showing extensive mosquito control drainage ditching on a Delaware coastal marsh area (Courtesy 4146 Army Air Forces Base Unit, A.T.S.C.)

for estimating the existing population and determining the number of animals that should be removed for best results and yet leaving a sufficient reserve of breeding stock. In these early counts only the large or so-called "nesting" houses were included. With the establishment of the U. S. Fur Animal Field Station on the refuge in the late fall of 1937, the annual house count has been continued by station personnel, using the "strip" method and employing the services of three men, boat equipment, and hand tally counters. This consisted of a total count of all houses, including both "live" or nesting houses and the feeding shelters.

The low ratio of houses to animals trapped during the period 1933-37, in comparison with the more detailed and accurate count of total houses made from 1938 to the present, would seem to indicate that the early house census definitely represents an underestimation of the actual population. These figures do show, however, the very definite improvement in marsh conditions and upward swing in the population that took place.

It is roughly estimated that perhaps 20 per cent of the total number of muskrats trapped may be "bank" inhabitants. This has not been taken into account, however, in the accompanying Table 1 which gives the changes in the population with corresponding catches.

Elton and Nicholson (1942) state that muskrat populations tend

Figure 4. View on Sunken Island marsh of the Blackwater National Wildlife Refuge, Maryland, showing density of muskrat houses at the peak, December 19, 1938

toward a more or less definite 10-year cycle, based on their analysis of Canadian fur records covering many years. Data on the catch from this refuge, as clearly shown in Table 1, corroborate the fact that periods of scarcity and abundance exist between population peaks in the case of the coastal muskrat but that these appear to be somewhat longer. This is further substantiated by the actual number of muskrat houses or nests counted on the area, an index that emphasizes the fact that such fluctuations cannot be attributed to trapping variation.

According to data given by LeCompte (1934), the take of muskrat pelts in Maryland in 1928 was over a million and the 1929 season was also very satisfactory. The extreme drought that prevailed throughout the entire section of the eastern coastal region from March

TABLE 1. MUSKRAT POPULATION TRENDS AND RESULTANT CATCH ON THE BLACKWATER NATIONAL WILDLIFE REFUGE, MARYLAND (1933-1947)

| Year | Total houses | Per cent change | Houses per acre | Muskrat catch | Per cent change |
|---|---|---|---|---|---|
| 1933 | 1,254 | + | 0.24 | 6,039 | + |
| 1934 | 1,377 | +9.8 | 0.26 | 8,580 | +42.1 |
| 1935 | 2,048 | +48.7 | 0.39 | 9,290 | +8.3 |
| 1936 | 5,269 | +157.3 | 1.01 | 22,454 | +141.7 |
| 1937 | 4,652 | —11.7 | 0.88 | 20,499 | —8.7 |
| 1938 | 27,373 | +488.4 | 5.2 | 26,286 | +23.3 |
| 1939 | 29,893 | +8.4 | 5.7 | 21,876 | —16.7 |
| 1940 | 30,578 | +2.2 | 5.8 | 19,310 | —11.7 |
| 1941 | 11,175 | —63.4 | 2.1 | 9,895 | —48.8 |
| 1942 | 6,601 | —40.9 | 1.3 | 6,730 | —32.2 |
| 1943 | 6,250 | —5.3 | 1.2 | 4,169 | —38.1 |
| 1944 | 2,575 | —58.5 | 0.49 | 1,061 | —74.6[1] |
| 1945 | 2,481 | —4.0 | 0.47 | 2,268 | +113.8[2] |
| 1946 | 3,055 | +23.0 | 0.58 | 1,845 | —18.6[3] |
| 1947 | 5,185 | +70.0 | 0.99 | | + [4] |

[1]Trapping limited to units 1,6,9,10 and 27 in 1944
[2]Trapping limited to units 6,7,8,9,10 and 27 in 1945
[3]Trapping limited to units 5,7,8,9,10 and 12 in 1946
[4]Trapping limited to units 1,2,3,4,5,6,7,8,9,10,12,13a,14,15,16 and 27 in 1947.

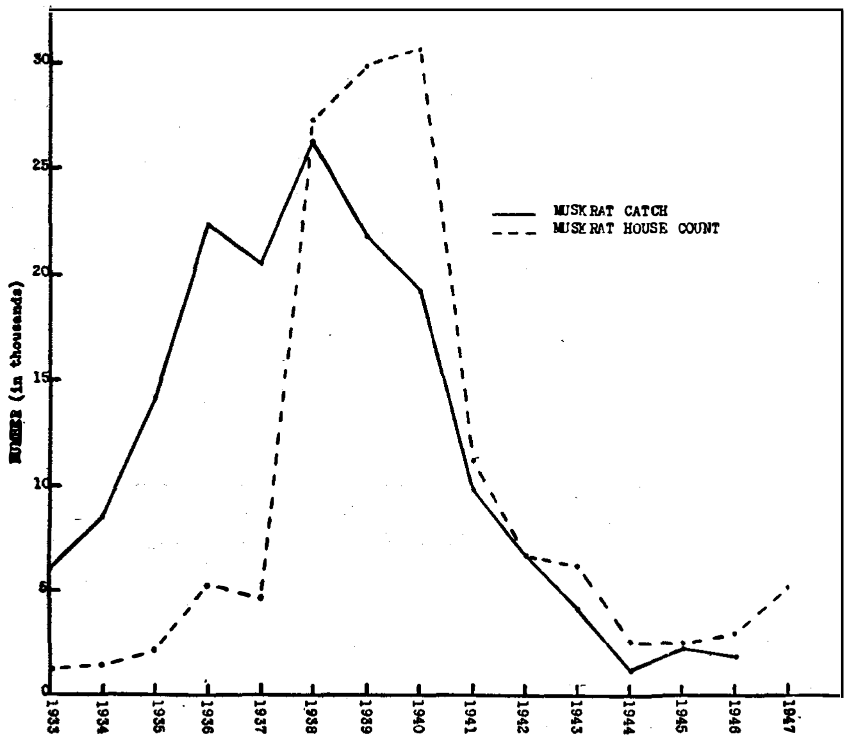



Figure 5. Muskrat house count and catch on the Blackwater National Wildlife Refuge, Maryland, seasons 1933-1947

to November 1929, however, was catastrophic. "Thousands of small lakes in the muskrat areas became absolutely devoid of water, causing aquatic plant life to become very scarce and an unprofitable trapping season in 1930. The drought not only reduced the brood stock in the marshes but thousands upon thousands of young animals died from lack of food and water."

The Delmarva Fur Farms, Inc., who at that time owned the area comprising the present Blackwater Refuge, trapped 13,500 muskrats from the same during January 1 to March 15, 1929. Due to depletion of muskrat stock and their natural marsh food plants by the drought that followed, this company deemed it inadvisable to carry on trapping operations at all during the 1930 trapping season. Intense drought continued during the summer of 1930, with a record of 48 days of 90 degree temperatures. Smith (1938) in writing about the drought of 1930 states "as the water level sank lower and lower on the Maryland marshes that year, many muskrats deserted their homes and followed the receding water down the creeks and rivers. Trappers reported that they had gathered along some streams in great numbers. New and unusual conditions were encountered. The water became stale, and the salt water of the bay that replaced the normal fresh or brackish water of the marsh destroyed their favorite food plants. The three-square sedge, their chief food, was killed out in large areas. Deprived of both proper food and water, they practically disappeared on some areas, and very few young were raised that year."

During the late summer of the 1930 drought, the marshes of the refuge area were invaded by attendant record high tides that flooded the marsh with salt with disastrous results, further depleting the muskrats and the desirable marsh vegetation. Turtles of all kinds, as well as frogs, were killed in large numbers. The snapping turtle was nearly exterminated, the bleached shells being scattered over the marshes in large numbers. Since 1930 regular summer rains, often even floods, occurred bringing an abundance of water. The catch for 1931 is said to have dropped to 30 per cent of the average catch for the previous 5 years with practically no kits, indicating an almost total loss of litters during the previous breeding season.

A hurricane that occurred on August 22-23, 1933 with high wind and accompanying heavy rain, drove the waters of the Chesapeake Bay up over the low marshes from 3 to 4 feet higher than ever before recorded. All muskrat houses were either swept away or submerged, leaving the animals without shelter or food, under high water conditions that existed from 2 to 3 weeks. Vast numbers on the lower marshes perished as there were no elevation on which the animals could seek safety. The survivors were widely dispersed and confined to the higher islands, resulting the following winter in some small areas being well stocked with animals, while others that contained an abundance of good food were entirely untenanted. While great numbers drowned, many died from disease, starvation, lack of fresh water, and predation.

Very heavy rains occurred during all of the later summer of 1934. Heavy rains in 1935 caused a small flood that raised the water levels about 1 to 2 feet but without any attendant tide. With an abundance of fresh water, *Scirpus olneyi* made excellent growth, crowding out

Figure 6. View on Keene's Ditch marsh of the Blackwater National Wildlife Refuge, showing minor drought conditions, November 12, 1939

the *Spartina patens* and by 1936 the older trappers were saying that conditions for muskrats looked the best in some 25 years.

A steady rise in the muskrat population took place up until a peak in 1938-39. The trapping records show a peak catch from January 1-March 15, 1938 of 26,286 for the refuge, but the largest of houses was counted in the fall of 1939, in spite of a minor drought the same summer.

During the 1940 trapping season, however, intense cold prevailed and ice and snow covered the marshes. The heaviest snowfall in 40 years closed roads and schools. A few days of trappable weather from January 15 to 22 was then followed with a record-breaking snow blizzard that hit on January 23 and resulted in the death of one trapper at Elliotts Island. Trappers were forced to vacate their shanties on the open marsh by the blizzard, and few ventured back in to get the muskrats that were caught and buried in the ice and snow. Only a comparatively few traps were set and extremely few muskrats were taken, the catch dropping to 19,310, a figure that did not represent a true picture of the actual population. Observations made just prior to the second snow blizzard showed that the musk-

Figure 7. View on frozen marsh, showing badly eaten out area surrounding a muskrat house, Jan. 19, 1940

rats had started to "cut out of the ice." There was evidence that many animals perished in the snow and also inside of their nests in the houses. Some of these were in badly emaciated condition, due apparently to a lack of food in badly eaten out areas. Others perished inside their nests in good flesh, possibly through some virulent form of disease.

Examination of many muskrats direct from the trap line or on the marsh in February of that season showed most of them to be extremely heavily infested with mites *(Laelaps multispinosus* Banks and *Listrophorus validus* Banks) or "lousy" as termed by the trappers. The latter stated that these mites had been the most plentiful in their entire experience, during both 1939 and 1940. It was evident that the extreme cold didn't hamper the development of these mites and may have, on the contrary, through enforced inactivity of the muskrat in its nest, brought about the conditions responsible for their unusual abundance.

During the fall of 1940, a serious epizootic of disease that produced a virulent septicemic condition occurred in our experimental pens and marsh enclosures and this carried through into the following summer. Apparently the same disease occurred in the open marsh and, although Armstrong (1942) attributed this outbreak principally to infection by *Salmonella typhimurium,* possibly several organisms, including a virus, may have been involved. The radical drop in number of muskrat houses from 30,578 in 1940 to 11,175 in 1941 and a corresponding drop in actual catch from 19,310 to only 9,895 would tend to support the writer's contention that this unidentified disease was a major factor that started the decline.

The downward trend has been continuous since 1940, accelerated by the years of drought and heat, with corresponding increased salinity, to a new low in 1944. This decline has not been confined to the Blackwater Refuge but has been general over the entire Delmarva or Eastern Shore Peninsula.

The Weather Bureau's Baltimore Office reported the summer of 1943 as a whole the second hottest since 1872, with an official average temperature of 79.1 degrees for the months of June, July, and August. The heat was terrific with a total of 24 days of 90 degrees for the period July-September. Water levels dropped so low that the large fresh-water ponds near refuge headquarters dried up almost completely, with a total loss of fish.

The summer of 1944 saw a continuation of the drought of the preceding year and the muskrat reached its lowest ebb on the lower salt marshes. The November count of houses showed a 4 per cent over-all decrease over that of the preceding one, denoting a levelling off at the bottom of the decline. It is interesting to note that the only significant increase over the refuge occurred on those fresh-water units located on the upper reaches of the Little Blackwater River.

The summer of 1945 was one of the wettest on record and resulted in a conspicuous decrease in salinity. There was an over-all increase of 23 per cent in the number of houses. It became evident that the low had been definitely passed and that the population had increased on over half of the 27 trapping units. There was a remarkable improvement also in the vegetation, starting on the lower brackish marshes as well as on those units affected by the abundant rainfall and fresh-water runoff. The concentration of houses on the upper part of the areas adjacent to the wood edges and smaller ponds and creeks, which are most influenced by the fresh-water runoff from the Greenbriar and Kentuck Swamps and along the impoundment dike, is rather striking and conclusive.

With high precipitation and cooler temperatures prevailing, the muskrat has continued to show a rapid "come-back." A total of 5,185 houses was counted in the fall of 1946 as against 3,055 the preceding year, an increase of 70 per cent.

*Habitat requirements and salinity as a limiting factor.*—By far the most important type of muskrat habitat falls under the general terms "marsh." Under this is included the great inland fresh-water river bulrush, cat-tail, and round-stemmed bulrush areas, and the extensive marshes of the coastal regions. It is in the vast areas of marshland that the muskrat is found and trapped in greatest numbers. Coastal marshes are composed of two types, known as diked or banked meadows and tidal marsh. Diked meadows are those in which the marsh is enclosed by an earthen bank, with sluice gates installed at various locations for drainage into the tidewater streams (Harris, 1937). In this manner the depth of the water can be more or less regulated. Many owners keep the marsh as dry as possible and operate the area for haying purposes, hence the name "meadow." For muskrat production, the surface of this type marsh is kept wet enough to insure a dense growth of cat-tails and other marsh vegetation for muskrat food. Properly handled bank meadows are said to produce on an average more muskrats per acre than any other type of marsh. They are found principally along the New Jersey Coast.

Tidal marsh is further subdivided into fresh-water tide marsh and salt-water marsh. These marshes are open and subject to the ebb and flow of the tide. They are penetrated by a system of meandering rivers, small ditches, creeks, "guts," and numerous ponds. These marshes along most of the coast and those bordering nearest the largest bays, such as the Delaware and Chesapeake Bays, are largely salt-water marshes and the vegetation consists principally of big cord-grass *(Spartina cynosuroides)*, salt-marsh cord-grass or "blade" grass*(Spartina alterniflora)*, salt-meadow grass *(Spartina patens)*, saltgrass *(Distichlis spicata)* and dense stands of black rush or needle-grass *(Juncus roemerianus)*. While these plants are eaten to a limited extent by the muskrat it is very evident that the growth of the more relished food such as the cat-tails (*Typha* spp.), and the favored brackish-water three-square (*Scirpus olneyi*) together with the muskrat population, become less as the salinity of the water increases.

Running back from these bays practically every tributary is quite brackish and at a certain point forms what are known as fresh-water marshes. In the sheltered coves along the larger creeks and rivers of the upland are found nice stands of cat-tail and other desirable muskrat food. There the muskrats live in considerable numbers, mostly in bank dens. In the lowlands nearer sea level where the salt-marsh surface is covered with water most of the season these marshes may be known as "still-water marsh" or "ebb and flow marsh," depending on their access to tidal water action. The principal plant growth of these marshes consists mainly of the three-square sedges *(Scirpus olneyi, S. americanus* and *S. robustus)* with cat-tail, tall reed *(Phragmites communis)*, cord-grasses *(Spartina cynosuroides* and *S. alterniflora*), needle-grass and spike rushes (*Eleocharis* spp.), occurring in limited stands.

During most of the year these marsh areas are more or less partly submerged with water. Living conditions approach the ideal for the muskrat and the three essential requirements to sustain a maximum muskrat population are generally to be found: (1) an abundance of suitable aquatic vegetation for food and protective cover, (2) sufficient fresh or moderately brackish water for swimming and proper sanitation, and (3) the most suitable type of peaty humus bottom in which to dig their systems of canals, underground tunnels, and runways.

Muskrats do not seem to like the red clay silt or sand which is present at the terminus of many of our coastal rivers. This, together with too great a daily variation in tide level, coupled with high salinity, may well account for the fact that distribution of the muskrat along the Eastern Coast stops at or near Pamlico Sound, North Carolina; also that this aquatic animal is absent from the coastal region of South Carolina, Georgia, Florida, part of Alabama, and that of California in spite of the occurrence of extensive "marsh" areas at certain points. A deficiency of certain chemical elements and other edaphic features may also play an important role and need investigation badly.

The distribution and abundance of the best or preferred muskrat food plants is limited to a great extent by their ability to withstand varying degrees of intermittent and prolonged submergence and of tolerance to different concentrations of salt or chlorides. A few inches difference in the elevation may make a profound difference in the living conditions. Hathaway and Penfound (1936) have shown that in southeastern Louisiana "within a given area slight differences in elevation are associated with striking differences in salinity (a) high land shows low salinity, presumably due to the leaching action of rain water; (b) low land, where rain water accumulates on the surface, shows relatively low salinity in the surface water; (c) the zone in which we find water of the highest salinity is usually one in which the average water table is just below the surface: the land is too high to permit the accumulation of much surface water, but too low to make leaching very effective, and the water table is so close to the surface as to provide for copious evaporation, with resulting concentration of salt.'' In the salt marshes of the Atlantic and Gulf Coasts the muskrat, although able to survive in waters of rather widely different salinities, is most abundant where the tidal influence is not great. As pointed out by Smith (1938) ''salt water kills the favorite food plants of the muskrat and accounts for muskrat scarcity in salt-water areas. During the unprecedented drought of 1930 in Maryland the fresh-water marshes under observation were invaded by record-breaking salt-water tides from the Chesapeake Bay. The best food plants of the muskrats were destroyed or seriously depleted, and many of the animals died. Two years later the vegetation had practically regained its normal growth and muskrats were again numerous.'' Many other disastrous high tides have occurred over the long period of years and each has meant a ''set back'' and often a radical change in both vegetation and muskrat abundance over the lower marshes.

The time and height of tides are normally governed by inexorable natural laws but they are strongly affected by the force and direction of the wind and the depth and contour of the shore and topography. In both the Delaware and Chesapeake Bay areas a northwesterly wind favors a low tide, and a southwesterly wind a high tide.

In order to obtain desired data on salinity throughout the Blackwater Refuge, three representative water sampling stations were established in 1944 at which samples have been collected at regular intervals for chloride determination.

These stations are located at three widely separated points:

1. *Big Blackwater River bridge*—this is at the western edge of the Blackwater Refuge and is the freshest point, due both to the extensive fresh-water runoff from the vast Kentuck Swamp into the Big Blackwater River above this point and to its greater distance to the salt. The distance by river to Shorter's Wharf is approximately 13 miles and a total of 23 to Fishing Bay which empties into the middle part of the Lower Chesapeake Bay.

2. *Headquarter's boat house*—located on the Little Blackwater River which receives the fresh-water runoff from the large Greenbriar Swamp. This river joins the Big Blackwater River after mean-

dering through a large part of the refuge. The distance to Shorter's Wharf is about 9 miles and a total of only 19 to Fishing Bay.

3. *Shorter's Wharf bridge*—this station lies a short distance south of the refuge boundary on the lower part of the Big Blackwater River through which all of the drainage from this refuge empties into Fishing Bay. Via river mileage it is only 10 miles from Shorter's Wharf into Fishing Bay. It therefore represents a high degree of salinity approaching the maximum limits for muskrat survival.

The acute drought of the summers of 1943 and 1944 and the evident corresponding great rise in the degree of salinity, accompanied with heavy mortality of muskrats in both our experimental breeding enclosures and over the marsh itself, led to the collection of these samples at regular semimonthly periods, starting May 1, 1944.

The nature of the marshes under discussion is such that most of it is bathed directly by daily tidal river water. There are very few "still-water" areas on the Blackwater Refuge. In addition to the three river sampling stations, six others were established at interior points over the marsh units themselves in order to obtain a better over-all picture. These minor fluctuations are not discussed in detail here, however, as it is felt that the river collecting points show the salinity trends significantly.

Detailed figures are given in Table 2 in order that a clearer picture can be had of the direct correlation between the degree of freshness of the water over the refuge marshes and the corresponding rise and fall of the muskrat population. Records prior to May 1, 1944 are from salinity readings made at irregular intervals by Francis M. Uhler of the Fish and Wildlife Service. Although these early records are incomplete and meager, they do show the marked increase in degree of salinity up to that point, comparable to the summer salinities from the Chesapeake Bay near the mouth of the Potomac River.

The accompanying graph (Figure 8) illustrates strikingly the effect of the rise in summer temperatures and lack of effective rainfall in the increased salinity at the peak of the 1944 drought and also the tidal influence. The highest salinity point was reached following the prolonged droughts of 1943 and 1944, the peak occurring during September 1-15, 1944 when the highest concentration at Shorter's Wharf in our experience reached about 42 per cent of the salinity of average Atlantic Ocean water or a chlorine content equivalent to approximately 8,205 parts per million of total chlorides. The muskrat population correspondingly reached in the summer of 1944 its lowest point in the memory of our oldest trappers and fur buyers, being especially apparent over the lower saline marshes. This condition seemed to be

TABLE 2. SALINITY OF WATER SAMPLES FROM THE BLACKWATER NATIONAL WILDLIFE REFUGE AND VICINITY (1932-1947)[1]

| Date of collection | Big Black Riv. Br. Chloride content | Big Black Riv. Br. Per cent salinity | Headquarters Chloride content | Headquarters Per cent salinity | Shorter's Wharf Chloride content | Shorter's Wharf Per cent salinity |
|---|---|---|---|---|---|---|
| February 27, 1932 | 582 | 2.97 | 479 | 2.45 | 3,032 | 15.53 |
| October 5, 1933 | 3,255 | 16.66 | 3,110 | 15.91 | | |
| July 27, 1935 | | | 514 | 2.63 | | |
| September 8, 1935 | | | 382 | 1.96 | | |
| August 8, 1939 | | | 4,507 | 23.07 | 5,475 | 28.02 |
| June 18, 1940 | 1,528 | 7.82 | 2,695 | 13.79 | 4,450 | 22.72 |
| August 31, 1941 | 5,581 | 28.57 | 5,570 | 28.50 | 6,284 | 32.16 |
| August 4, 1942 | 2,188 | 11.20 | 684 | 3.50 | 5,390 | 27.58 |
| August 3, 1943 | 6,489 | 33.21 | 6,489 | 33.22 | 6,527 | 33.41 |
| August 30, 1943 | 7,482 | 38.29 | 7,798 | 39.91 | | |
| May 1, 1944 | 177 | 0.91 | 106 | 0.54 | 603 | 3.10 |
| June 1, 1944 | 542 | 2.78 | 1,514 | 7.75 | 3,972 | 20.64 |
| June 15, 1944 | 2,126 | 10.88 | 3,389 | 17.34 | 5,537 | 28.34 |
| July 1, 1944 | 2,867 | 14.67 | 3,497 | 17.90 | 4,908 | 25.12 |
| July 15, 1944 | 4,928 | 25.22 | 5,071 | 25.95 | 5,442 | 27.85 |
| August 1, 1944 | 4,742 | 24.27 | 5,216 | 26.70 | 5,823 | 29.80 |
| August 15, 1944 | 5,380 | 27.53 | 6,079 | 31.11 | 7,166 | 36.68 |
| September 1, 1944 | 6,301 | 32.25 | 6,935 | 35.49 | 8,265 | 42.30 |
| September 16, 1944 | 7,590 | 38.84 | 7,811 | 39.99 | 8,195 | 41.94 |
| October 1, 1944 | 7,566 | 38.72 | 7,714 | 39.48 | 8,238 | 42.17 |
| October 15, 1944 | 7,414 | 37.95 | 7,524 | 38.51 | 7,870 | 40.28 |
| November 1, 1944 | 7,016 | 35.92 | 7,006 | 35.86 | 8,064 | 41.28 |
| November 15, 1944 | 7,036 | 36.02 | 7,100 | 36.34 | 8,052 | 41.22 |
| December 1, 1944 | 5,340 | 27.33 | 5,740 | 29.38 | 6,728 | 34.44 |
| December 15, 1944 | 2,974 | 15.22 | 3,144 | 16.09 | 4,574 | 23.41 |
| December 19, 1944 | 3,136 | 16.05 | 3,300 | 16.89 | 5,079 | 26.00 |
| January 1, 1945 | 4,008 | 20.52 | 4,317 | 22.10 | 6,595 | 33.75 |
| January 15, 1945 | 2,851 | 14.59 | 2,005 | 10.26 | 4,654 | 23.82 |
| February 1, 1945 | 980 | 5.02 | 534 | 2.74 | 1,581 | 8.10 |
| February 15, 1945 | 1,792 | 9.18 | 1,550 | 7.93 | 5,050 | 25.84 |
| March 1, 1945 | 526 | 2.70 | 205 | 1.04 | 1,474 | 7.54 |
| March 15, 1945 | 618 | 3.16 | 790 | 4.05 | 2,377 | 12.16 |
| March 31, 1945 | 936 | 4.80 | 971 | 4.96 | 3,794 | 19.42 |
| April 16, 1945 | 2,042 | 10.45 | 2,428 | 12.43 | 5,708 | 29.22 |
| May 1, 1945 | 1,781 | 9.12 | 2,444 | 12.50 | 5,257 | 26.91 |
| May 15, 1945 | 2,360 | 12.08 | 3,104 | 15.88 | 6,158 | 31.52 |
| June 1, 1945 | 1,505 | 7.71 | 189 | 0.97 | 3,879 | 19.86 |
| June 15, 1945 | 442 | 2.26 | 149 | 0.77 | 2,351 | 12.03 |
| July 2, 1945 | 1,333 | 6.82 | 1,492 | 7.64 | 3,838 | 19.64 |
| July 16, 1945 | 252 | 1.29 | 702 | 3.60 | 2,485 | 12.72 |
| August 1, 1945 | 21 | 0.11 | 26 | 0.13 | 114 | 0.58 |
| August 16, 1945 | 124 | 0.63 | 134 | 0.68 | 281 | 1.44 |
| August 31, 1945 | 216 | 1.10 | 354 | 1.82 | 842 | 4.32 |
| September 14, 1945 | 682 | 3.49 | 964 | 4.94 | 2,785 | 14.26 |
| October 1, 1945 | 497 | 2.54 | 893 | 4.57 | 2,574 | 13.18 |
| October 15, 1945 | 527 | 2.70 | 1,225 | 6.27 | 2,206 | 11.30 |
| November 1, 1945 | 594 | 3.04 | 1,283 | 6.57 | 2,058 | 10.53 |
| November 16, 1945 | 627 | 3.20 | 1,144 | 5.85 | 1,817 | 9.30 |
| November 30, 1945 | 294 | 1.50 | 144 | 0.74 | 2,377 | 12.17 |
| December 14, 1945 | 170 | 0.87 | 33 | 0.17 | 539 | 2.76 |
| January 2, 1946 | 73 | 0.38 | 12 | 0.06 | 269 | 1.38 |
| January 15, 1946 | 119 | 0.61 | 108 | 0.56 | 329 | 1.68 |
| February 1, 1946 | 277 | 1.42 | 337 | 1.73 | 763 | 3.91 |
| February 14, 1946 | 439 | 2.25 | 527 | 2.70 | 1,162 | 5.95 |
| February 28, 1946 | 2,246 | 11.50 | 651 | 3.33 | 464 | 2.37 |
| March 15, 1946 | 519 | 2.66 | 575 | 2.94 | 1,429 | 7.31 |
| April 1, 1946 | 509 | 2.61 | 898 | 4.60 | 3,845 | 19.67 |
| April 15, 1946 | 529 | 2.76 | 1,023 | 5.24 | 3,168 | 16.20 |
| April 30, 1946 | 445 | 2.28 | 683 | 3.50 | 2,122 | 10.80 |
| May 15, 1946 | 198 | 1.01 | 77 | 0.40 | 1,058 | 5.42 |
| May 31, 1946 | 498 | 2.55 | 933 | 4.77 | 4,157 | 21.28 |
| June 14, 1946 | 355 | 1.81 | 726 | 3.72 | 2,132 | 10.91 |
| July 1, 1946 | 1,584 | 8.11 | 2,469 | 12.64 | 5,149 | 26.35 |
| July 15, 1946 | 1,732 | 8.86 | 2,853 | 14.60 | 4,611 | 23.60 |
| July 31, 1946 | 2,495 | 12.77 | 3,077 | 15.74 | 4,367 | 22.35 |
| August 15, 1946 | 1,603 | 8.21 | 2,847 | 14.57 | 4,106 | 21.02 |
| August 30, 1946 | 2,855 | 14.61 | 4,117 | 21.07 | 4,940 | 25.28 |
| September 16, 1946 | 4,720 | 24.15 | 5,103 | 26.12 | 6,645 | 34.01 |
| October 1, 1946 | 3,234 | 16.55 | 3,550 | 18.17 | 4,869 | 24.91 |
| October 15, 1946 | 4,365 | 22.34 | 5,223 | 26.73 | 6,135 | 31.39 |
| November 1, 1946 | 3,560 | 18.22 | 4,014 | 20.54 | 5,688 | 29.11 |
| November 15, 1946 | 3,468 | 17.75 | 4,454 | 22.80 | 5,397 | 27.62 |
| November 29, 1946 | 2,369 | 12.12 | 4,003 | 20.49 | 4,695 | 24.03 |
| December 17, 1946 | 3,379 | 17.29 | 3,908 | 20.00 | 5,709 | 29.22 |
| January 2, 1947 | 631 | 3.23 | 965 | 4.94 | 2,447 | 12.52 |
| January 15, 1947 | 741 | 3.79 | 1,273 | 6.52 | 3,865 | 19.78 |
| January 31, 1947 | 521 | 2.65 | 1,312 | 6.72 | 4,677 | 23.93 |

[1]Total chlorides in milligrams per liter or parts per million per cent of salinity of average Atlantic Ocean Water

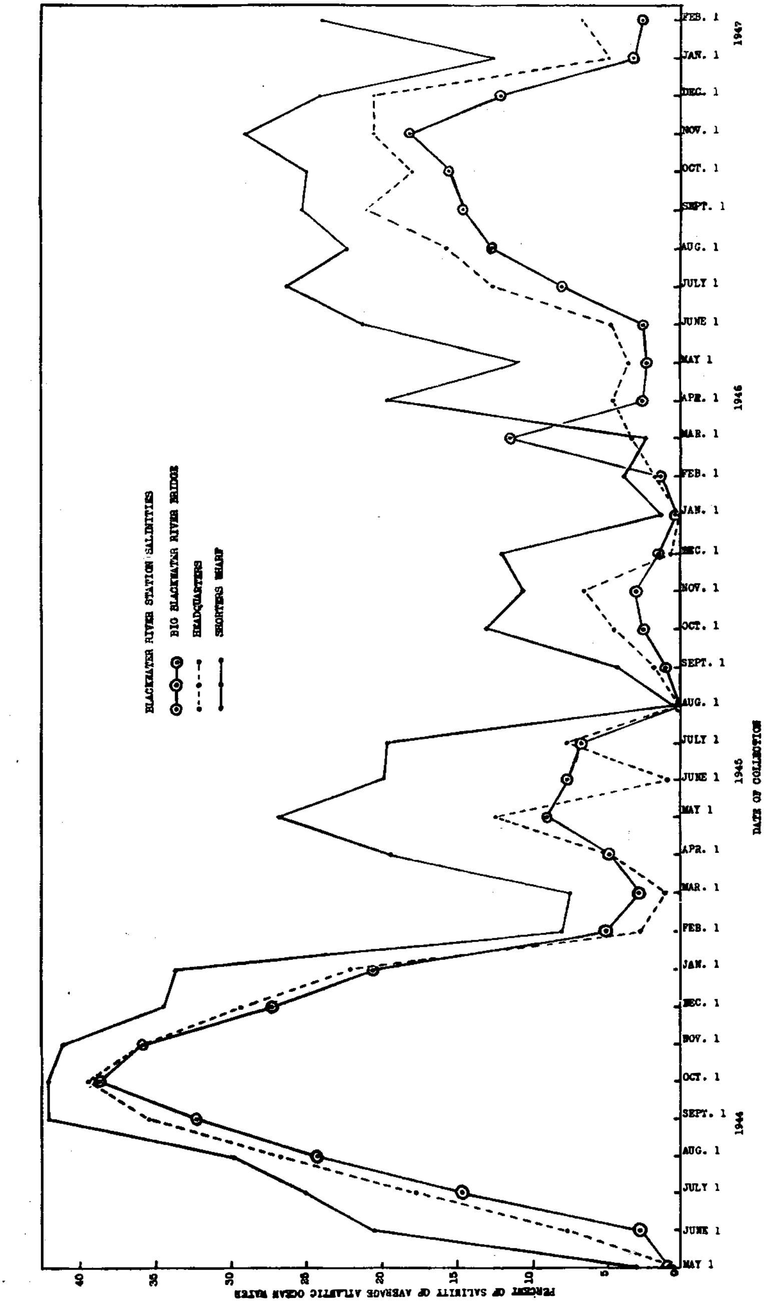



Figure 8. Monthly fluctuations in water salinity, Blackwater National Wildlife Refuge, Maryland (May 1, 1944-February 1, 1947

general over the eastern United States, from New York to North Carolina.

With cooler temperatures and more effective rainfall in the late fall and winter following, the salinity tapered off and has continued downward to its present low. This is reflected in the gradually increasing muskrat population and improved growth of its preferred food plants up to the present time. The annual count of muskrat houses on the refuge for the 1945 trapping season brought out the interesting fact that the muskrat population had continued its decline except on the Stevens marsh (Unit 9), Flag Pond marsh (Unit 10), Short's Creek marsh (Unit 13a), Blackwater Pond marsh (Unit 15), Deadwoods marsh (Unit 16), and McGraw Island marsh (Unit 19).

The improvement on these six units was in marked contrast to that on the remaining 21 units and in seeking an explanation for this study of the topography revealed that these six areas were the ones most influenced by the fresh-water drainage runoff from the surrounding farm areas and woodland, especially the great Greenbriar Swamp. There is a saying among the old local trappers and marsh owners of this section that ''Following a low in the muskrat population, the start of the comeback is always at the head of the river.'' This old adage certainly holds true in the case of the present low in the population for marsh owners all along the upper marshes of the Little Blackwater River report more houses and signs than for some time and the greatest comeback in number of houses on the refuge is on the Stevens marsh and the most northern boundary of the refuge, bordered and influenced by the fresh water of the Little Blackwater at this point.

The farther one went down the river the less houses and signs of muskrats were to be found. In the vicinity of Shorter's Wharf scarcely a house could be seen and old-time trapper residents such as Garfield Smith, Joseph Willey, Al Garcia, Jessie Shorter, and others informed the writer that conditions in that area appeared the worst in their life time experience. It became at once apparent that the nearer the salt water the less muskrats there were. A study of the Flag Pond (Unit 10) marsh, where muskrats have staged a comeback for the past 2 years, showed it to be greatly influenced along its northeastern half by the fresh-water drainage from the adjacent farm and woodlands. It was on this still-water half that most of the muskrat houses and signs were to be found. The Deadwoods marsh (Unit 16) owes its very existence to the great runoff of fresh water from the large Greenbriar Swamp on its northern boundary. This shows an increase in muskrat population proportionate to the filling in of the ponds following the prolonged drought that almost dried up the unit.

The muskrat population on the upper reaches of the Big Blackwater River above the highway bridge has also shown improvement, according to Richard Linthicum and other marsh owners, but this hasn't been reflected on Units 1 and 2 which are located just below the bridge. On the contrary these show a decline in the number of houses. It is thought that this is due to the comparatively small amount of fresh-water runoff from the cultivated farm lands and woods adjoining the northern border of those two unit sand to a road that runs from the refuge headquarters to the paved Church Creek-Golden Hill highway.

The more the situation is studied the more important becomes the aspect of the fresh-water runoff or drainage water from the large Kentuck Swamp that borders the refuge along the north of Units 3, 4, and 5 of the Greenbriar Swamp that drains into the upper part of Unit 10, into Turtle Pond at the head of Unit 12 through a large drainage ditch, and which is largely responsible for Deadwoods Unit 16 being a fresh still-water marsh.

***Effect of increased salinity on muskrat litter production and survival in experimental marsh breeding enclosures.***—A further striking substantiation of the adverse effect of increased salinity on muskrat production is shown by the breeding records of our experimental stock, held in 18 by 18 foot marsh enclosures at the U. S. Fur Animal Field Station, under conditions approximating as nearly normal brackish three-square marsh as possible under the circumstances. Experimental breeding with muskrats has been conducted at the latter since 1938 to the present time. This has served as an accurate index to what was actually occurring at the same time on the open marsh.

Due to the installation in 1942 of a 2-inch main through which water was pumped from the Blackwater River boat house to our marsh enclosures, the latter had an abundance of slightly brackish water, partially controlled by use of gate-valves leading into the various enclosures. Conditions as a whole in these were much better than before with a wonderful stand of *Scirpus olneyi*. The mild spring weather of 1942 was the earliest on record. A total of 34 litters was produced, in spite of terrific temperatures that prevailed at times, and the survival ratio proved to be the poorest yet experienced.

The record-breaking high temperatures and prolonged drought of the summer of 1943 resulted in a great increase in salinity of the water over the marshes. The pumped water was very brackish at the start and on August 3 contained 6,489 parts per million of total chloride. By August 30, it had increased to 7,798. In spite of the fact that conditions and the start obtained were among the best in years, only 16 litters were produced. The salinity increased to the point where salt was crystallizing out on the vegetation and incrusting the netting sides of the enclosures. So many muskrats died in these by the end of August that it was deemed advisable to remove the little remaining stock to a ground battery of holding pens where fresh water in wooden troughs could be supplied them for drinking purposes. Some of the surviving adults and young appeared emaciated and in poor condition but comparatively few were lost after the transfer was made.

With the above unfortunate experience in mind, the same enclosures after renovation and restocking with paired animals, were kept supplied in 1944 with only fresh artesian well water through a hose. The comparatively small amount of such water possible to supply in this slow manner was retained for the most part in a small dug out spot at the entrance to each nest box. Again, due to a second record-breaking drought, these enclosures remained with little water but there was sufficient for the *Scirpus olneyi* to keep in fair condition. The muskrats constructed leads and archways beneath the turf and produced their young largely in small ground nests. For this reason it proved impossible to make an accurate check on the date of birth of most litters and on the actual number, color, and sex of these. A total of 15 litters were produced in these enclosures. The fact that only two adults were lost during the entire season in these marsh enclosures, with fresh water supplied as against the high loss of the previous season when only pumped river water of high salinity was furnished, stands out as indicative of the toxicity of water of high salt concentrations on marshes where it becomes so dry and with so little effective rainfall that the muskrats cannot obtain sufficient fresh water for drinking purposes by digging deep enough or through succulent plants.

*Survival of young under fresh-water versus saline marsh conditions.* —During the 1945 trapping season on the Blackwater Refuge the sex, weights, body measurements, and classification into adults, subadults, and kits were taken on a total of 472 muskrats from February 14 to 28, inclusive, as a sample of the population. This enabled us to obtain comparative data on growth classes occurring on our freshest marsh "hunt" (Stevens Unit 9) as against the lower saline Twin Ponds (Unit 6), following the drought of the preceding summer of 1944. The trapper on the saline unit caught only very large, old muskrats with less than a dozen young-of-the-year in a total of 177, while the trapper on the fresher marsh unit brought in adults and numerous kits of various ages with a total of 896.

A careful examination of the internal reproductive tracts of the females from both units showed the majority of those taken on saline Unit 6 also had numerous uterine scars or placental sites present, proving that they had produced the same average of young as the females from the upper, fresher Unit 6. This would seemingly indicate the strong possibility that survival of the young muskrats especially is adversely affected by the higher degree of salinity.

## SUMMARY

1. Distribution of the Virginia or coastal muskrat (*Ondatra z. macrodon*) is briefly outlined, with its greatest abundance found to be centered on the Delmarva or Eastern Shore Peninsula.

2. Changes in the topography and water tables along the coast, due to natural causes such as break-throughs brought about by hurricanes and storms, and man-made changes, e.g., canals, reclamation and pest mosquito control drainage projects, dikes and road construction, have all tended to either permit ingress of saline ocean water or have caused large areas to be completely drained for agricultural use. In the case of both extremes, radical changes have occurred in the natural marsh vegetation and have tended to create habitat largely unsuitable for muskrats.

3. Muskrat population trends on the Blackwater National Wildlife Refuge, based on an annual census of houses and actual catch records, covering the period 1933-1947, have been given in detail in order to more accurately evaluate the effects of salt tides and increased salinity in comparison with other possible factors that prevailed at the time, such as climatological ones, disease, parasites, and predation.

4. Collection and chloride analyses of water samples from three major stations over the Blackwater Refuge and vicinity at intervals (1932-1947) has revealed a marked seasonal fluctuation in salinity concentration, directly correlated with the rise in summer temperatures and lack of effective rainfall. The influence of salt tide fluctuations on the marsh vegetation and muskrat population at these points is discussed. In general, the farther one progressed down the river towards the higher salt of the Bay the more the muskrat population decreased.

5. A lack of effective rainfall together with high temperatures and evaporation of the existing brackish or fresh water cause periods of drought which bring about abnormally high salinities over the marshes. These excessive chloride concentrations, when prolonged, often destroy the favorite food plants of the muskrat and exert a deleterious effect on the muskrats themselves. High tides can also cause similarly unfavorable saline conditions. Recovery of marsh

vegetation and restoration of a normal muskrat population may be retarded over a long period of years.

Although it is recognized that muskrats do exist on some of our coastal marshes under highly saline conditions they are usually present in comparatively limited numbers. Possibly in such cases they manage to survive through long adaptation and by utilization of succulent foods.

6. Adverse effect of increased salinity on litter production and survival in experimental breeding enclosures is shown. Highly saline water pumped from the Blackwater River into marsh enclosures produced high mortality of both adults and young during the 1943 season with significantly better survival the following summer, under similar intense drought conditions, when only a small amount of fresh artesian water was supplied.

7. The possibility that survival of young muskrats is particularly affected adversely by high salinities is shown by data obtained from a population sample of the catch from a fresh-water unit in 1945 compared with that from a lower, highly saline one. From the latter, the trapper caught only very large, old muskrats with less than a dozen young-of-the-year out of a total of 177 while the catch from the upper fresh-water unit consisted of a total of 896 adults and numerous kits of various ages.

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## DISCUSSION

SENATOR FREDERIC C. WALCOTT (Connecticut): What do you call a normal population per acre?

MR. DOZIER: I would say that a normal population is one house per acre.

# IMPERATIVE NEED FOR GULF OF MEXICO PELAGIC FISHERY INVENTORY

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This discussion concerns the destiny of one of the great fisheries of the world, the shrimp fishery of Louisiana.

Last prewar figures revealed shrimp as sixth in volume of 58 different listed fisheries and fourth in value of 56 different listed fisheries of the United States and Alaska. It was outrankd in volume only by pilchard, menhaden, salmon, tuna, and mackerel and was outranked in value only by salmon, tuna, and oysters, all of these being indicated in their respective order. Louisiana produces approximately 70 per cent of this total catch. This is undoubtedly due to the influence of the Mississippi River.

Based chiefly on one species, the common sea shrimp (*Penaeus setiferus*), the Louisiana fishery has had a spectacular career. Primitive cast nets, then 1,800-foot haul seines were in turn succeeded from 1912 to 1917, by low-powered otter trawl luggers, shallow draft, and operating only 5 miles offshore.

It is necessary, to understand what follows, to gain some picture of the common sea shrimp's extraordinary life history. Less known, fifteen years ago, than any other economically important marine resource, the common sea shrimp was completely mysterious; its breeding, its growth, its longevity all blank pages.

Louisiana, dubious of the safety of a fishery so rapidly expanding, under a mechanization that alarmed the traditionally traditional son of his grandfather Cajun fisherman, sought and secured the aid of the Federal Government. Cooperative Shrimp Investigations were organized in 1931 with headquarters in the Louisiana Department of Conservation. Federal activities were directed successively by Frank Weymouth, Milton Lindner, and William W. Anderson. The speaker had charge of Louisiana's participation. Georgia and Texas also cooperated.

Clear and unexpected was the life cycle picture that emerged from these researches. The definitive reports are now being written by the Federal Government. Materials here presented have already been publishd. Succintly stated, the shrimp is a weird animal. Shrimp

The speaker wishes particularly to acknowledge the aid given by William Werlla, field auditor, of the Department of Wild Life and Fisheries, New Orleans, Louisiana; Joseph King, aquatic biologist, of the Federal Fish and Wildlife Service, New Orleans, Louisiana and J. L. Baughman, marine biologist, Rockport, of the Texas Game, Fish and Oyster Commission.

spawn offshore but the helpless hundredth-inch planktonic larvae must drift inshore or, apparently, they perish. Some dozen larval metamorphoses accomplished, they grow rapildy, move seaward and apparently live but one year. Some fishermen believed their life span to be 18 years.

Discovery of heavy concentrations of large ("Jumbo") shrimp offshore in 1937 led to the development of a 20-million pound additional catch where not a pound of shrimp had previously been produced and led concomitantly to the next evolution of the shrimp fishery.

War intervened bringing depletion of man power, loss of equipment, and the black confusion of the black market.

The war over, those gold rush days of the shrimp market in the war years attracted attention and investment of great sums of money by many people including many veterans.

Now comes the point of this discussion. The Louisiana shrimp crop as far as we can at present ascertain, is suffering from no depletion. Louisiana production fluctuates at somewhat above 100 million pounds a year. The limiting factor is apparently the capacity of the nursery grounds. Therefore, barring discovery of new offshore concentrations, the pattern becomes the simple mathematical one of dividing up a biologically stabilized crop among more and more harvesters equipped with more and more expensive and efficient machinery. Economically, that just won't work. Constantly larger, constantly more costly shrimp boats are now built. One recent unit, for example, cost $165,000 00. Twenty-four hundred shrimp boats operated in Louisiana in 1940; 3,030, in 1946; 2,327 of them under 45 feet long; 326, 45 to 50; 338, 50 to 60, and 39, over 60 feet. Deep draft, these boats cannot operate inshore.

Another economic factor emerges, the development of the Baja California fishery for shrimp on the west coast of Mexico. The speaker had as his guest only 2 weeks ago, the dynamic executive, Senor Hector Ferriera, who directs these enterprises in the Bay of San Carlos. He stated that in one day 34 canoes, equipped only with cast nets, caught 10 long tons (a total of 22,000 pounds) of shrimp and that last season he shipped into the United States 1,500,000 of fresh, iced shrimp, 10 million pounds of frozen, headless shrimp.

Still another factor enters, interstate and international competitions and complications. Wayne Heydecker and Fred Zimmerman have aided us in the establishment of a Gulf States Fisheries Compact for which we now seek and shall secure necessary Congressional authority. We can then iron out interstate differences, quit quarrelling among ourselves, and provide intelligent, effective, and friendly approach to the solution of serious international problems that have already begun to arise in the Gulf of Mexico.

It all adds up to this, $30,300,000.00 worth of shrimp boats in Louisiana alone plus the shrimp boats of our other Gulf States, will have to find other eggs in other baskets.

An inventory of potential Gulf of Mexico resources must be made. The Gulf of Mexico is a vast, amazing, and virtually unknown sea. One thousand miles east to west, 800 miles north to south, and 716,000 square miles in area, it remains in great part an enigma. Ranging from coastal shoals and often wide continental shelves to depths of over 2 miles, the Gulf of Mexico annually produces its estimated one and one-half billion pounds of fishery products—shrimp, oysters, fish, sponges, and other marine resources. We must be able to give these men who are investing in the Gulf of Mexico some of the answers they need. We cannot do that now. Researches from Alexander Agassiz's *Blake* cruises to the explorations by the *Atlantis* have provided much scientific data, but the economic categories imperatively needed are still largely lacking.

It is a shameful and almost incredible fact that the United States at this moment does not have in operation a single marine research vessel although we have presented to other nations not several but many vessels equipped for precisely this important work of marine economic investigation. The actual figures of such transfer of equipment to the Union of Soviet Socialist Republics, to the Commonwealth of the Philippines, and comparable aids to other sovereign countries would startle into utter alarm the most obtuse student of economic fisheries. When, at this very moment, the need for such researches is greater than at any other time in our history, we appear to be reaching the lowest ebb in our national support of this work upon the sound results of which alone can be founded the successul development of our marine resources.

Menhaden, Spanish mackerel, kingfish, tuna, shark, and probably bluefish should all be studied and their potentialities evaluated. An adequate and costly vessel and competent scientific personnel, aware of and sympathetic with commercial problems, can alone serve to fulfill this task. The expansion of the Shrimp Investigations into the Gulf Fisheries Investigations is excellent, but the magnitude of the task in terms of ships and scientists and the profound need for getting the answers as quickly as possible cannot be overstated.

The shrimp industry, one of the great fisheries of the world, is at its most critical cdossroads. Only full effort and swift action can prevent intolerable and irreparable economic damage.

## DISCUSSION

MR. J. L. BAUGHMAN (Texas): About 67 per cent of the American shrimp crop is produced in Louisiana. Texas produces nine. Our shrimp crop has probably reached its optimum. More vessels, bigger vessels, more power, more gear have not produced an additional increase in shrimp.

Yet our trend here as well as in Louisiana is towards more and larger vessels and towards higher power and more gear. Every day men come into our office saying, "What do you know about sharks? What do you know about the snapper fishes?" Frankly, we know very little.

We have tremendous schools of Spanish mackerel here at times. I have seen them extend as far as I could see. Yet for all their abundance we know very little about them, and we don't utilize them adequately.

We have no knowledge whatever of the offshore fisheries. When the *Albatross* was in operation, the survey line ran, roughly, from a little east of New Orleans to Catoche to Yucatan. If you draw a line there, you will see a great portion of the western Gulf that has never had any fishery research vessel in it at all. We have reason to believe that there are large untouched fishery resources there, not only for shrimp but for fish.

Our fisheries in the Gulf are littoral, based mainly on the trout *Cynoscion nebulosus,* on the red bass *Sciaenops,* and on the drum *Pogonias.* There are no pelagic fisheries. It is imperative, it seems to me, that some effort should be made to explore these resources, and to develop our fisheries for them.

The shrimp stocks to the east and to the west of the Mississippi have not shown any tendency to combine.

MR. BAUGHMAN: This is consistent with this hypothesis which I have set up: that the western portion of the Gulf of Mexico is biologically a separate entity from the eastern portion; that the fish stocks in the two do not intermingle.

There is no place else in the United States, for instance, that you can find two species of sawfish. We have, for example, *Pristis barracuda* and the large form *Pristis microba* which is found along the northern shore of South America through the southern West Indies. Until we can get research vessels in here of the proper size, and the personnel to explore these problems, the Gulf and Caribbean fishery are going to be confined to the littoral zones, and will be constantly and continually dwindling.

# TECHNICAL SESSION

## Wednesday Morning—February 5

*Chairman:* Warren W. Chase
Professor of Wildlife Management, University of Michigan, Ann Arbor, Michigan

*Vice-Chairman:* Philip F. Allan
Regional Biologist, U. S. Soil Conservation Service, Fort Worth, Texas

## WILDLIFE AND LAND-USE CONCEPTS

### WET LAND—HOW SHOULD IT BE USED?

Wallace L. Anderson
*U. S. Soil Conservation Service, Milwaukee, Wisconsin*

The use to be made of wet land has long been a controversial issue. Sportsmen and many professional wildlifers have advocated its use for wildlife. Farmers and land-developers have believed it should be drained and used as pasture or cropland.

Too often these conflicting views have been based on opinion rather than fact. The sportsman is inclined to believe that all wet lands are unsuited for crop production and are best used for wildlife. The farmer is inclined to think that all wet land can be drained and made to produce bumper crops. Both groups have been guilty of wishful thinking. They have formed their opinions on the basis of what they wanted, rather than on the basis of what the wet land is capable of producing.

Let's see what the wet-land problem really is in the United States. It is estimated that there are 127 million acres of wet land, of which about 57 million acres have been drained (37 million) or are suitable for drainage (20 million) (Anonymous, 1946). That leaves about 70 million acres that will serve best if used to produce timber and wildlife.

Undoubtedly many areas of wet land should be managed to produce wildlife. Examples of such land include areas having shallow peat over sand. This land might be productive of farm crops for a few years but it would soon become submarginal agricultural land. This is well illustrated in the northern Minnesota and central Wisconsin wet-land areas which were once drained and have now been returned to wildlife production.

On the other hand, there are many wet-land areas that are not wet enough to produce waterfowl, muskrats, or wild rice; yet they are too wet for upland forms of wildlife and too wet for cultivation. Many of these areas could be drained and used to produce farm crops. If that were done, and the land well-managed, they might even produce more wildlife than they do at present. In the north central United States, we have examples of such land in undrained areas of the Clarion-Webster soils in Iowa and Minnesota, the Brookston-Crosby soils in Indiana, Michigan, and Ohio, and the Drummer-Flanagan soils in Illinois.

It is impossible to generalize, as many sportsmen and farmers have done, on the best use to be made of wet land. Each individual area must be judged on its own merits. The major controversy, of course, has always been whether or not wet land should be drained for agricultural purposes.

The answer to the question of whether wet land should be drained depends almost entirely on four considerations:

1. What is the land capable of producing?
2. What effect will drainage have on adjacent lands?
3. What is best for the public interest?
4. Can the land be drained adequately and economically?

Let's see what is involved in each of these considerations.

*What is the land capable of producing?*—To answer this question it is first necessary to have a detailed soil conservation survey made by a competent soil scientist. Such a survey can tell the landowner, first of all, whether the area proposed for drainage contains soil that can be adequately drained. Second, and more important, it will tell whether the area, if drained, will be capable of producing high-value agricultural crops on a permanent basis. If the answer to both of these questions is "yes," the landowner may proceed safely to the remaining three considerations.

Before he does so, however, he should be sure that his wet land will not produce as profitable crops without drainage as it would if it were drained. Many wet-land areas, properly managed, will yield a good return without drainage or cultivation if used to produce muskrats, cranberries, cypress, blueberries, cat-tail, or other wildlife crops.

*What effect will drainage have on adjacent lands?*—In many parts of the country, the use made of the wet land may have a definite effect on the use of other land on the farm, particularly if the rest of the farm is sloping upland.

Most areas of well-drained upland are already being used too intensively. Many of them are eroded or are in danger of erosion. More of this sloping upland should be used for meadow and pasture in the interest of soil conservation. Drainage of wet land suitable for cultivation will help make this adjustment possible by taking some of the "pressure" off the upland. A high proportion of cultivated crops can be grown on drained land because such land is usually flat and rich in organic matter. Compared with the upland, it is much less subject to erosion damage or soil deterioration from intensive cropping.

On the other hand, draining wet land just enough to produce meadow or pasture will make the desired adjustment more difficult, because the landowner must balance grass and grain crops. If he produces most of his meadow and pasture on formerly wet land he must produce grain crops still more intensively on the sloping upland. To do that is not in the best interest of the land, the landowner, or the public.

Thus if the drainage of wet land will not facilitate needed land-use adjustments, the landowner is better off to forget it and use the wet land to produce wildlife.

*What is best for the public interest?*—The landowner is not likely to give much consideration to this question unless the public's interest happens to coincide with his own. Yet there is a definite public need to maintain some wet lands in their present condition. I am thinking particularly of the need for public shooting grounds near centers of population; also of the need for waterfowl breeding grounds in other places.

Considering the present rate in the decline of the nation's soil resources, it may also be in the public interest to maintain some wet lands having potentially high agricultural productiveness in their present state. They may be needed as a reserve for food production in the event of a future national crisis such as we had during the past war.

Private landowners, however, do not always manage their land in the public interest unless that is the same as their own interest or unless they are compensated in some way for so doing. In some cases the public interest will be served best by public purchase of the private land when it is needed for recreation, game preserves, and similar purposes. In other cases, lease arrangements may be worked out that will serve the public interest and still maintain the land in private ownership.

*Can the land be drained adequately and economically?*—All too frequently this is the only question considered by the landowner before drainage is planned. And sometimes even this question is not given the consideration it should have. The question can be answered satisfactorily only after a detailed engineering survey by competent engineers.

Using the criteria already discussed it is possible to define as desirable the drainage of only those wet lands that are of high fertility, capable of permanent production of agricultural crops, and so located that they can be drained adequately and economically. In addition, such drainage should contribute to desirable land-use adjustments. Such drainage will usually be in the public interest, but if, for special reasons, it is not, public purchase is a possible way to prevent it.

Using the same criteria, it is possible to define as undesirable the drainage of wet lands of any of the following types:

1. Those having soil of low fertility, not capable of continuous production of agricultural crops.
2. Those capable of returning as high a net income from crops that can be grown without drainage as they would produce after drainage.
3. Those whose drainage will make more difficult the needed land-use adjustments on adjacent lands.
4. Those whose drainage would not be in the public interest, recognizing, however, that private landowners should not have to carry the public's interest if the land is otherwise suitable for drainage.
5. Those having fertile soils which are so located that they cannot be drained economically or adequately.

Once it has been determined whether drainage is desirable or undesirable for a specific area, it is necessary to decide the best management for the area, drained or undrained.

If drained and properly managed, many former wet-land areas will be more productive of wildlife than they were before drainage. It is known that drainage ditches produce greater yields of muskrats than any other land type in many parts of the country (Yeager, 1945). The production of farm crops on the drained land adjacent to the ditch will usually produce more food for wildlife than it did before and produce it closer to cover and water. Drained land is certainly producing plenty of pheasant hunting in northwestern Ohio, north central Iowa, and southwestern Minnesota.

How then should drained wet lands be managed to produce maximum wildlife crops? The Soil Conservation Service recommends that ditches be dug with 3 to 1 side slopes and that the banks be seeded to adapted grasses and legumes immediately after construction of the ditch. It is further recommended that the banks be protected from grazing or mowing until after the time of grain harvest. If this is done, a good habitat for wildlife is created and maintenance of the water-carrying capacity of the ditch is made simple.

Proper management of undrained wet lands is even more important from the standpoint of wildlife production. Too little is known about this type of management, but there are two techniques that offer promise: water-level controls and level ditching. There are, of course, many marsh areas that do not require either of these treatments but which may benefit from other practices such as controlled burning or protection from grazing. Each wet-land area presents its own problem, requiring considerable knowledge of ecological factors to work out the best management procedures. There is a great need for further research work to help evaluate these ecological factors. It is important that land management biologists be able to advise landowners about sound management measures for undrained wet lands. If that can be done, much undesirable drainage can be prevented.

## SUMMARY

The conflicting views of sportsmen and farmers with respect to the management of wet land have been based on opinions rather than facts. If, in the future, they are based on facts, the conflict will disappear. There are definite criteria that can be used to establish the facts. Only careful use of these criteria can determine whether drainage of wet lands is desirable or undesirable. The criteria should be used and only that drainage which is shown to be desirable should be done. Both drained and undrained wet lands should be wisely managed. In that way they can be made to produce both farm crops and wildlife to the limit of their capability.

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## DISCUSSION

MR. A. E. BORELL (New Mexico): You referred to the cat-tails as a product of the wet lands. Is there a value for use of cat-tails other than for muskrat food?

MR. ANDERSON: I wouldn't say it has extensive use but there is a company operating in Minnesota and Wisconsin that has been buying cat-tail fluff. They have processed it during the war into life jackets, and they are trying to develop new peacetime uses. I don't know just how far they have gone with that but

I know it has been used in the manufacture of kitten-balls and as an insulation material for hot pads and also insulation in phone booths, so there is a possibility of it being a commercial crop.

MR. HOYES LLOYD (Ontario, Canada): I happen to know a little of the use of Typha down as a war product. The machine was invented during the war for removing the tiny seeds from the Typha and the man that invented that machine said that the man that invented the cotton gin was a piker. He had a big seed to take out and it was a simple one. The man who took the seed out of the Typha really did a difficult job. The seeds had to be removed because otherwise the rats on shipboard would destroy whatever was built from it and the material would go rancid. He bought up to one million pounds of Typha down and it was gathered together in one place for thrashing, I suppose you call it—removal of the tiny seeds and it did have extensive use.

MR. JOSEPH DAVIDSON (Illinois): The question we have here in the Midwest is how we can slow down the various agencies that are promoting drainage. We are confronted right in Illinois not only with the War Department and other federal agencies but even by some of our own. We have a Corps of Engineers with a staff of men who are interested in drainage that are exploiting much of our wet land. I think that is the main problem we have all over the country, men who are promoting the draining of much of our farmland. We are strong against it.

CHAIRMAN CHASE: Mr. Davidson, to open up the subject, for just a minute would you like to say more, specifically, about some of the things that are being done on wet land in Illinois that should not be done and to point out who is doing them and what can be done about it, in your estimation?

MR. DAVIDSON: I think enough had been said about our flood-control program in the Illinois River Valley. As far as we are concerned, it is the draining of the small slough areas and the wet land near Chicago and larger cities where wildlife is probably in the greatest demand of any crops we grow. It is greatly cutting down our good pheasant hunting, and up and down the Illinois River if the present plan of the War Department goes through, it will further shrink the feeding areas for waterfowl. It will practically eliminate the Illinois River Valley as a waterfowl area. That is our biggest problem.

CHAIRMAN CHASE: Thank you, Mr. Davidson. Certainly the river valleys need watching to put them in the right use so that they are not ruined for the flow of water. That is their main purpose. Their future use for wildlife is important, too. The point of responsibility that came up, I think, is very important. There is certain wet land we don't need to use right now for food production that sometime in the future, if it is good enough land to be used for food production for human beings—that will always be a conflict, I suppose, with wildlife and wildlife's use of this wet land.

MR. M. S. MCMURTREY (Nebraska): I would like to ask Mr. Davidson if that is state or private land?

MR. DAVIDSON: It will affect both state and private land but largely private-owned farmland. The thing that we are trying to dig out is who is giving the impetus to the increased amount of drainage. We don't feel it is all the landowner. We feel there are a lot of people expanding into the draining business and for the sake of their own organization are wanting to keep the personnel together and so they are expanding over into small tributaries that we have in the state. That is a problem.

CHAIRMAN CHASE: The question is really whether or not any agency or any group of people can prevent, or should try to prevent, a private landowner from draining his land, to produce more on that land and therefore interfere with wildlife on private land. Does anybody here want to answer that question?

MR. MCMURTREY: I would like to say if it is private land, if the people of Illinois will educate the owners to the value of drainage, I think the problem would be solved. If it is state land, then it is up to the public as a whole.

MR. DOUGLAS E. WADE (New Hampshire): I would like to point out that in the Northeast—and this is quite true throughout the rest of the country—there are extremely small marsh areas, perhaps a half acre on up, and those small areas are producing bits of wildlife which cannot be produced anywhere else. As we go along, we eliminate one area after another and there are certain parts of those wildlife areas which are being eliminated entirely. I thnik in the Northeast we have been trying to keep some of the unusual bits of wildlife in production.

CHAIRMAN CHASE: That is very important.

MR. GEORGE MACKENZIE (Minnesota): I guess you are quite familiar with some of the past experiences we have had in our great state up there. We have had a lot of indiscriminate drainage but I think we are making some progress in preventing this wasteful proposition. We finally passed a law whereby any meandered waters, before they can be drained, must join the conservation department in a suit in the petition and hearings are to be held before the public so that the people interested may have their say about the proposed drainage matter.

That has given quite an impetus to the sportsmen in their efforts to prevent this indiscriminate drainage. The smaller sloughs that aren't covered or aren't meandered waters, of course, present a different problem. We had a case recently in our own country. It contains just about 70 acres of good duck-breeding grounds and good feeding grounds. It is in the heart of an agricultural district and the farmers presented the proposition that because of the value it would present as an agricultural proposition after it was drained, that it should be gotten rid of and drained. We presented our side of the picture, showing it was a profitable breeding and feeding ground, and we are now awaiting with bated breath the decision of our conservation commission, but I have an inkling we are going to win out and prevent the 70-acre slough drainage.

# WILDLIFE AND THE NATIONAL PARK LAND-USE CONCEPT

VICTOR H. CAHALANE
*National Park Service, Chicago, Illinois*

Segregation of land for the perpetuation of wildlife is not new. Many centuries ago, small "parks" consisting of highly modified forest were enclosed in the eastern Orient in order to perpetuate and display certain hoofed mammals. We are indebted to this concept of land use for the preservation of Pere David's deer (*Elaphurus*). Otherwise, even by Marco Polo's time this species would have been only a tradition. In medieval Europe, parks were established to maintain a reliable supply of animals of the chase. The privilege of hunting was restricted to a comparatively small number of persons—the nobles. Wood cutting and grazing of domestic stock was strictly limited. Some of these areas were relatively large—the New Forest in Hampshire, for example, at its greatest extent embraced 120,000 acres. Its founder, William the Conqueror, evicted the human inhabitants from about 100,000 acres of the area and promulgated strict laws against trespass by the common people.

Since these hunting parks were little modified by man, they served to perpetuate numerous species of mammals and birds. With some exceptions, notably the aurochs (*Bos primigenius*), hoofed game survived in Europe because it was selfishly protected from the general public. Due to the preservation of their habitat and considerable freedom from disturbance, even some of the unwelcome raptorial birds and larger carnivorous mammals succeeded in perpetuating themselves. Outside of the preserves, only the smaller, least conspicuous, or most ubiquitous forms of life were able to persist in a land where all available space was required to satisfy basic human needs.

With the conquest of the Western World, a new biotic empire came under the gun and the ax. The hunters, trappers, and colonizers brought with them the Old World outlook on assimilation of natural resources. But they did not also bring the feudal view that game should be reserved for the privileged few. The wave of destruction rolled westward. As it burst onto the Great Plains, many pioneers foresaw the rapid destruction of the remarkable assemblage of large mammals, including the bison, antelope, elk, Audubon bighorn, mule and white-tail deer, plains grizzly—and the Indian!

One of the travelers, George Catlin, gave expression in the quaint prose of more than a century ago to the wish that a sample of this magnificent wildlife spectacle might be saved for posterity: "... what a splendid contemplation . . . when one (who has travelled these realms, and can duly appreciate them) imagines them as they *might* in future be seen (by some great protecting policy of government) preserved in their pristine beauty and wildness, in a *magnificent park,* where the world could see for ages to come, the native Indian in his classic attire galloping his wild horse, with sinewy bow, and shield and lance, amid the fleeting herds of elks and buffaloes. What a beautiful and thrilling specimen for America to preserve and hold up to the view of her refined citizens and the world, in future ages! A *nation's park,* containing man and beast, in all the wild and freshness of their nature's beauty!

"I would ask no other monument to my memory, nor any other enrolment of my name amongst the famous dead, than the reputation of having been the founder of such an institution."

But this proposal was ignored. The Great Plains fauna was destroyed as a natural entity. It remained for the Montana lawyer, Cornelius Hedges, to make the specific proposal which led in 1872 to the establishment of the first great nature preserve—the Yellowstone National Park. Although Yosemite Valley had been turned over to the State of California 8 years before "for public use, resort, and recreation," no wildlife conservation policies were formulated. The

Yellowstone Act, therefore, set a precedent of vast importance. It dedicated a large natural area "as a public park or pleasuring ground for the benefit and enjoyment of the people"; it provided for the preseravtion of the natural wonders "in their natural condition"; and it prohibited the "wanton destruction of the fish and game . . . and their capture or destruction for the purposes of merchandise or profit."

Although it eventually became necessary by the Act of 1894 to provide more explicitly for the protection of the wildlife, the Yellowstone Act initiated a movement which culminated in the National Park System of the United States. This legislation also led to the establishment of national parks and nature monuments throughout the world. Many of these, such as Wood Buffalo Park in Canada, Kruger National Park in South Africa, Parc National Albert in Belgian Congo, and the Lorentz reservation of the Netherlands East Indies, contain wildlife resources of immense value and provide sanctuary for a number of vanishing species.

For many years in the United States, the national parks constituted the only form of land use on a nationwide scale under which wildlife and its habitats could be preserved. During the past 15 years, the system of National Wildlife Refuges has expanded sufficiently to become a major factor in the protection of migratory birds as well as certain upland game birds and mammals. A number of important state refuges also have been developed. The national parks, however, remain the one form of land use in which the entire wildlife community—plants and animals together—can be legally preserved in inviolate sanctuary.

This concept of complete protection did not come into being full-blown. On the contrary, it evolved slowly through three quarters of a century. In fact, it is still in process of evolution. We have seen that the original act establishing Yellowstone National Park did not specifically prohibit *all* killing of wildlife; it merely stated that animals must not be "wantonly destroyed." The excesses of hunting that subsequently took place resulted in the very explicit Act of 1894, which prohibited the capturing, wounding or killing of "any bird or wild animal, except dangerous animals, when it is necessary to prevent them from destroying human life or inflicting an injury," and provided severe penalties for violations. This language was incorporated in practically every act under which subsequent parks were established.

To most persons, it did not occur that this protection mantle should be extended over the predators. With a few notable exceptions, park administrators during the first four decades used every resource at their disposal to eliminate wolves, cougars, and coyotes. At times, the list of prescribed species also included lynx, bobcat, foxes, badger, mink, weasel, wolverines, fisher, otter, and marten, as well as hawks and owls, pelicans, kingfishers, and other birds which were universally persecuted at the time. Gradually, the blacklist was narrowed and control methods were made more selective in character.

By the mid-1930's, a new predator policy was in force throughout the National Park System. No predator was controlled unless scientific inquiry proved such action necessary to protect a vanishing species. While this policy reflected the most advanced findings concerning the relationships between ungulates and carnivores, it came at least a decade too late. Overemphasized protection of "game" had resulted in range deterioration in a number of key areas. This is probably the most serious basic problem in wildlife management in the national parks.

Protection of predators within the parks, it is sometimes charged, is inimical to the best use of neighboring lands. The parks are alleged to serve as breeding grounds for carnivores, such as coyotes, which then move out and destroy domestic stock and game animals. In most cases, the charges are based on circumstantial or meager evidence. Fundamental biological principles are disregarded. All too often, the most bitter complaints originate in areas where game animals are overabundant and are destroying their own food supply. Or the protests may come from stock ranges where resident breeding predators are already numerous and where conditions in adjoining high elevation parks are not suitable for building up large populations of carnivores. In other localities of controversy, the facts are more obscure and less liable of interpretation. A beginning has been made in scientific studies which should give a clearer understanding of the true effect of this phase of park administration on land use outside of the parks. If this protection policy is determined to be seriously detrimental in any area, means should be found to protect livestock and other interests without wreaking fundamental changes in the park fauna.

If the parks are to function as natural reservations, their animal life must be subjected to the least possible regulation. Under normal conditions, each and every species is fluctuating numerically with respect to every other species. "Nature's balance," that much-derided term, is never static, but always in motion on its fulcrum.

Unlike animal populations under other concepts of land use, national park faunas are not managed to provide maximum numbers nor to furnish stable exhibits for the public. Instead, the objective is to maintain the natural ebb and flow of animal life. It is worth noting, for example, that the life and death of a beaver colony excites much popular interest and often is of great educational value. Park management policy permits interference only to prevent extermination of a species which is threatened either directly by reduction of its numbers below the safety level, or indirectly by enormous expansion of its population and resulting destruction of the food supply.

I once outlined this "hands-off" policy to a friend, a forester who specialized in intensive management of small farm wood lots. Apparently he perceived only its most superficial aspects, for he snorted, "Anyone who follows that policy has nothing to do!" On the contrary, park administrators are confronted by many specialized and difficult problems. Several of them—the overpopulation of ungulates, the subsequent damage to range, and the relationships of predators to industry outside of the parks—have been mentioned. Among other problems are the preservation of vegetation in scenic "sacred" areas such as Zion Canyon which attract great numbers of browsing mammals. Then there is the protection of visitors from dangerous bears. And, inevitably, the protection of bears from well-meaning but "dangerous" visitors. There is also the serious problem of preserving a wilderness in close proximity to visitor travel routes and living areas. Roads, trails and developed areas must be so planned and located that they do not destroy the very thing that draws the public to the parks.

The only wildlife not completely protected in the national parks are the various species of fish. This nonconformity is partly due to the comparative lack of appreciation of the underwater environment and its animal and plant life, and to ignorance of the interdependence of many aquatic and terrestrial species of animals. The legislation establishing most of the national parks specify that fish may be taken "by hook and line, . . . at such seasons and in such times and manner as may be directed by the Secretary of the Interior." This provision of the law indicates an intention by the Congress that fishing by hook and line only would be permitted, but only under such reasonable rules and regulations as the Secretary might promulgate. Some of the parks contain excellent fishing waters which have become renowned throughout the world. Accordingly, the more accessible lakes and streams are subjected to heavy use.

The fish populations of practically all park waters have been modified by long-time angling, by artificial stocking, or by migration of imported species to new waters. In some instances, native races of fish have been exterminated. In others, haphazard fish cultural practices of earlier times have resulted in unfortunate biological legacies. Stocking of alien races or closely related species produced numerous hybrids. In a few areas, streams were modified by removal of the forest cover prior to park establishment. In so far as possible, aquatic faunas should be brought back to an approximation of their original composition. This may take decades.

Artificial methods of restocking are now avoided whenever possible. Instead, fishing pressure is regulated in accordance with the capacity of the waters to provide park-type angling. When artificial methods are essential, the minimum size of fish is stocked that will yield satisfactory results. Native predators on fish are permitted to share in the benefits of fish culture.

The American public generally approves of the national park concept of use for lands of outstanding scenic type. Biologists think of national parks as outdoor laboratories in which living species of animals and plants can be studied in their natural habitats and in their natural relations to one another. As a body of reports and published literature on these studies is amassed, the parks will become of increasing importance to wildlife managers who are dealing with modified areas and with modified faunas. Workers in other branches of natural science regard the parks in a similar light. The general public is much less specific and less articulate in describing its need for occasional recreation in unspoiled surroundings. Many people have a deep-rooted desire to escape the noise and dirt, the confusion and crowding, the loss of individuality, and the limited horizons of city life. To a lesser degree, perhaps, this need is shared by those who dwell under less crowded conditions.

In 1946, more than 22 millions of these persons were refreshed and stimulated by the opportunity to enjoy the magnificent natural scenery of the parks. The sight of wild animals, pursuing their normal routine of life added immensely to the pleasure and education of these visitors. National Park land use needs no further justification.

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# STATUS OF MEXICAN BIG-GAME HERDS[1]

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Of the original 10 species of hoofed big game in Mexico, the elk and bison are extinct, the antelope, bighorn sheep, and tapir are well on the road to extinction, and the 3 species of deer and 2 of peccary are generally reduced in numbers and locally in distribution. By and large, the condition of Mexico's big-game herds is similar to that which existed in the United States early in this century before the conservation movement began to gain momentum.

Accelerated exploitation of Mexican forests and grazing lands is reducing the habitable range, while year-long hunting pressure keeps the total big game population well below even the present productive capacity of the habitat.

The purpose of this paper is to review the status of the eight remaining species of hoofed game in Mexico and to point out the problems of land use and controlled hunting which must be overcome in a program of restoration and management.

The various species are grouped below under catagorical headings which indicate their present status. Accompanying maps show the ranges of the eight species which still occur in Mexico. Information on which the maps are based was gathered from various sources. For the white-tailed deer, mule deer, and collared peccary, most of the records of occurrence I gathered personally during 2 years of field work in Mexico (August 1944 to November 1946) and these are designated in the legends as "Recent Records." On the antelope and bighorn maps, "Early Records" taken from the literature are plotted to indicate original range and "Recent Records" (known occurrences since 1935) to verify the limits of range still occupied. My data on tapir, brocket deer, and white-lipped peccary are so limited that it seems best to combine the recent and early records as "Records of Occurrence," and no attempt is made to show shrinkage of range that is known to have occurred at least in the case of tapir.

## I. EXTINCT IN MEXICO

### Merriam Elk *(Cervus merriami)*

This form of elk occurred originally in Arizona, New Mexico, and northern Sonora and Chihuahua. It has been totally exterminated.

[1]Report based on information assembled during a survey of the wildlife resources of Mexico, supported by Pan American Union and Comision Impulsora y Coordinadora de la Investigacion Cientifica (Mexico, D.F.).

There have been no reports of occurrence in Mexico for at least 60 years.

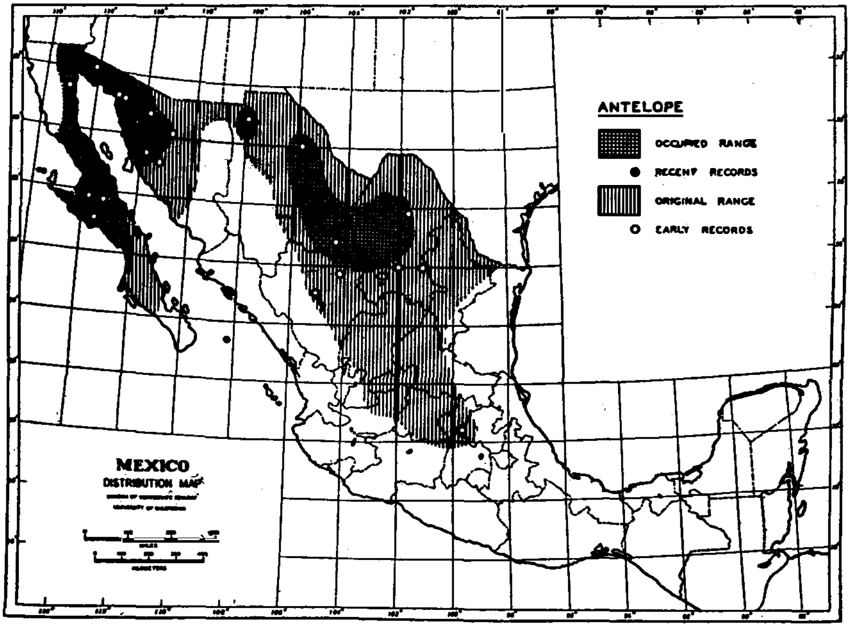
Plain Bison *(Bison bison)*

The bison disappeared from northern Mexico before 1800. Early records from Chihuahua and northeastern Sonora are cited by Brand (1937).

## II. NUMBERS AND OCCUPIED RANGE GREATLY REDUCED

Pronghorn Antelope *(Antilocapra americana)*

The pronghorn originally occupied all the northern deserts and grasslands of Mexico, as far south on the central uplands as Hidalgo.




Fignre 1. Excessive hunting and local overgrazing have eliminated the antelope from the Mexican grasslands and parts of the desert. The present sparse population occupies the more inaccessible desert areas

Early in colonial times the species was pushed back from the better grazing lands, and for at least 100 years it has persisted only in the sparsely settled desert areas of Lower California, Sonora, Chihuahua, Coahuila, and northern Durango.

In 1925, Nelson reported on the existing antelope herds in North America; he estimated the total population of northern Mexico at about 2,400 head. Many recent reports have verified the continued existence of antelope in places where Nelson found them, but despite a nominally closed season since 1922 hunting pressure remains heavy and there is no indication of any general increase in numbers.

Desert Bighorn *(Ovis canadensis)*

The situation of the bighorn in Mexico is even more critical than that of the antelope. Scattered bands still survive on some of the desert ranges of Lower California, Sonora, and northern Chihuahua,

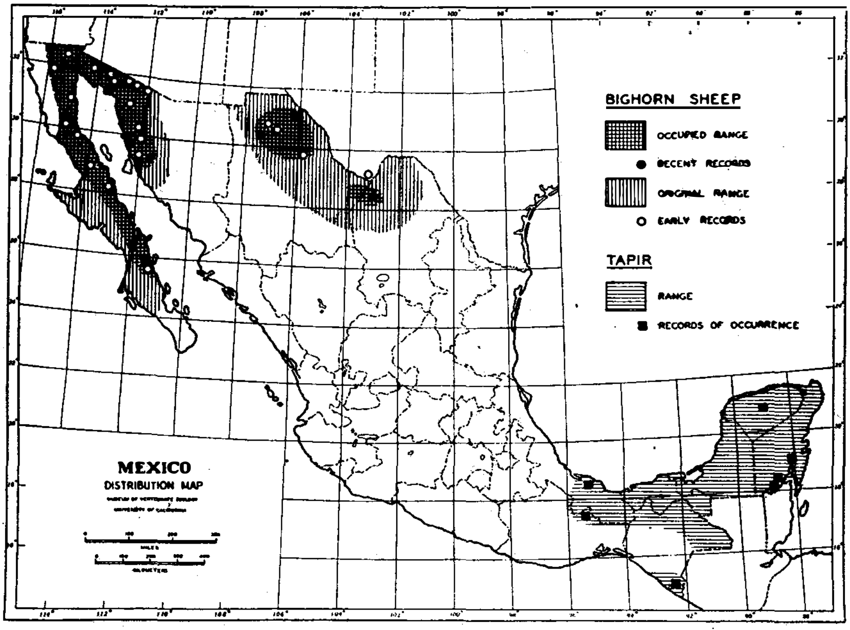



Figure 2. The desert bighorn of northern Mexico is dangerously reduced in numbers, although the population is dispersed over a considerable area of "occupied range." Not all of the tapir range shown here is still occupied. Clearing of the rain forest has eliminated tapirs from two thirds of this area

and Coahuila, but the total population has declined appreciably in recent years. Hunting, legal or otherwise, is probably the critical factor. Most sheep hunting is done by local people but many American hunters visit Mexico for the purpose of hunting rams, even though there is no legal season and it is difficult or impossible to bring home the heads or meat. The fact that the bighorn survives at all is due to the isolation of the rough and virtually waterless desert ranges which it inhabits.

Lumholtz, Hornaday, and others found fairly good numbers of sheep in the Pinacates and nearby ranges of northwestern Sonora 20 to 30 years ago. Seth Benson saw very little sign of sheep in the same area in 1938, but in the Sierra Seri country he observed one band of about eight animals and noted considerable sign. Carl Sauer reports that there are still some sheep in the Sierra de la Giganta, Lower California; he received a local invitation to attend a sheep hunt in 1945. In northern Chihuahua, Brand (1937) reports the presence of a few bighorns "arounds the Laguna Santa Maria and in most of the isolated arid mountains from the Sierra del Presidio to Sonora." Marsh (1937) cites evidence that a handful of sheep still exists in the Santa Rosa Mountains of northern Coahuila.

Although the occupied range indicated on the map is quite extensive, the number of animals is probably not over one to two thousand and these are distributed on only a part of the desert ranges in the "occupied" zone.

Tapir *(Tapirella dowii)*

The tapir apparently occupies only areas of virgin rain forest. It has disappeared wherever the forest is cut over, either because of the destruction of habitat or accompanying hunting, or both. The present tapir range in southeastern Mexico is limited to unexploited corners of tropical forest probably comprising less than a third of the original range of the species. Gaumer (1917) encountered many bands of considerable size in southern Quintana Roo and that wilderness doubtless still supports the best population to be found in Mexico. The species is in no immediate danger, but it is almost inevitable that exploitation of the tropical forests eventually will eliminate tapirs from the Mexican fauna unless parts of the virgin forest are set aside for preservation in their natural state.

## III. GENERALLY REDUCED IN NUMBERS BUT ORIGINIAL RANGE STILL LARGELY OR ENTIRELY OCCUPIED

White-tailed Deer *(Odocoileus virginianus)*

The white-tail is without question the most important game species in Mexico. It is distributed throughout the country except Lower California and is hunted constantly. Yet only in very limited areas where habitat destruction and hunting pressure are most severe has the species actually been eliminated. Nowhere has there been any general reduction in occupied range, in fact the species has expanded its range in recent years by occupying cut-over rain forest in the southeastern tropics. White-tails do not occur normally in virgin rain forest. With all its remarkable tenacity in the face of persecution, the white-tail population has been kept far below optimum over much of Mexico and the actual yield is only a fraction of the potential yield under regulated kill and habitat management.

It will be of interest to American game managers to know that nowhere in Mexico has the white-tail displayed any irruptive population outbreaks. In regions where all the large carnivores have been eliminated the deer population is more than adequately kept under control by hunting alone. In wilderness areas, such as remote parts

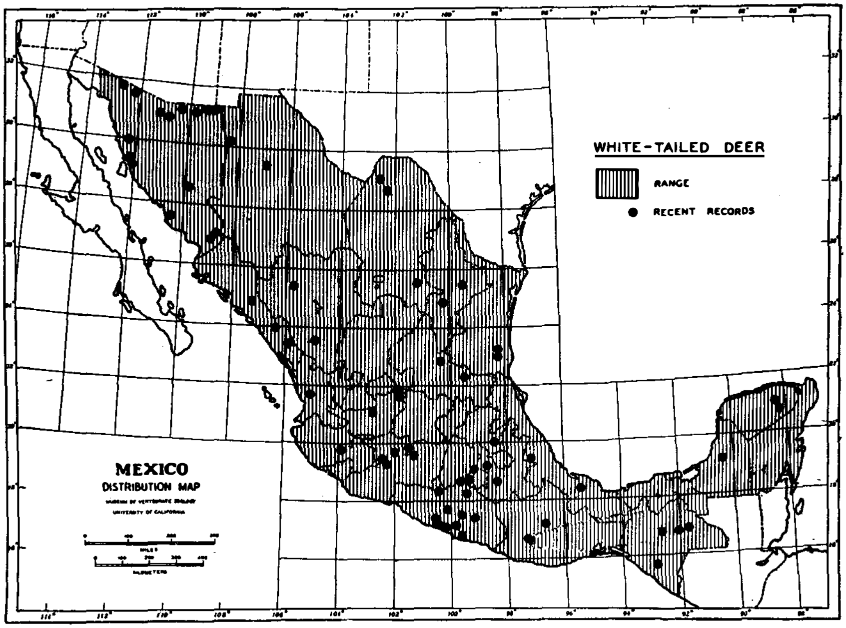



Figure 3. The density of the white-tail population is low over most of southern Mexico, but there are no large areas of unoccupied range

of the Sierra Madre Occidental, hunting is light but the wolves and lions keep the population in balance. The combination of too much predator control and not enough compensatory hunting pressure, which seems to be responsible for our deer irruptions in this country, has yet to occur in Mexico.

Mule Deer (*Odocoileus hemionus*)

Throughout most of northern Mexico mule deer are associated with desert ranges. Only in northern Lower California is the species found in mesophitic pine and oak forests. In the desert areas, the mule deer is hunted more or less to the same degree as the bighorn; the deer population has sustained itself very well whereas the sheep is approaching extinction. With a little protection from over-shooting and control of livestock grazing the productivity of the mule deer herd should be maintained indefinitely.

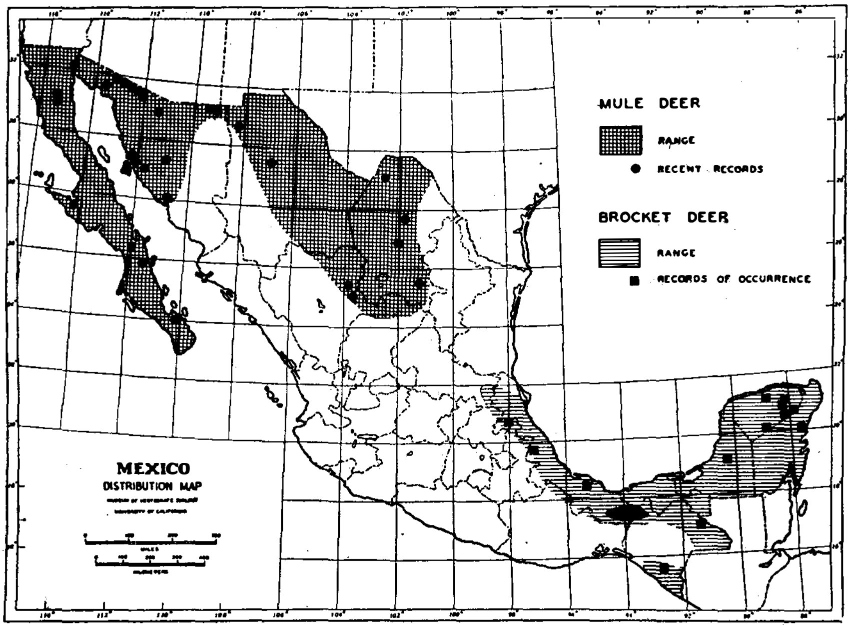



Figure 4. The range of the mule deer has not been reduced appreciably, but the brocket has disappeared from most of Yucatan and Vera Cruz. Perhaps half of the brocket range here shown is no longer occupied

## Brocket Deer *(Mazama sartorii)*

The little red brocket is typical of the virgin rain forest of southeastern Mexico. It is shy and retiring in habit and is not much hunted because of the difficulties of pursuit in the dense jungle. Brockets become scarce or may even disappear entirely when the rain forest is cut; they are generally replaced by the white-tail on cut-over lands. Most of the original range is still occupied but the numbers are much reduced in the tropical lowlands and foothills that have been taken over in whole or in part for agriculture. Permanent preservation of parts of the remaining virgin jungle would profit the brocket as well as the tapir.

## Collared Peccary *(Pecari angulatus)*

The common "jabeli" of Mexico shares the wide range of the white-tailed deer and is equally tenacious under heavy hunting. It is widely hunted for hides as well as for food but has persisted throughout its original range in fair numbers. The greatest reduction in numbers has occurred in parts of the pine-oak uplands where timber cutting, fire, and grazing have reduced the quality of the range. In many parts of the tropical lowlands peccaries are still abundant enough to do considerable damage to crops.

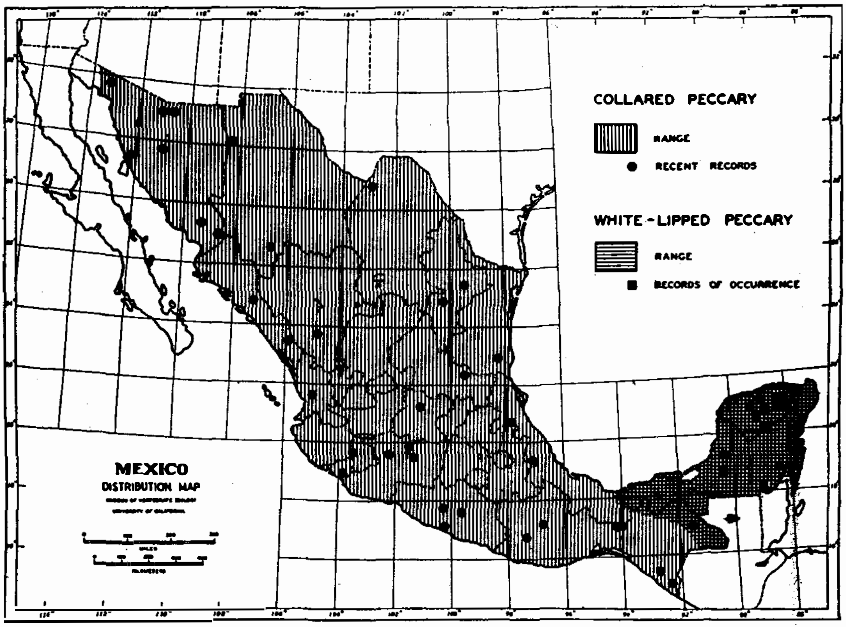



Figure 5. The collared peccary or "jabeli" still occurs throughout most of Mexico. Its range overlaps that the tropical white-lipped peccary on the Yucatan Peninsula

## White-lipped Peccary *(Tayassu pecari)*

This species of peccary inhabits only the heavy rain forest east of the Isthmus of Tehuantepec. It has largely disappeared in the State of Yucatan but it presumably is still abundant in the wilderness areas of Tabasco, Campeche, Quintana Roo and Chiapas.

*Land use in the temperate uplands.*—The advent of the logging truck has given great impetus to the lumber industry in Mexico. Forest products have been utilized of course for 400 years but never at the present rate. Many areas of wilderness or semi-wilderness, such as the Sierra Madre Occidental in the west, the Sierra Madre del Sur in Guerrero and Oaxaca, and parts of the Eastern Escarpment, have been inaccessible until recent years; now the logging trucks are penetrating all of these areas and some of the tropical forests of southern Mexico as well. Mexico has become an exporter of lumber. This mechanized attack on the forests has altered game range in several ways.

In the pine-oak uplands, the principal big game species are the white-tailed deer and the jabeli. I have seen repeated examples of a sharp decline in populations of these two species immediately following the commencement of logging, but I am quite certain that the initial reduction (which sometimes borders on local extinction) results from hunting by the logging crews rather than from the alteration of the habitat. In theory cut-over pine lands could become better game range than was the virgin forest, and this might happen if the loggers would withdraw after an operation is completed. Such, however, is rarely the case. Squatters generally remain on the cut-over tracts to eke a poor living from the unfriendly land. A transitory sort of agriculture is practiced in which small cornfields are moved from one hillside to another to keep ahead of erosion. Recurrent fires and grazing prevent normal recovery of the natural vegetation and bring about a general desiccation of the upland soils. And lastly, the hunting pressure which started with the loggers remains constant and heavy as the unfortunate squatters attempt to piece out their submarginal existence with a game diet. These unsound conditions are not confined to a few local areas in Mexico but already apply to millions of acres within the pine-oak zone; and the process of complete exploitation is now following the logging trucks into the remaining upland wilderness areas. As mentioned earlier, the resourceful whitetail, and by and large the jabeli also, have managed to persist under these conditions but in numbers so low that the productivity of the populations is negligible. Some forest species like the wild turkey, grizzly and black bears, and even the wolf and lion generally are exterminated in the process of "opening up" the wilderness.

In the semi-arid grassland and mesquite areas, and on the deserts proper, the principal form of land use is grazing. To a greater or lesser degree livestock compete for forage with the antelope, bighorn, and mule deer. Where grazing is excessive the range deteriorates and of course the game suffers. For example, as a result of overgrazing the grama grass sod of northern Jalisco and Zacatecas is being invaded in places by thick stands of nopal cactus, and some of the mesquite-grama country in Chihuahua and in the northeastern Mexican states shows accelerated erosion and a gradual disappearance of the perennial sod. On the other hand, I have seen magnificent stands of grama in parts of Durango and Sonora that were scarcely being grazed at all. Grazing pressure is spotty in northern Mexico, and overgrazing is not a universal condition such as we have in the arid southwestern United States.

*Land use in the tropics.*—In tropical Mexico, the land-use picture varies from extremes of land exploitation and destruction to complete lack of development of rich agricultural soils. Along the Eastern Escarpment and in the mountains of Oaxaca and Chiapas, certain Indian groups that have exhausted the upland soils of their original homelands are drifting down the tropical mountain slopes, clearing the forests in order to grow a few crops of corn on each field before it is gutted by erosion and has to be abandoned. An observant traveler on the Pan American Highway will notice the destruction of forests and soils where the road crosses the escarpment between Tamazunchale and Jacala. Cornfields are cleared (by fire) on the precipitous mountain slopes, planted for 3 to 5 years until the soil is gone, and then deserted to scrubby jungle which thereafter produces neither forest products nor game.

In the tropical lowlands, however, the situation is very different. Forests are constantly being cleared to make way for agriculture but many of the lowland soils are deep and rich and the development of tropical agriculture is economically entirely sound, even though productive forests and game range are lost in the process. The lowlands on the Gulf Coast from the Huasteca region of northern Vera Cruz to Campeche is the largest zone of good arable land in Mexico, and by no means all of this has yet been brought under cultivation. It may seem a curious thing that the Mexican uplands are being severely overexploited while large areas of genuinely productive land in the lowlands remain undeveloped. The reason is simply that the bulk of the native Indian population in Mexico now lives, and has always lived, on the healthy temperate uplands. Until the advent of modern medicine the wet tropics as a whole could not be intensively developed, and the recent advances in tropical agriculture are due in large part to the control of tropical diseases.

Unfortunately, most of the tropical species of big game disappear with the initial cutting of the virgin forest. The tapir, brocket deer, and white-lipped peccary have either been exterminated or become very scarce in all parts of the tropics that have been extensively developed for agriculture, and we may expect a continuance of range shrinkage in these three species in the future. However, the ubiquitous white-tail and jabeli compensate in part for this loss by invading cut-over tropical lands, and the white-tail in particular becomes an important game species on these areas.

A large block of rain forest in Campeche, Quintana Roo, and eastern Chiapas still remains in more or less virgin condition. Chicle contractors penetrate the area to extract the gum of the zapote tree and some mahagony logs are being removed from streamside locations where they can be floated out. But on the whole, transportation difficulties still preclude wholesale export of products from this interesting region. For the time being the tropical game species listed above and such additional forms as spider and howler monkeys, the quetzal and harpy eagle are secure here. Eventually modern mechanical ingenuity will find ways to remove the valuable forest products but it is to be hoped that at least some parts of the wilderness can be preserved with the native flora and fauna intact.

*Hunting.*—Big-game hunting in Mexico is universal and excessive. The national government has enacted an excellent set of game laws and the Department of Forestry and Game tries honestly to enforce them. But practically nowhere in the country are game laws enforceable. With a shortage of wardens and public apathy toward conservation in general the department is unable to compel obedience to the government edicts. In most rural areas the game regulations are unknown and might as well not exist.

The hunting of deer and other big game goes on year long and all sex and age classes are taken indiscriminately. ''Jack-lighting'' is one of the most popular deer hunting methods in southern Mexico among those who can afford a light. Ambushing at waterholes, salt-licks and bait stations, and hunting with dogs likewise are common practice. In short, any method that results in killing a deer is considered ethical.

White-tailed deer absorb most of this hunting effort, and although populations are generally overshot the ''venado'' still persists throughout most of Mexico. Antelope and bighorn on the other hand have suffered an appreciable reduction in range due to extermination by hunting. The mule deer, tapir, peccaries, and brocket are under less hunting pressure and at least among the tropical species the loss of numbers and shrinkage of range is probably due more to destruction of habitat than to direct hunting kill.

## SUMMARY

Mexican big-game herds are being decreased by a combination of destruction of habitat and overshooting.

The most lamentable wastage of forests, soils, and game range is occurring in the pine-oak uplands and in some tropical mountain

areas which are being gutted by transient agricultural development instead of being managed as forest lands.

Clearing of some of the lowland tropical forests is reducing the range of tapir, brocket, and white-lipped peccary but is economically justified since the agricultural lands so derived are highly productive and non-eroding.

White-tailed deer are hunted more than any other Mexican species, but they stand the pressure well. Antelope and bighorn on the other hand have been reduced to the brink of extinction by hunting.

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### DISCUSSION

MR. A. J. NICHOLSON (Montana): We have had recently a history of extermination of big-game herds in order to make room for more livestock, particularly in our plains. I wonder if there is any definite effort on the part of the cattlemen or livestock men to kill off the game on ranges to make more grass in Mexico?

MR. LEOPOLD: I have not encountered that sentiment anywhere in Mexico. The game is killed because it is there and they carry 30-30 rifles on their saddles. As a matter of fact, nowhere in Mexico is the game abundant enough on areas occupied by livestock to be a star competitor. The high populations of deer and big game, where they do exist, are in the wilderness areas where livestock is not in competition.

MR. GEORGE E. BARCLAY (New Mexico): We hear stories of Americans going down to Mexico hunting and ruthlessly killing big quantities of game. I would like to know whether or not there is anything to it. Is it all by Mexican people or is it largely by Americans?

MR. LEOPOLD: I am sorry to say, Mr. Barclay, that it is true. Many American hunters do visit Mexico and generally a large part of them misbehave when they cross the border. In particular, this applies to shooting mountain sheep. Although sheep have been protected for some twenty odd years, the hunting parties continue to enter lower California and Sonora and I understand recently Chihuahua, in part, and shoot rams knowing they can't bring back the heads or meat. But the hunting presure throughout Mexico is a local matter. The people that live on each ranch or around each village—that is where the big pressure comes. Only in the case of sheep, and perhaps antelope, is the hunting pressure from the United States side of the line a critical factor.

MR. BARCLAY: We must admit, of course, that there is a definite relation between the big-game herds and the predators and whenever man comes in and starts taking from the herds, naturally his take plus the predators' take which theoretically kept the herds in balance, is certain to unbalance it. I am wondering whether or not in Mexico any effort is being made to keep the predators down toward the present shrunken condition of the game herds?

MR. LEOPOLD: The control of the large predator, Mr. Barclay, is accomplished by the stockmen for the purpose of guarding their stock and with no ideas of balancing the predators and the game herds. It would be of interest to all American game managers to know that nowhere in Mexico has a deer irruption or anything resembling an irruption occurred. Wherever hunting pressure or the encroachment of ranching or farming has been high enough to eliminate the big predators, it is also severe enough to hold the deer populations down and on the wilderness areas where hunting pressure is light, the deer populations are kept in balance by their natural predators which are present in some numbers. Nowhere in Mexico have we developed this combination of excessive control of predators without compensatory hunting pressure which I presume is the origin of our irruptions in deer.

MR. HOYES LLOYD (Ontario, Canada): There is one point that might be brought out at this time. Mr. Starker Leopold did not want to mention it perhaps but American money has been used to help Mexico and our other Central and South American republics get started on a conservation program. One of the organizations of which I happen to be chairman is doing work of that kind; the Pan American Section of the International Committee for Bird Preservation is its name. It has some funds donated mostly by residents of the United States to help our sister republics get started in this conservation work.

MR. LEOPOLD: Yes.

# NEW TECHNIQUES FOR BREEDING GROUND SURVEYS[1]

LYLE K. SOWLS

*Delta Waterfowl Research Station, Delta, Manitoba, Canada*

Is wildfowling on the way out? Many old-time wildfowlers at Delta, Manitoba, were convinced last fall that it was as they sadly witnessed the poorest flight in history. Unfortunately, they were not the only ones who saw few ducks to shoot—it was the same with duck hunters far and wide. Tonight, however, we are doing more than asking that question. We are fumbling to find a way to avert one of the greatest disasters that could possibly come to sporting America—the end of wildfowling.

As we review the circumstances that accompanied the great duck depression of the 30s as well as the present tragic decline of waterfowl, we are mocked by our inadequate knowledge of this important resource. We do not even know how to make an evaluation of our breeding population. We have continually made up the rules for the harvest without knowing whether or not we had a shootable surplus to reap. The current decline of waterfowl has been attended by enthusiastic reports of increases. Only a year before the decline was apparent, we were told of overpopulations. Thus the lag between a serious condition and the application of corrective measures has been 2 years long. This lag is devastating to our ducks and a deadly threat to wildfowling.

[1]Read by H. Albert Hochbaum.

Throughout the vast northern breeding grounds only three or four trained biologists have been available to appraise the yearly duck crop. Their surveys have been woefully inadequate, particularly for the important prairie regions where the bulk of the field work did not begin until the breeding season was nearly over and mass dispersals had already begun.

Our flyway men have been the first to realize that their methods were antiquated and have sought help to correct them. The U. S. Fish and Wildlife Service already has made a big step in the right direction. They have added a first-rate technician to the Mississippi Flyway and have made full use of available aircraft which we now know to be indispensible in breeding ground surveys.

This flyway group and the Delta Station are now cooperating to develop new techniques for breeding ground appraisals. Accurate methods of appraising the yearly duck production and application of this information in establishing regulations is one of the keys to the future of wildfowling. Ducks as game for future generations cannot be assured unless we start right now to find out what we are producing and thus make up our regulations accordingly.

My purpose is to tell you about the study we are undertaking and how it can help to insure the future of wildfowling. When and how, then, are we going to make these appraisals? First, we have found what we suspected all along: The survey can't wait as it has in the past until June is half gone. Time is at a premium on the swiftly moving calendar of the breeding grounds. The surveys must begin with the first thaws; the intensive work must span the critical months of April, May, and June. This is the key period. This is the period that catches the birds on their breeding areas before the beginning of the complicated post-breeding season shift which may carry Delta redheads to Saskatchewan, Alberta mallards to the Northwest Territories.

Before we can find out how many young will be produced we must know how many breeding pairs the marshlands have. We can obtain this figure only during these three spring months. It is then that the breeding pairs are at home, so to speak. Then each little slough and pothole, each bay corner, each lake shore has its own individual breeding population. This population can be counted; it can be compared statistically one year with the next. Each pair selects a portion of the marsh and stakes out its claim to that area. There the breeding pair, and later, after incubation begins, the drake alone may be found day after day for a period of 10 days to 3 or 4 weeks. This particular spot is the territory belonging to the pair using it. It represents a nest nearby but is a separate and distinct unit of marsh and does not include the nesting site which may be a few yards or several hundred yards away from the territory. The drake defends the territory against intruders of his own species but allows other kinds to come in. Thus the number of breeding pairs per unit of marsh is a precise biological figure. When a pothole, slough, or bay holds its limit of breeding pairs it has reached its full carrying capacity or what Robert H. Smith, Mississippi Flyway biologist, has suggested we call "par."

Because pairs stay in one place for a period, it is possible to count a whole season's breeding population for that area by making a series of visits.

The period of tenure upon a given territory varies not only between different species but even within the same kind. It is generally longer than 10 days, and sometimes it may last up to 3 or 4 weeks. For our sampling techniques, we are determining the average length of time a territory is used by each species; the extremes and the causes of the differences; the relationship between the phenology of nesting and territorial behavior; the time of season and time of day to make counts; the methods for recording exact data so that pairs will not be confused on later visits: and the number of counts necessary to get the whole season's picture.

Further questions arise in regard to territorial tolerances. A pothole large enough for one pair of mallards and one pair of pintails might have room enough for two pairs of shovellers and four pairs of blue-winged teal. Mallards and pintails require more space; they are quicker to defend. They do not allow strangers so close to home. Blue-winged teal are the most tolerant of all. Though the drakes are belligerent toward other teal drakes, their defense flights do not take them far from their home territories. We are finding out the details of these tolerances, how they vary, and how they are affected by the vegetative patterns of the areas where they occur.

Different species have different territorial requirements. A shallow, open whitetop swale favors mallards, pintails, blue-winged teal, and gadwall. Another one nearby that is the same except for a few cattail clumps in one corner may favor in addition a pair of redheads, a pair of canvasbacks and a pair of ruddy ducks. A third breeding spot with a deep center, dense cat-tails around the edge and without mud bars or loafing space, will favor only diving ducks.

Type waters thus have their own particular species-composition which is determined by the character of the area. Numbers depend upon the specific tolerances of the birds and, of course, upon how many survived the wildfowling season of the previous autumn.

You may ask: How can this system of appraisal be applied after the details are ironed out? Obviously we cannot record the breeding population of every duck-nesting area throughout the breeding grounds. We propose, instead, to develop a system of sampling a whole chain of type areas and applying these exact appraisals to the broad regions of which they are a typical part. On the type areas, we intend, through intensive study, to measure populations year after year. For example, one of the areas we have chosen is the Minnedosa pothole region in western Manitoba. There, last spring, a group of breeding areas were studied intensively; what we found to be true there we found to be true also of the whole region when we covered it by plane and car.

By thus appraising the breeding population during the breeding season we will have a figure of potential reproduction by early summer each year, giving an objective measurement to guide the regulations for the autumn. Local production may be modified, of course, by drought or extensive outbreaks of botulism, hence surveys should continue until the crop is on the wing.

In the past, evaluations have been expressed in terms of "more abundant," "less abundant," or "the same as last year"; these evaluations being based only occasionally on any measurement at all and more often upon recollection alone. It was the great English ecologist, Charles Elton[2], who pointed out the flaws in such a system. Elton says that the chief difficulty in recording changes in numbers of any animal which undergoes fluctuations is in finding a standard to which abundance in different years can be referred. Such statements as "more abundant than usual" cannot be safely used for two reasons. The first is that we do not know what "usual" means; the second is that it varies from year to year and in the minds of different people. Elton goes on to say that the word "usual" when applied to numbers may mean practically anything according to the particular emotions, powers of observation, and strength of memory of the observer.

In contrast to such indefinite evaluations, a yearly count of territorial pairs on sample areas gives a standard or "par" for the breeding grounds. These comparisons from year to year are objective because they are based on actual counts of a stable population on the ground where it is productive. At present they show only trends but the trends are clear-cut. What were these trends in 1946? Down—downhill at a sharp angle. In 1946, we found for the first time perfectly good breeding areas where there was not a single breeding duck for the entire season. On many other areas the number of breeding pairs was only a fraction of what it had been in 1945. Citing an actual example, one area at Delta in 1945 had 15 breeding pairs, in

[2]Elton Charles. 1927. Animal ecology. The Macmillan Co., New York. p. 175.

1946, only 3. The area had a stable water level; no visible change whatever had altered its attractiveness to breeding ducks. It was underpopulated simply because not enough birds came back last spring.

In other words, there were more suitable water areas than there were ducks to fill them. This was true all over southern Manitoba, and we were able to report as early as last May that even with an excellent hatch and the best possible brood success there would not be a large flight of ducks from the region. This prediction was borne out by the events of the summer and autumn. All of the ducks produced in this area should have been saved as breeding stock for 1947. But a large portion of those ducks raised in 1946 have already been shot. We have sold our breeding ducks down the river like a wheat farmer who sells all his grain and leaves none for spring planting. Farmers can borrow more grain—where can we borrow breeding birds?

We're asking: "Is wildfowling on the way out?" Those of us who study ducks on the breeding grounds are asking a parallel question: "How far below 'par' have we gone?" The dark answer to both your question and mine is the same: If we don't give the breeding stock time to recover, wildfowling will be only a memory and "par" will never have been determined.

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## DISCUSSION

MR. W. L. JONES (South Dakota): I would like to know if these birds come back to the same spot every year—to those sloughs up there, the marshes?

MR. HOCHBAUM: Delta measured a great number that way through banding but the classic example is Mr. Lincoln of the Fish and Wildlife Service. The mallard came back for about 9 or 10 years in the exact same spot on the farm, I believe, in Iowa. Some of our females, we know, come back to exactly the same pond and nest in exactly the same patch of reeds they nested in the year before.

DR. J. R. STURRE (Minnesota): I haven't heard anyone speak of this duck situation, and I am in agreement that the ducks are certainly down; but in speaking of ducks we are always talking about ducks on water and God knows we have got a lot of water in Minnesota. In my experience from a little boy on, I have found more ducks on the nesting season in high land and up in the fields and a half a mile from a pothole. Mallards are nesting up in little stubble fields. Your diving ducks are nesting in trees and everything else. I think there is fully as many ducks that nest up on the land as nest on water.

CHAIRMAN CHASE: What about the nesting up on land as well as near the water?

MR. HOCHBAUM: That question was brought up the other night. We have the same thing, for instance, on the portage plains where the water came back in 1944. The greater portion of the breeding population was on the uplands in little shallow water areas far back from the main marsh and rivers, but in that country in the drought years the ducks are forced back to the stable marsh areas.

Another point, in those small uplands the movement is almost entirely in river ducks and largely in mallard and pintail. There is very little movement of the diving ducks. They remain good years and bad, largely in the stable bullrush marshes.

MR. MEINING (Massachusetts): I would like to ask Mr. Hochbaum, having established your breeding trend to the prairies, what do you propose for your northern breeding areas with larger groups of ducks which would be much harder to evaluate?

MR. HOCHBAUM: I spoke of the prairie region as the barometer of duck conditions. The prairie region is the area which we have had in mind all these years, the area where the drought has come, where the great loss has come, where a change in weather can meet a great number of ducks breeding here or great success or, on the other hand, poor production and many losses. If we can get an accurate picture of this tremendously large area on the prairie, I think we do have a much better picture of the old over-all waterfowl situation and the picture that we need.

I don't believe it will be for the present or some time to come that we will be able to cover the whole waterfowl area far up to the Arctic seas and through Alaska as carefully as on the prairies.

DR. JAMES N. GOWANLOCH (Louisiana): I happened to know very familiarly as a child the very area in which you have worked; I was brought up there. I should like to ask you this. What is your opinion as to the returning ability of these ducks? What do you think would be the re-invasion of an area which has been completely shot out? What would the period of time be?

MR. HOCHBAUM: I think perhaps Dr. Cottam could tell us something about this. How quickly do the ducks come back to the Lower Souris?

DR. CLARENCE COTTAM (Illinois): I think that would depend on the total number of birds in a given area. If the number is down, it would take quite a long time. If the number is high, their recuperative ability is great. If the population goes up, it is readily recuperative. If the general population is low, I think it would take a long time.

MR. HOCHBAUM: I think that is the proper answer which should be modified by saying it will take a long time and if it takes a long time it is going to take a lot longer time for the diving ducks than it will for the river ducks. We are going to have to start thinking in terms of the diving ducks as the bottom, if we are going to bring the waterfowl populations back.

MR. FRANK C. BELLROSE, JR. (Illinois): I would like to hear what Dr. Gowanloch found in his first year's study on the Souris refuge? I recall he gave a paper about that at a previous Wildlife Conference.

DR. GOWANLOCH: I do not have a sufficiently retentive memory to retain figures of breeding birds on Lower Souris of work done in 1937, 1938 or 1939. But at that time, Lower Souris was gradually coming back. The adjacent marshlands had been re-established. I saw it in that formative stage. I did not see it at an earlier stage, but it is my conviction that marsh areas are repopulated rather rapidly if there is waiting there a potential breeding population to occupy it.

I recall some of the early work in Alberta and Saskatchewan and there again it is a matter of impression, just day-by-day observations where you see certain potholes or bodies of water with water in them but not up to optimum levels or optimum marsh conditions. You will find pairs of birds sitting around doing nothing. It is my conviction that if that marsh is eventually rehabilitated and becomes a suitable breeding ground, those individual birds will get busy and reproduce. Until that marsh becomes optimum in their minds they may just sit around for a year or two.

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# THE FUTURE OF WILDLIFE IN FOREST LAND USE

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The purpose of this paper is to point out the opportunities in forest wildlife management in the immediate future, and to present briefly three things that will determine the extent to which we realize these opportunities.

There are 462 million acres of commercial forest land in the United States, of which approximately 341 million acres is in private ownership. These privately owned forest lands constitute probably 90 per cent of the potential timber-growing capacity of the United States.

The Nation is facing a critical shortage of timber products at a time when abundant supplies are urgently needed. Lumber stocks are at an all-time low. At the same time there is desperate need for a vast housing program, of possibly 1¼ million units annually over a 10-year period. Obviously the heavy drain on our forest land will not be of short duration.

Approximately 90 per cent of this tremendously increased harvesting of timber products during the next 10 to 20 years will occur on the 341 million acres of privately owned forest land. Inasmuch as this privately owned forest land makes up slightly more than one sixth of our total land area, and a much larger proportion of our wild land area, it means that a very large percentage of our total wildlife habitat is going to be affected in one way or another by the forest practices employed on these lands in the immediate and more distant future.

The figures quoted above cannot give a true picture for any particular part of the United States because of the unequal distribution of our forest lands. To take a more specific example, the total area of New England and New York is approximately 70 million acres and of this amount 40 million acres, or 58 per cent, is forested. In this area of 70 million acres, with a resident population of approximately

24 million people, 3 of every 5 acres of the total land area has already or soon will be changed in some degree as a result of cutting practices.

We have every reason to believe that the primary use of our privately owned forest lands during the next decade or longer will be the furnishing of lumber and other timber products so sorely needed in both national and world economy. This is inevitable and will result in more widespread and intensive cutting than we have ever before experienced. How is this going to affect forest wildlife?

Whatever the primary objective of any land-use program, the practices employed may serve additional secondary purposes. These secondary results may be simply incidental to the primary aim or they may be an integral part of the work, planned and provided for in the program. If they are merely incidental, some of the effects will be adverse rather than beneficial, some of the beneficial effects will be only partially realized, and none of them will be coordinated so as to derive the maximum good from the money and effort expended. If they are an integral part of the program, planned and provided for from the beginning, their complete accomplishment can be realized at very slight additional cost in either money or materials and the program will then assuredly result in the greatest good to the greatest number.

The situation confronting us on forested lands, contrary to what one might suppose, offers an opportunity for wildlife management the like of which none of us is apt to see repeated. To make the fullest use of this opportunity there must be a coordinated land-use program for the areas involved.

Coordinated land use is dependent upon three things: (1) a knowledge of the various practices or techniques that are to be employed, (2) permission to include the necessary practices or techniques in the land-use program, and (3) funds to pay the cost of the labor and materials required. Although there is much that we do not know about the management of wildlife on forested land, I believe it is safe to assume that we know enough to plan a worth-while and productive program. Certainly we know far more than we are at present putting into practice. I am not so sure that we are in an equally advantageous position with respect to securing permission to put the program on the land, or to obtaining the funds needed to pay its costs.

If landowners and administrators are reluctant to include wildlife management in their land-use plans, it is probably because they are not convinced that it is worthy of inclusion. This becomes, then, a question of the *values* possessed by and the *services* performed by wildlife. Can it be demonstrated that these are sufficient to justify the costs in time, labor, land, and money necessary for the conservation and management of this resource? I am afraid the answer must be ''no''—but only because we are not in agreement as to what constitutes value in this case, and because we have made no conscientious effort to determine and present accurate quantitative data on these matters.

A quotation from the section entitled ''Wildlife a Forest Resource'' in ''A National Plan for American Forestry'' (Roberts, 1933) aptly describes this situation. The writer says: ''Reliable factual information regarding the full extent of our wildlife resource is sadly lacking. . . . In general the data extant on the quantity and value of wildlife gives no more than an inkling of the astonishingly large and widespread importance of the resource. Lack of reliable nation-wide data is in itself sufficient to justify a systematic organized effort to obtain comprehensive information regarding our country's wildlife situation. Common sense demands that working plans not only for the development of this resource but for its coordination with broad plans embracing other forms of land utilization must be based on sound fundamental facts.'' Although this was written 14 years ago it is still true in every respect. We do not have at this time any reliable figures on the total economic value of our wildlife resource, and only the sketchiest sort of knowledge relative to its specific values on particular areas. The information available is so general that it is far from convincing, and in most instances is obviously nothing more than the roughest sort of estimate.

The total economic value of our wildlife resource is the sum of its several values plus the worth of the several services it performs. All of these values and services may be included under six general headings. These are:

1. Commercial values—the income derived from the sale of wild animals or their products, or from direct and controlled use of wild animals and their progeny; *e.g.,* commercial fishes, furs, fur and game farming, domestication.

2. Recreational values—moneys expended in the pursuit of wildlife in connection with sports and hobbies.

3. Biological values—the worth of the services rendered man by wild animals, *e.g.,* insect and rodent control, sanitation, suppression of diseases, conversion, tillage, fertilization, etc. (some of these services could be performed by man in the absence of wild animals but only by increasing operating costs; for others of these services we are totally dependent on wild animals).

4. Social values—the values accruing to the community as a result of the presence of wild animals.

5. Esthetic values—the values of objects and places possessing

beauty, affording inspiration and opportunities for communion, contributing to the arts through music, poetry, literature, and painting, and possessing historical and patriotic significance (in these last-mentioned respects native species of wild animals are similar to sites of physiographic, political, military, and biographical interest). These values are largely purely personal but are, nevertheless, of vital concern to practically everyone spending any amount of time in the out-of-doors and, in addition, are the values that induce a goodly number to become interested in the out-of-doors and the conservation and proper management and administration of its various related aspects.

6. Scientific values—values realized through the use of wildlife as a means for investigating certain fundamental and widespread natural phenomena that may affect man's interests either directly or indirectly.

Extensive knowledge of these various values is not essential for one's personal enjoyment of wildlife, but it is necessary if one is to prepare and administer land-use programs that will provide (a) the greatest good to the greatest number, (b) the largest return from land use, (c) the best assurance of multiple land use, and (d) sustained yields. As stated by Taylor (1930): "Everybody is in theoretical agreement, at least, with the administration of lands on the principle of highest use. 'Highest use' is an empty phrase, however, unless we have the economic facts on which to base it."

If, because of our convictions or simply to avoid argument, we grant that wildlife is to be included in our land-use programs, questions immediately arise relative to the degree of inclusion. What share of the available funds, land, and labor is to be devoted to wildlife interests? To what extent may developments primarily for the benefit of wildlife be permitted to interfere with the development of other resources? If a choice must be made between the degree of consideration accorded wildlife and some other resource, which is to be favored? These and numerous similar questions are bound to arise. They cannot be answered on any logical basis until we possess far more accurate information relative to the several values of wildlife, and until we have comparative data for areas of different kinds in different locations subjected to different kinds and degrees of use by the public.

It would seem, then, that the obtaining of these statistical data might constitute a worth-while project. The problems confronting us are not purely biological—they are in considerable part economic and social. I do not advocate a moratorium on management research for the biological problems are important and numerous; but the economic and social problems are not less important and they have not received their fair share of attention. We should take steps immediately to remedy this situation.

In fairness to landowners and others charged with the responsibility of administering lands we should not expect them to adopt land-use practices unless we can demonstrate a possibility of some return on their investment. In our present state of knowledge we cannot put up a very convincing argument. Is this because wildlife doesn't possess sufficient value, or is it because we do not yet know enough about the values possessed by and the services performed by wildlife?

Grinnell (1924), in a discussion of wild-animal life as a product and as a necessity of forest areas, said "I am led to believe the forest trees themselves depend for their maintenance in the condition in which we observe them in this age of the world, upon the activities, severally and combined, of the animals which inhabit them now, and which have inhabited them in the past."

What, however, do we know about the specific activities of wild animals and their relationship to forest growth that will enable us to convince a hard-headed timber owner or a practical-minded forest manager that wild animals are a necessity on forest lands? The answer to this question is contained in the vertebrate ecology, the economic vertebrate zoology, and the forest zoology textbooks that have not yet been written because we do not have the necessary data. We not only cannot convince the present-day forest manager, we cannot even convince the present-day forestry student. This situation need not continue. Correction and alleviation require only that we direct a share of our research effort toward obtaining the necessary facts.

These data on values and services, if and when they are obtained, will do little good until they become an accepted part of our national thinking with respect to wildlife. It is conceivable that our efforts to teach American citizens *how* to conserve wildlife would be more productive of results if we would at the same time teach them *why* they should conserve wildlife. This, of course, is the part of education.

Whenever wildlife conservation is discussed there is usually almost unanimous agreement that education offers the best if not the only solution to many of the conservation problems still only partly solved. This in spite of the fact that during the past 15 years our colleges and universities have been turning out scores of wildlife technicians each year. During this same period the grade and high schools have included more and more conservation teaching in their curricula, and every other educational medium has been used to some extent to present the principles and preach the practices of conservation.

There are three aspects of this teaching. These are, first, the technical training provided in universities and colleges for those students preparing themselves for the profession of wildlife management; second, the less technical and generally less specialized knowledge of conservation imparted to students of all ages from the lower grades to the graduate level; and third, the admixture of conservation ideas and ideals, facts and fancies, much of which is very good and some of which is very bad, that is supplied the public through the medium of newspapers, magazines, pamphlets, books, and radio.

This widespread interest in conservation is a potentially powerful force. If properly harnessed and directed it can be productive of much good. If it is not harnessed it will be largely dissipated, and if it is not directed it will accomplish relatively little good and may do a great deal of harm. To the degree that our conservation efforts are successful it will be increased and intensified. Certainly it should be fostered and encouraged, but just as certainly as it develops into a strong force it should be molded into a good force and directed toward the most worth-while ends.

The responsibility for molding and directing this growing force rests upon those of us who have elected to make conservation our profession. It is the greatest contribution that education can make to the future progress and development of conservation, and it is a contribution that not only permits but actually requires the participation of every individual in the profession. Whether our participation is willing or reluctant, informed or otherwise, it is bound to be effective. Effective for good in the one case, for evil in the other.

Textbooks, technical papers, and professional reports are obviously a part of this participation. Popular articles, radio talks, addresses before lay audiences, and newspaper comments and interviews are just as certainly another part. In some respects these activities mentioned last are more valuable, possess more possibilities for good, than those mentioned first. They reach a larger audience, one more in need of education, one that is perhaps less receptive and is certainly less able to assimilate what is offered, and one that is less critical.

If, then, each of us must participate in this process of education, and if all of us, layman and professional conservationist alike, are involved in this business of conservation, it seems we could well afford to examine our educational and conservational aims to determine if we are pulling together or against each other. This presupposes some general agreement on ends to be attained. In so far as our educational program is concerned those ends should not be difficult to define. They, however, should be clearly defined and re-examined frequently in order that this general agreement will be insured, and to prevent our losing sight of primary objectives. This will make for less confusion in the minds of the public and less conflict among ourselves.

Conservation education outside of the professional field should not be primarily concerned with techniques. Its chief concern should be the development of a proper attitude toward the earth and its resources, a philosophy of life that is based as much on man's relations to and involvement in earth's phenomena and resources as it is on his dependence on and opportunity to use these forces and materials. This philosophy must be in some part practical because of man's need for the very things he is seeking to conserve. To this extent conservation education should include training in techniques; these, however, should be management techniques. The development of a proper attitude is dependent upon an understanding of the principles that must govern our treatment of these resources if we are to use them and at the same time insure their continued existence. There can be no understanding of these principles without first understanding the fundamental nature of the resources we are dealing with.

It is believed that the following basic concepts are sufficient to clearly explain the fundamental nature of the wildlife resource and enable us to derive the principles that govern its conservation and management:

1. The Organic Nature of the Wildlife Resource.

Simply because wild animals are living creatures those of us with biological training have assumed that the general public is fully aware of or can readily grasp the distinction between organic and inorganic resources, and the full significance of this difference. We have been wrong on both counts. The widespread tendency to confuse management with "farming" or even with "mining" is proof that a serious misconception prevails. Professionally we have put our faith in management. Obviously we are convinced that we are dealing with a manageable resource. Its manageability is inherent in its organic nature and possible only because of this nature. We have not, however, taken the time or the pains to explain this to the layman. He will never fully comprehend the techniques of management, and he can have little appreciation of its possibilities and no conception of its results until he understands the one thing that makes management possible.

2. The Various Values of the Wildlife Resource.

These have already been discussed and it only necessary to point out that failure to understand and appreciate these several values has been and still is a retarding influence. There are two ways in which this influence manifests itself. First, because many people are unaware of the total value of the resource they are not convinced that money, time, and effort devoted to wildlife conservation is a justifiable expenditure. Second, most individuals recognize only one, or at most two or three of these values, and insist that the ones they do recognize be given primary, if not exclusive, consideration. This has led to the unfortunate situation wherein various organized groups, all intensely interested in wildlife conservation, advocate and demand conservation programs that are antagonistic to each other, incomplete in their provisions, and likely to do more harm than good should they be enacted.

3. The Dynamic Nature of Environments.

It must be made clear that each environment has to provide that great variety of foods, coverts, water, and special factors needed during the different seasons for the various activities of both sexes and all age groups of all the species it is intended that the environment shall support; and that this applies not only to the materials necessary for the animal's physical well-being but also to the pattern or arrangement of these materials suited to the animal's physical abilities.

This concept of the environment, however, is not complete. Neither the methods nor the results of conservation can be understood until we can conceive of environments not as things static and having only linear dimensions, but as things happening and in a state of constant change. Each environment has both a past and a present, not merely horizontal extension; at any given time it may be in a condition of stress, in the process of adjustment, or in relative equilibrium. Progression through these stages or from one stage to another is ordinarily an orderly series of changes constituting a natural succession. It is frequently necessary in conservation to hasten, retard or even reverse succession. Once a desired stage has been attained it is necessary to retard succession on the area in question or have available other areas approaching the same stage. For these and other reasons a clear conception of succession and the dynamics of environments is essential to any real understanding of wildlife conservation.

4. The Universal Application of Biological Laws.

Confirming evidence from many sources has long since established the full physiological significance of the essentially similar fundamental, living material of all organisms. In this one basic respect all animals are alike; therefore, the biology of all animals is to a large degree similar and it must follow that the requirements of all animals are to that same degree similar. In our efforts to conserve wildlife we have too frequently failed to emphasize the all-important fact that fundamental biological principles apply to wild animals as well as to those of proven greater economic worth. To illustrate: This generation, more than any other, is acquainted with and has profited from sound nutritional principles. The terms vitamins, essential minerals, and balanced diets have become household words. We have come to realize that food is not just a matter of quantity, palatability, and calories. We are aware of the importance of the various vitamins to our general health and well-being; of the necessity for certain mineral elements in our diet if we are to possess sound teeth and sturdy skeletons; of the peculiar and different needs in these respects of adults, growing children, and infants. Those familiar with the animal industries know that these same peculiar needs occur in domestic animals and the same forethought and precautions are required in connection with their diets if they are to thrive and reproduce. Too few realize that wild animals are no less in need of these same food elements so universally required by other forms of animal life, and are equally dependent upon these fundamental biological laws.

5. The Nature of Adaptations.

The word adaptation indicates that certain structures or functions possessed by an animal, or certain modes of behavior exhibited by it, enable it to use to advantage many of the factors that go to make up its environment; in other words, it is adapted to its surroundings. We must remember, however, that highly specialized adaptations definitely limit the range of activities of their possessor. There can be no gain without some sacrifice. Specialization allows for greater freedom along some lines, but at the same time it restricts within narrow limits activities in other lines. Adaptations are just as truly limitations. Second in importance to the requirements of animals are those limitations imposed upon them by their structure and habits.

These restrictions give rise to definite sets of habits which constitute the animal's behavior pattern. This pattern is an expression of the animal's abilities and ordinarily it can be modified only slightly. It is in reality the sum of the responses the animal is compelled to make to its environment. As a consequence, our conservation measures must be such as will fit not only the needs of wild animals but their abilities as well. They cannot change to suit our convenience.

6. The Properties of Animal Populations.

Just as particular adaptations are characteristic of the individuals of a species so are there modes of behavior characteristic of aggregations of these individuals. Leopold has called these modes of behavior characteristic of entire species their population properties, and points out that just as in the case of man some of them are not discernible in the individual bird or mammal, but become apparent only through a study of the behavior of entire populations.

We undoubtedly know relatively little as yet regarding these properties. There are perhaps many awaiting discovery and much more to be learned about those we already recognize, but we know enough to prove their existence and demonstrate their importance. It is not necessary for the public to understand all of the fine points included in this large body of technical knowledge, but a general understanding of the fundamental fact of population properties and their nature would be most helpful. It would aid in making clear that wildlife conservation must be primarily concerned with the needs and abilities of the entire species and not with exceptional requirements or modes of behavior as noted occasionally by the casual observer.

7. Total Populations.

The maximum population of any one kind of animal that can occur on an area, *i.e.*, the species' saturation point, is not known for many species. In those instances where it is known it seems at first thought to be surprisingly low, for example, one bobwhite quail per acre, or one ruffed grouse per four acres. These apparently low species populations are actually maximum populations, and occur only rarely, and on only exceptionally productive areas. Except for purely temporary concentrations on locally favored areas, wild-animal populations rarely, or never, closely approach the population levels popularly supposed to exist. It is necessary for those seeking to understand wild-animal behavior to adjust their ideas to a relatively new conception of the population levels of individual species.

This, however, is only half of the picture. A second and equally difficult adjustment has to be made with respect to the total number of all the kinds of animals present on any given area. A single environment usually supports several kinds of animal life, and an area on which a number of different kinds of environments occur will ordinarily support a great variety of wild species.

These population concepts add much of interest to our study of wild animals. They are of most importance, however, in connection with our efforts to conserve wildlife. Although we may determine the carrying capacity of an area for one or several species in which we are interested, or although we may know the maximum populations attainable for a number of species we wish to encourage, it does not follow that providing foods and coverts in quantities sufficient to meet the needs of these predetermined numbers will insure these quantities to the species we are attempting to conserve. There are always the several score of other species occurring on the same area and their total populations are far in excess of those of the species we are seeking to encourage. They must eat, find shelter, and provide for their special needs, and these demands on the environment must be met from the stock of materials that provides for the favored species. Any conservation program must take into account these total populations.

Elimination of this lesser fauna is impossible and would be unwise if it were possible. It would be too expensive, it would disrupt important ecological relationships, it would remove necessary buffer species, it would destroy links in food chains on which certain of the more favored species are dependent, and it would remove species of interest to groups of people who are as much entitled to their rights and interests as are any other groups.

8. The Sensitivity of Population Curves.

Due to the inherent force of natural increase wildlife populations are constantly striving toward increase and expansion. This expansion is just as constantly opposed by the resistance offered by the environment. The result is usually either a stable or a declining population.

By far the greater part of our conservation effort is directed toward increasing wildlife populations. Usually the best means of accomplishing this is through a reduction of environmental resistance. In order that environmental manipulations may be most effective and most economical it is necessary to identify the various factors offering resistance, that is, responsible for the losses, and determine the relative value of each. When the factors are known and their effects evaluated it is quite frequently the seemingly insignificant or those responsible for relatively small losses that are most amenable to quick and economical control.

The tendency is to ignore these apparently minor influences and concentrate on those which obviously account for larger losses. This tendency would be much more easily corrected if the public realized how even a slight reduction in the mortality rate in the majority of species results in a disproportionately large increase in survival rate. If, for example, each pair of a species produces 12 young per year and they all survive, each family, which originally included only two individuals, would at the end of the first year consist of 14 individuals, a 700 per cent increase. If the number of individuals remains the same year after year, then there are not more than two members of each family surviving each year. Under these conditions the 12 members of each family lost each year equal 100 per cent of the mortality in each family; then one individual equals approximately 8 per cent of the total mortality. If the mortality rate could be reduced as much as 8 per cent, leaving three individuals alive at the end of the year instead of two, there would be a 50 per cent increase in survival and a doubled population in 2 years. It is unlikely that any such results will ever be attained. Even the most ardent conservationist would probably be satisfied if we could succeed in doubling a population over a period of years. Under the conditions outlined above a 1-per cent reduction in the mortality rate would result in doubling the population in 12 years.

9. Interrelations and the Effects of Land Use.

No program having to do with the conservation of natural resources can be limited in its application and results to a single resource. All of the organic natural resources are so interrelated that any attempt to control or influence one is bound to affect the others. Failure to recognize this fact has resulted in much unintentional harm in the past and has on occasion seriously retarded conservation work. Organic resources are so intimately associated with surface features that their conservation can be accomplished only through manipulation of these features and manipulations, inaugurated for the benefit of any particular resource, are bound to affect every other resource dependent to any extent upon the same surface features.

A comprehensive program which makes allowances for these interrelations, utilizes such knowledge as is now available relative to these other resources, and provides a coordinated and correlated scheme of work based on this knowledge, will not only avoid making changes detrimental to wildlife but will very often greatly enhance wildlife conditions at no additional cost in either labor or materials.

We must constantly keep in mind that the demands made upon both the environments and the wildlife, the innumerable influences brought to bear upon them, and the various uses to which they are subjected, condition every effort we make at conservation and every response we obtain.

10. The Objective of a Conservation Program.

Finally there must be an understanding and agreement on the objective to be attained. This is mentioned last, not because it is less important than the other points discussed, but because the preceding discussion should aid in its formulation and expression. It may be stated very briefly, and I cannot do better than paraphrase Leopold in this connection: The objective of a conservation program for wildlife: to retain for the average citizen the opportunity to see, hear, admire, enjoy, and use, and the challenge to understand, the varied forms of wildlife indigenous to his region. This implies not only that these forms be kept in existence, but that the greatest possible variety of them exist in each community.

A better understanding of the concepts presented above would not only aid in attaining this objective, that is, retain for the average citizen these several opportunities, but would also better equip this same citizen to make the most of these opportunities.

Presenting the facts necessary to prove the worth of wildlife, and the principles governing its conservation will do much to assure the adoption of a coordinated land-use program. There is, however, one additional step that must be taken before wildlife conservation is accorded its rightful place in an integrated land-use program. Wildlife conservation is still the one large public interest, the one principal public business in which complex aspects and technical problems are resolved or decided by popular vote.

Public interest is desirable, in fact, necessary, and should be encouraged, but deciding technical problems by straw vote is, to put it politely, an indication of a lack of confidence in professional wildlife workers or an indication that the public is unaware of the professional help available in this field. The public looks to the medical profession, the engineering profession, and similar professional groups for guidance in their respective fields. The public not only expects these professional groups to keep them informed but actually to impose upon them the things that are to their best interests. Individuals may complain and criticize but they accept and comply, and they rarely either as individuals or as organized groups presume to dictate the programs.

Is the wildlife profession ready to assume this type of leadership? This aspect of the problem is also in large part educational, but education is rarely effective or successful unless the students are under the direction of a respected leader.

## SUMMARY

The intensive and widespread cutting on commercial forest lands during the next 10 to 20 years will affect a large percentage of all forest wildlife habitats in this country. The effect, in general, will be to benefit wildlife. Whether these benefits will be only temporary and slight or permanent and extensive depends upon the degree to which the various phases of land-use planning are coordinated.

To insure the inclusion of provisions of wildlife in these plans three things are needed:

1. Much additional reliable data on the values possessed by and the services performed by wildlife. These data would enable us to determine to what extent we are justified in modifying current land-use practices to favor wildlife, and to what extent we are justified in investing money, time, and effort in the conservation and management of this resource.

2. Widespread appreciation of the importance of conservation edu-

cation, agreement as to what constitutes conservation education outside of the professional field, and coordination of our educational efforts.

3. The willingness, if necessary the insistence, on the part of our profession to assume the leadership that it is, or should be, best qualified to provide.


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# A POWER COMPANY'S STAKE IN WILDLIFE


Walter G. Gumbel
*Monongahela Power Company, Fairmont, West Virginia*


Gentlemen, I want to first express my appreciation for the opportunity to meet with you and to present my views on wildlife conservation.

Many of you, no doubt, are wondering why an electric power company should be so interested in conservation that it would employ a soil conservationist and permit him to talk about his work all over the country. I'll try to explain why.

*Power company's interest is economic.*—Briefly, the company which I represent, and many others like it, have awakened to the realization that it is sound business for them to protect their large investments in rural electric lines by helping their customers and potential customers increase their incomes and improve their economic and social standards. It is sound business because the company figures that out of each income dollar earned by the farmer it will receive in return 1.2 cents—and that is enough to justify participation in wildlife, soil, water, and forest conservation activities; also in other phases of a broad agricultural-development program.

Our investments in rural lines and equipment are fixed. When wildlife, forests, soil, and water resources of a farm or community are depleted we cannot pick up our poles and lines and move. Those lines are installed permanently. Through them moves the electric current our company sells. Our only course, then, is to help in every way to make it possible for the farmer to be in a more favorable position to buy our product. Bankrupt farmers on bankrupt land cannot buy electricity.

The rural customer who develops a good business through the application of practical wildlife conservation measures thereby encouraging the sale of more hunting and fishing permits and other services, or the marketing of fur is a better customer for us, just as is the rural community that profits from the hunters and fishermen who come into their area in search of game. This also applies to the application of all other kinds of conservation practices that protect the land, thereby increasing farm income.

I heard a speaker recently describe this policy as being one of "enlightened selfishness." That, I think, is a good term. The power company is active in soil and wildlife conservation and in agricultural development because it will eventually receive a profit from its investment. But before the profit gets to the power company, all but a very small fraction of it has found its way into the pocket of the farmer, and into the cash register of the merchant who can supply the landowner with goods that will enable him to improve his standard of living.

That is the story, generally speaking, of why a power company is interested in conservation. But we are here to speak specifically of wildlife conservation. That directly affects farm income, to be sure. But it goes even farther. It brings people and money into our territory and state during the hunting and fishing seasons. It provides recreation for our own employees and thousands of our people. The power company looks upon wildlife as a product of the land which is related closely to the economy of the area it serves, and means almost as much to our urban population as it does to rural communities.

The depletion of wildlife resources in heavily populated areas, the continuing effect of soil erosion, forest fires and other destructive forces are problems recognized by our industry. Their solution depends upon careful planning by the biologists and by the land management specialist working in cooperation with the farmer, soil conservation districts; also local, state, and national wildlife organizations. And this is where a power company can come into the picture. Our industry stands ready to support and help promote a clear-cut wildlife conservation program that is basically sound—a program that is built on the capability of the land with supporting wildlife conservation practices. Such a program, however, must be properly related to all other enterprises on the individual farm and be productive of results.

*Problems that concern everyone.*—Let us take up the salient points of the kind of a program I am talking about.

First, we need to recognize the importance and place of a sound wildlife research program. It should be based on the more practical and immediate problems, thereby resulting in the increased application of sound wildlife conservation practices on the land. This principle also applies to long-time research projects. The industry, for obvious reasons, should not be expected to support a wildlife conservation program unless it is based on fact.

Second, local, regional, and state-wide wildlife conservation problems including education, research, planning, application, and maintenance, need to be more carefully developed. Such programs should be planned and organized by those who thoroughly understand the many problems—the farmer, the sportsmen, soil conservation districts, representatives of industry and wildlife organizations, and established governmental agencies that know the basic wildlife needs of a given area. Industry's assistance is supplemental. It can provide a measure of leadership, publicity, and a means of helping to coordinate the efforts of the practical and the scientific.

Third, cooperation between the landowner and the sportsman is of utmost importance. Too often have we found sportsmen and the farmers in conflict when, by simple cooperation and willingness to consider each other's basic and long-range viewpoint, they could find a solution to their problems which would be beneficial to both. This problem would be greatly simplified if the two groups could help plan and develop a practical wildlife program for their areas as pointed out above. Soil conservation districts are in an excellent position to help bring these groups together.

*How power companies can help.*—Perhaps I have been talking in generalities. What you are probably more interested in are some specific things that a power company can do to help.

I have touched upon the place of research, program development, leadership, education, and the coordination of efforts into an over-all plan. But there are other items that concern the power company.

*Many power companies own large tracts of land.*—One company recently employed a conservationist to see that its lands are properly handled in so far as conservation is concerned. That includes wildlife management in all its aspects. Other companies are cooperating with their local soil conservation districts with the same objectives in mind.

Here's another way companies can help. Throughout the country there are miles and miles of high tension transmission lines with cleared and maintained right-of-ways that cut through wooded areas, valleys, and agricultural lands. Here is an opportunity, especially in the wooded areas, for the border planting of shrubs to provide food and cover for wildlife purposes. Arrangements are being made to study the development of such an undertaking. I would like to mention here that my company is now giving serious consideration to the idea, and already our operations engineer has given his hearty approval. Such a plan could result in a very definite contribution to the wildlife program.

The educational part of a wildlife conservation program fits into a power company's public service facilities easily. As I mentioned before, many power companies have agricultural development programs and many more are considering programs of that nature, including conservation. In support of such programs, the companies have publicity and advertising facilities that are ideally adapted to spreading the story of wildlife conservation.

If you will abide with me a bit longer, I will try to describe for you exactly how my company is cooperating in the development of a long-range wildlife conservation program.

*Getting the job done.*—The Monongahela Power Company, through its resources and faculties, implements wildlife conservation activities in the area it serves. The program is being carefully planned and organized through soil conservation districts and in cooperation with local and state agencies having wildlife conservation responsibilities, including sportsmen's organizations, farm groups, and others. It should be noted that the Power Company provides no technical services. This is a responsibility of established conservation agencies. Our concern is to see that employees of the Company, along with the general public, thoroughly understand the many problems involved; also how they can help get the job done. The programs must be sound and result in increased farm income where possible. Here are some wildlife conservation activities engaged in by the Power Company:

1. Employee education and leadership training involves the problem of acquainting the many employees of the Company with the wildlife conservation needs of the territory it serves. In addition, representatives of the Company in agricultural development, sales, and public relations, are constantly being brought up to date showing the relationship between conservation and sales promotion; also how they can implement the activities of local wildlife conservation groups. Information, materials, and project outlines for this purpose are provided by the soil conservationists.

2. Wildlife conservation is a part of the Company's Farming for Better Living program which, during 1946, reached more than 2,300 West Virginia farm families. This program is in the form of a contest and features the entire farm as a unit, including the home. Wildlife and other kinds of conservation are an integral part of this activity.

3. Representatives of the Company, in cooperation with Friends of The Land, farmers, sportsmen's organizations, civic and wildlife conservation groups, are encouraging conservation forums throughout the territory. Wildlife management along with all other phases of conservation that relate to the entire farm economy are always stressed. It is an excellent medium through which correct information can be presented to the general public.

4. The facilities of the Publicity and Advertising Department are used to prepare and release special and feature wildlife conservation stories. Each item or story is usually illustrated and is always related to an individual landowner, an organization, or an agency that is making a worth-while contribution.

The advertising page offers an additional outlet through which certain wildlife conservation programs are featured. This approach is being used effectively to show the increased use of electricity on the farm resulting from conservation.

Exhibits in Company store windows and those of merchants in general, provide outlets that are relatively new. This, along with visual aids, presents an excellent opportunity to reach many additional people.

5. Rural-urban cooperation provides for bringing together key leaders in agriculture and conservation with a similar group representing soil conservation districts, wildlife conservation agencies, industry, commerce, civic clubs, sportsmen's groups, schools, and others to discuss objectively how the application of wildlife conservation practices on the land can be increased. Meetings of this character provide an opportunity to thoroughly explain and develop the basic principles of a wildlife conservation program. They also help to bring together groups having different points of view, thereby correcting misunderstandings that otherwise would continue to grow between the farmer and the sportsman.

6. There is need throughout the territory to demonstrate the development of a complete land-use adjustment program along with supporting conservation practices on an area or a community basis. Such an area would involve from 30 to 50 farms that are usually located on a small watershed. This activity is now underway in several counties and is being developed through and in cooperation with

local soil conservation districts, including the Extension Service, the Soil Conservation Service, Forest Service, Conservation Commission, and others.

The area demonstration will provide for the complete utilization of all suitable lands for wildlife conservation purposes. It should also result in the maximum returns from wildlife to the area, thereby directly relating such returns to income and other community standards. In addition, the demonstration would encourage people, having common problems, to work together, not only to develop wildlife conservation, but all other phases of conservation. It is obvious that this approach would result in a more efficient utilization of resources and services available to farmers on a neighborhood or community basis.

7. The Company, through its educational facilities, cooperates with many groups that are interested in promoting and developing wildlife conservation programs. Civic groups, chambers of commerce, garden clubs, farm organizations, schools, churches, and many others are constantly requesting the soil conservationist for the Company to help them plan and develop programs; also to participate in their activities. This also applies to 4-H and FFA groups.

There are other opportunities, in addition to those outlined in this paper, through which an effective wildlife conservation program can and should be presented to the general public. The Power Company has many facilities that can be easily utilized provided the material presented is authoritative, basic and implements the wildlife conservation activities of recognized groups already established in the field.

## CONCLUSION

The power industry has much to gain in supporting a strong wildlife conservation program. Increased farm income, better hunting and fishing, and improved relations between the sportsman and the farmer, are only a few of the more important contributions. In addition, the investment in rural lines and services by the company is made more secure through the application of a sound conservation program of which wildlife is an important part. An excellent beginning, we feel, has been made and the future with power and light should indeed be bright.

# TECHNICAL SESSION

## Wednesday Morning—February 5

*Chairman:* FRANK C. EDMINISTER
Regional Biologist, U. S. Soil Conservation Service, Upper Darby, Pennsylvania

*Vice-Chairman:* FREDERICK M. BAUMGARTNER
Oklahoma A. & M. College, Stillwater, Oklahoma

## WILDLIFE OF FARM AND RANCHES

# COTTONTAIL MANAGEMENT IN IOWA

GEORGE O. HENDRICKSON[1]
*Department of Zoology and Entomology, Iowa State College, Ames, Iowa*

Iowa harvests between one and two million Mearns cottontails yearly, the largest number of any game species. The season on rabbits is closed only from March 1 to August 1 as a protected breeding period during which the animals may be taken only in event of crop damage. The use of repellents on vegetables is advised to keep the loss of crops to cottontails as low as possible during the summer. The daily bag limit is 10 rabbits, and a possession limit is not set. Rabbits may be sold by the hunter and may be shipped out of the state. A wild species able to stand up against such liberal hunting provisions may be expected frequently to be a pest in control of which vigorous hunting measures may be advised to decrease its numbers at low costs. Orchardists are advised to protect young trees against bark damage in winter, particularly with woven wire netting cylinders. Many farmers invite rabbit hunters to decrease cottontail as pests in years of large populations and occasionally advertise in city papers for such assistance. Were one to give monetary values to the

[1]Journal Paper No. J-1428 of the Iowa Agricultural Experiment Station. Project No. 568. The Iowa State College, the Iowa State Conservation Commission, the Fish and Wildlife Service (U. S. Department of the Interior) and the Wildlife Management Institute, cooperating.

healthful recreation for the hunters in terms of costs in commercialized entertainment, the cottontail as an asset would go into the big-money class.

With recreation for the hunter in mind colony traps and ferrets, both mammal and mechanical, have been legislated out of use in taking rabbits. The bag limit and open season length may be changed yearly by the Conservation Commission to make the surplus crop go around among the hunters and save a seedstock for the next year. So far those regulations have relied on diminishing returns more than on inventories of rabbits. Three fourths of a heavy population may be harvested and the remaining seedstock may be expected to reproduce as well the next year under good food, cover, weather, and other general conditions. A sportsman is not so interested in the exact number of rabbits on a hunted area as he is in the number that may be flushed in a given time during good hunting weather. For practical purposes, game managers rely on random line flush counts per unit of time in estimating shooting populations previous to an open season, and compare counts from year to year with hunter successes. To obtain summer preseason population data, conservation officers are advised to make roadside counts at sunrise and sunset when the rabbits are most often seen in open areas.

The Conservation Commission, in recent years advised by biologists to rely on improvement of natural cover and food conditions to increase cottontails, has prepared long-range plans for such improvements based upon research and has arranged educational programs to explain the plans to land managers and hunters. Conservation officers and biologists repeatedly call the cover interspersion and edge-effect principles to the attention of farmers and hunters. Field investigations disclose normally large numbers of cottontails on areas showing an interspersion of grasses, forbs, shrubs, and all-aged timber. There the edge-effect is at a maximum as the ecotone is extended over an area on which advanced subclimax types are far more evident than climax types. Cut-over timber areas are of that nature. Such tracts have grass for summer feeding, and bark and buds for winter feeding. At the bases of stumps and in short grass patches near escape cover nests are placed. Moderate grazing by livestock tends to dstribute short grass patches which supply fast growing succulent food to the cottontails, sites for sunning, and ranges for play. Cottontails have been observed to make and maintain such clearings in grasses and legumes. A long growing season prolongs forage production and favors the welfare of the rabbit. Small groves of conifers interspersed in deciduous timber areas harbor and feed cottontails during emergency periods of zero weather and deep snow.

Close interspersion of protective and grassy cover favors nesting on an area. Of 126 nests found in several types of cover, the farthest was 13 rods from protective cover, and more than one half were within 3 rods of substantial shelter. In a cut-over timber tract, all nests were within 1 rod of escape cover, whereas, in a hayfield 40 rods wide and 80 rods long, and bordered by thickets, nests averaged about 4 rods from the protective edges. Distribution of pellets, field observations, and trapping data point to a territory often less than an acre in area used temporarily by a nesting female, whereas, the same female may use several to many acres in other seasons and a male may cut across territories of several females during much of the year.

For protective cover and nesting ground, grassy gully banks, grassy fencerows, and grassed terraces with shrubbery serve well. Where this shrubbery also shelters game birds, such as bobwhites, occasional conflicts in interest may occur. Cottontails in large numbers in winter may bark the shrubbery so much that the thicket composed largely of dead stems the next year is of little or no value as bobwhite shelter. To avoid that condition, close harvesting of cottontails is advised.

Fencerows, gullies, and terraces often attract burrowing mammals, notably the woodchuck, whose burrows are used by cottontails in coldest weather. Hunters in cold days frequently take more males than females. Females tend to hole up in burrows or sit tight in forms in dense vegetation, such as sedges, slough grass, foxtail in cornfields, and brome grass, more than males do under low temperature conditions. Thus, the more valuable part of the seedstock is protected.

Supplying artificial burrows has not brought increases in cottontails commensurate with the cost and effort in supplying them. Brush piles, loosely made during timber cutting, are frequently used by cottontails for shelter, but those of a more artificial nature made by bringing tree trimmings to a cleared area have not paid off in cottontail increase.

Every cottontail student, hunter, and manager notices at times areas with food and protective cover lacking in rabbits. The first thought is to trap animals where abundant, and stock the vacant places. Animals thus transplanted are lost from the stocked area in large numbers when the rabbits wander around seeking safety in other territories. A displaced animal is the prey to his own discomfort as well as to his natural predators. For either reason, the stocked animal does not bring successful production to a given area at a reasonable cost. Rabbit stocking is not encouraged in Iowa. Cottontails shipped in from other states must be examined for disease and not released if unhealthy.

To cottontails well-situated for food and other necessary cover, predators are not so destructive as to demand rigid predator control. The badger diggings in a grassy pasture furnish sheltering burrows for cottontails, often far from shrubbery or similar cover. Although the predator eats cottontails, the prey keeps a few individuals ahead of its burrowing host, the badger. Very detailed food habit and population studies of the horned owl and the red fox, both using the cottontails as staple food, show that the rabbit does not lose out badly. Rather, the prey well-situated in favorable weather, is known to increase ahead of the predators.

Territories without cottontails may lack in suitable arrangements or conditions of cover. Some of these deficiencies become apparent with casual examination, whereas, others are not detected even with detailed investigation. Grasses and forbs of advanced types such as bluestem grass and legumes are more attractive to rabbits than those of early stages such as three-awn grass and horsetail. Good and varied soil mineral content benefits rabbit production. Higher vegetation types are more nutritious than lower types, and often more succulent. Many observe cottontails around urban and rural homes. The greater variety of food, shelter, and cover interspersed in small areas is apparent at such sites.

The writer has recommended that substantial shelter cover be arranged at intervals of about 40 rods and interspersed with general farm crops to provide good shooting numbers of cottontail along with reasonable farm profits. Hay grasses and legumes supply nesting sites, rearing cover, and some shelter against heat in summer. Corn, when tall, furnishes shelter against heat late in summer after hay and cereal crops have been harvested. In winter, waste corn left in harvested fields supplies food and clumps of foxtail are form material to shelter against cold and predators. The roomy fields permit of enjoyable hunting more than those of closely placed thickets. Cottontails paw through light snow cover to find legume leaves and green grass and sedge as winter food. Damage to hay crops is occasionally detectable as the animals return for repeated grazing. The greatest amount of observed damage to oats was about a 2 per cent cutting of ripened stalks where the rabbits were estimated at one or two an acre.

In an epizootic of tularemia, whole counties may be almost depopulated of cottontails. The large hawks, often numerous then, arouse sportsmen who do not readily become aware of the hawks feeding largely on rabbit carrion on the highways and animals dead with tularemia in such periods of abundance. Foxes half-bury so many rabbits then that almost every hunter sees them and condemns the fox without realizing that the prey were disease victims. In other counties, areas of a few sections to several townships showing a great deal of tularemia may be interspersed between areas of relatively little disease incidence. And even an occasional entire county quite free of tularemia is sandwiched between others heavily diseased. Such strange interspersion adds to the perplexity of cottontail hunters and raises much skepticism until all the facts on predation and disease are considered. Other diseases and parasites such as the wart-disease, eye-disease, liver fluke, and flesh-fly may decrease rabbits on areas of varying extent and not be detected as causative agents of decimation except by very detailed observation in the field.

Heavy rains and floods may drive rabbits temporarily from an area and drown nestlings. The length of time such an area remains lightly populated depends upon how well neighboring animals are situated and the food and general cover conditions after the evacuations. Mud-covered grass and debris-filled thickets may remain unattractive a long time. Even though the conditions may not look bad to the observer, uncrowded rabbits in cleaner cover with more succulent fresh food may not adventure into the vacant spaces for some time. Small areas of good cover may be vacated by cottontails only temporarily when the animals are in mating activities in spring or are elsewhere in unfavorable weather at several times of the year. Unless such territories are visited several times, wrong population data are acquired.

In summary, good soil well-handled with interspersion of rotated cereal, legume and grass crops provides food, nesting and rearing cover, and some shelter, for cottontails. Gully, fence line, and terrace thickets at intervals of about 40 rods and farmstead shelterbelts provide escape and shelter cover. Soil well-covered with vegetation all through the year and moderately grazed pastures aid cottontails.

## DISCUSSION

VICE-CHAIRMAN BAUMGARTNER: Do you have any evidence that there is any sort of a definite period for these rises and falls that are associated with diseases, or is there any definite pattern?

DR. HENDRICKSON: The one that is probably most evident is the rise and fall with tularemia. During the tularemia epizootic (and epidemic we might say with people who got it from the rabbits) I worked closely with Dr. Jordan of the State Department of Health. Dr. Jordan went into the literature on tularemia and corresponded with all the state departments of health. As I recall now, in about 1928 there seemed to be a wave of tularemia in rabbits and in human beings which swept from the West to the East. Then a second heavy wave swept from the West to the East, the correspondence and somewhat meager data indicated in about 1938. So both Dr. Jordan and I would like to live at least until 1948 or 1949 to see whether or not it repeats. As you know, not every one of us in the United States is familiar with the fact that waves of human diseases come, as respiratory diseases do, in periods of years, so there may be periods in tularemia. But I think we haven't enough population data to speculate as to whether or not there are true cyclic phenomena in between these periods of heavy decimation. Those of you who are familiar with Dr. Herrington's literature of the last 2 years know that he has suggested we look for the true cyclic phenomena not at the peaks nor in the low periods brought on by adverse weather conditions or diseases, but rather that we look somewhere in between, and I think at least I haven't enough data to speculate on that very intelligently.

VICE-CHAIRMAN BAUMGARTNER: In that connection, we have had a rather peculiar situation in central Oklahoma. At least, it has been rather surprising to me. We had a terrific abundance of rabbits in '38 and '39, and then they died off almost completely. There was no evidence as to whether epizootic diseases were involved. There probably was, however. It came concurrent with the most prolonged period of cold weather in some 20 years, and peculiarly enough, rabbits have never built back in numbers to any great measure from that point on. There has been some increase, but it is an exceedingly uncommon species. Comparatively speaking there are plenty of rabbits, but they were exceedingly abundant at that time.

It was surprising to me that they stayed down that long.

CHAIRMAN EDMINSTER: I would like to ask if the cottontail is on the periphery of the cottontail range in Oklahoma. Don't you come pretty close to the edge there?

VICE-CHAIRMAN BAUMGARTNER: To some degree, yes. There are certain areas west of the area I am speaking of in the short grass plains where there aren't very many cottontails due to lack of cover, though there is pretty general distribution all over the state.

DR. HENDRICKSON: May I say at this point, that in Iowa, following the heavy die-off in February in the extremely cold weather of 1936, the rabbits bobbed back again to what was a peak population so far as I know, then in 1938 tularemia cut them down very low and they have been very slow in coming back.

I think they have not reached their peak number as yet and there is some possibility of their having gone down just a little bit around 1942 and then having gone up somewhat; but we had expected them to come back much faster than they did.

DR. THOMAS H. LANGLOIS (Ohio): I want merely to point out what I think is an unusual opportunity to make some detailed study of the carrying capacity of land.

As you know, I live on one of the islands in Lake Erie. There are cottontails on most of those islands and how they got there or how long they have been there, I don't know. We have seen them cross from one island to the other. So they do cross readily over the ice.

One of the islands, the one I want to talk about, is the West Sister which is about 15 miles west of the island I live on and has an area of perhaps a hundred acres. It is not a high island in the sense it does not rise very high out of the water.

It has a bed rock that is pretty close to the surface—about a foot to the maximum depth of the soil. There was a lighthouse on this island with a lighthouse keeper in 1925 and at that time they moved him away and installed an automatic light, and when he left apparently he just turned his domestic rabbits loose and at the present time there is the doggonedest hodgepodge of rabbits on that island you can imagine—blue, grey, brown, black, and some just look like ordinary cottontails. I do not know what the genetics are. The number is incredible.

We landed there twice last year. It is controlled by the Fish and Wildlife Service as a wildlife refuge. There is no hunting whatever. There is no one living on the island at all. There is about a 10-acre plot back of the lighthouse keeper's house. That is now overgrown with tall blue grass that just falls with its own weight. There are runways through that grass that look like wagon ruts with occasional burrows through the stuff where its two heavy runways run together at intervals.

As you land on the island you just see these pairs of ears looking at you from all directions, just a little ways away from you as you walk up on the island.

Our boys just made a little quick walk around and made a rough guess of the numbers. There were at least 500 rabbits on that island. We saw an occasional dead one. It is a dense population and it seems to me it does offer an opportunity to discover something about the carrying capacity of a definitely limited tract of land.

It's worth someone's attention.

DR. HENDRICKSON: I think that such an island situation is what we are all looking for. I feel rather confident that Dr. Langlois will see that it is carried further. In fact, we will want to hear about that from time to time, Dr. Langlois.

DR. LANGLOIS: It likely will involve the attention of a mammalogist. We don't happen to have any on our staff.

# THE PHEASANT DECLINE AND LAND-USE TRENDS, 1941-1946

DANIEL L. LEEDY AND EUGENE H. DUSTMAN

*The Ohio Cooperative Wildlife Research Unit*[1], *The Ohio State University, Ohio*

Pheasant population levels in Ohio following World War II had decreased by one third to one half of those levels attained during the 1938-1941 period. Similar decreases were reported in much of the pheasant range throughout the United States.

One of the reasons frequently advanced to explain this decline in pheasant numbers is land-use changes. It is well known that agricultural crops, and the weeds commonly associated with these crops, provide important elements of the pheasant's habitat in a considerable part of its American range. This paper does not purport to answer completely the question why the pheasant populations decreased. Its aim is to indicate certain relationships existing between cropping patterns and pheasant productivity, and to point out how the methods employed in harvesting agricultural crops affect pheasants both directly and indirectly through mortality, nesting losses, and habitat alterations.

## METHODS

The Ohio Cooperative Wildlife Research Unit employed extensive and intensive pheasant nesting studies, fall roadside pheasant counts, and hunter-kill reports in determining the relative status of pheasants in Ohio from 1938 to 1946. The assistance of many graduate and

[1]The Ohio Division of Conservation and Natural Resources, The Ohio State University, The U. S. Fish and Wildlife Service and The Wildlife Management Institute, cooperating.

undergraduate students in the extensive surveys is gratefully acknowledged. Much of the intensive study was done by Don H. Strode and the junior author on four square-mile sections of agricultural land in Wood County, Ohio, 1939 to 1941 inclusive, and during 1946. The farmer-interview method was used in the extensive nesting studies during the harvest seasons to obtain information concerning the numbers of nests observed in hay and grainfields. This information was verified and supplemented by personal observations made by Research Unit members working on the check areas. Since our information is most complete for Hancock, Hardin, Henry, Marion, Sandusky, and Wood Counties, Ohio, this report is particularly applicable to that part of the pheasant range.

## IMPORTANCE OF LAND-USE AND AGRICULTURAL CROPS TO PHEASANTS

*Food crops.*—In Ohio, corn, soybeans, wheat, oats, and the weeds commonly associated with these crops, such as smartweed (*Persicaria* spp.), lesser ragweed (*Ambrosia elatior*), rough pigweed (*Amaranthus retroflexus*), and foxtail grasses (*Chaetochloa* spp.), are important pheasant foods.

In the Ohio pheasant belt corn is available as food, in amounts varying with the manner of harvesting, throughout the winter and spring seasons or until the crop remnants are plowed or disced under. Preparatory to planting small grains the practice of discing has become more prevalent in some areas, thus leaving exposed waste corn that would ordinarily be covered up and inaccessible subsequent to plowing. Soybeans are an important pheasant food and, when combined, the waste may amount to as much as 14 per cent of the total crop. Unless the harvested fields are adjacent to suitable cover, the pheasants are exposed to predators in eating the waste beans. The beans deteriorate rapidly in wet weather and hence are not available in large numbers during the spring. Wheat fields are favorite feeding sites in the summer and early fall. The waste grain, which may amount to 6 per cent or more of the total yield when combined, is available until winter. The ragweed, so commonly found in wheat and oat stubble fields, remains until spring if not clipped off during the late summer. Wheat, planted in the fall, is a source of green food throughout the winter and is supplemented by oats planted in the spring. The insects, found so abundantly in hay and grain fields, are a valuable source of food, especially to the young pheasants.

*Cover.*—Probably more critical than food in the Ohio pheasant range, is the amount of suitable nesting cover available in close proximity to winter cover where pheasants are concentrated. Ideally, this cover should be of sufficient height and density at the beginning of the nesting season to be attractive to pheasants as a nesting site. To realize a high rate of pheasant productivity it should also remain undisturbed throughout the nesting season.

In Ohio, nesting studies indicated that approximately two thirds (64.2 per cent) of the pheasants nested in hay meadows during the years 1939 to 1941. Alfalfa, timothy and red, sweet and alsike clovers were the chief hay crops. The studies further indicated that, in spite of a high casualty rate resulting from haying operations, approximately 70 per cent of the pheasants produced on the study areas in the prewar period came from hayfield nests.

In 1946, on the same study areas, only 53.7 per cent of the nests were found in hay. During 1939 to 1941 an average of 12.4 per cent of the total area on the four square-mile study areas was devoted to hay crops. In 1946, only 7.4 per cent of the total area was in hay.

During the period from 1940 to 1945, the amount of hay grown in

TABLE 1. AGRICULTURAL CROP ACREAGES IN SIX OHIO COUNTIES, 1940 TO 1945[1]

| Kind of crop | Acreage in 1940 | Acreage in 1945 | Difference in acreage | Percentage of change |
|---|---|---|---|---|
| Hay .......... | 199,500 | 150,800 | minus 48,700 | 24.4 |
| Corn .......... | 376,200 | 395,200 | plus 19,000 | 5.0 |
| Wheat ........ | 206,600 | 238,900 | plus 32,300 | 15.6 |
| Oats .......... | 159,500 | 188,700 | plus 29,200 | 18.3 |
| Soybeans ...... | 143,400 | 256,600 | plus 113,200 | 78.9 |
| Total ..... | 1,085,200 | 1,230,200 | plus 145,000 | 13.4 |

[1]These counties, Hancock, Hardin, Henry, Marion, Sandusky, and Wood, lie in the Ohio pheasant belt.

six counties representing a cross section of the Ohio pheasant range was reduced almost one fourth. At the same time, the acreages devoted to the growing of corn, wheat, oats and soybeans were considerably increased. This information (Ray et al., 1943 and 1946) is summarized in Table 1.

The shift in crop acreages means that the amount of cover suitable for pheasant nesting has been considerably reduced. In addition to the decrease of 24.4 per cent in the amount of hay grown, many idle fields that formerly served as nesting areas were also put into row crops of relatively little value for pheasant nesting. Intensive nesting studies on four square miles in Wood County indicated that in equal areas of hay, wheat and oats, the ratio of pheasant nests in these cover types averaged about 100 to 10.7 to 10.0, respectively. The land devoted to hay crops on these four sections averaged 11.1 per cent of the total area and contained 61.6 per cent of all nests found. Contrasted with this, wheat crops occupied 12.9 per cent of the total area and yielded only 7.3 per cent of the nests; oat crops occupied 12.0

per cent of the area and produced only 6.8 per cent of the total nests found. Table 2 summarizes the information concerning nesting densities determined by four seasons of careful observations.

Pheasant nesting in soybeans is insignificant. There is practically no nesting in corn except for occasional early nests in the previous year's crop and these few nests are frequently plowed under before incubation has been completed.

Small grain stubble fields serve as suitable roosting, feeding, and loafing sites during the fall and winter months. Unclipped stubble left by combines is preferred to the shorter stubble left by binders. Corn that remains standing at the time of the hunting season provides good cover and affords considerable protection from hunters

TABLE 2. PHEASANT NESTING DENSITIES DETERMINED FOR THREE COVER TYPES ON WOOD COUNTY, OHIO, STUDY AREAS[1]

| Year | Cover types | Percentage of total area | Percentage of total nests | Nests found per 100 acres | Relative nesting density: 1 to 100 scale |
|---|---|---|---|---|---|
| 1939 | Hay | 13.8 | 63.5 | 100.0 | 100.0 |
| | Wheat | 13.0 | 5.9 | 9.7 | 9.7 |
| | Oats | 9.1 | 3.4 | 8.0 | 8.0 |
| 1940 | Hay | 14.1 | 67.8 | 100.3 | 100.0 |
| | Wheat | 10.5 | 4.3 | 8.4 | 8.4 |
| | Oats | 11.7 | 4.1 | 6.1 | 6.1 |
| 1941 | Hay | 9.3 | 61.4 | 100.9 | 100.0 |
| | Wheat | 12.5 | 9.7 | 16.5 | 16.4 |
| | Oats | 14.3 | 11.8 | 17.6 | 17.4 |
| 1946 | Hay | 7.4 | 53.7 | 78.8 | 100.0 |
| | Wheat | 15.4 | 9.4 | 6.6 | 8.4 |
| | Oats | 12.9 | 8.0 | 6.7 | 8.5 |

[1]The data summarized here are from intensive studies made on four sections (2,560 acres) of land in Wood County, Ohio.

who do not use dogs. Soybeans that remain standing during the hunting season also function as safety zones since those hunters who are considerate of the landowners will not hunt in the unharvested beans.

## IMPORTANCE OF HARVESTING METHODS TO PHEASANTS

Crop harvesting methods are of particular importance to pheasant production in that they affect the food and cover conditions and result in varying degrees of mortality. Many of these relationships have been pointed out by Leedy (1939), Randall (1940), and others.

*Effect on food and cover.*—Under Ohio conditions, the harvesting of corn by machine pickers is apparently more favorable to pheasant production than other methods. Much waste grain is left (often 200 or more pounds per acre) and stalks, although broken over by the machine, still provide considerable cover.

In 1936, over a large part of the Ohio pheasant range, about 10 per cent of the corn was picked. The remainder was cut and shocked preparatory to husking in the fall, or it was put into silos immediately, leaving but little food or cover in the field.

By 1939, field observations showed that approximately 50 per cent of the corn in western and northwestern Ohio was picked. In 1946, about 70 per cent of all corn in the better pheasant counties, and 50 per cent of the corn in the neighboring counties to the southeast, was picked.

In 1946, most of the picked corn was harvested by machine, whereas in 1938, about two thirds of the picked corn was harvested by hand. When the corn is picked by hand less waste is left in the field but the standing stalks provide better cover. The trend toward more corn picking is especially beneficial to pheasants in those border-line counties which previously lacked sufficient food for pheasants during the winter and early spring months.

A very high percentage of the soybeans now grown in Ohio is harvested by the combine method for beans rather than cut for hay. In 1936, according to Ray et al. (1943), the total soybean acreage in Ohio was 330,000 acres, of which 49.1 per cent was harvested for hay, 40.0 per cent for beans and 10.9 per cent for other purposes such as "hogging off" or turning under as green manure. In 1941, approximately 923,000 acres of soybeans were grown. Of these, approximately 24.0 per cent were harvested for hay, 73.0 per cent for grain, and only 3.0 per cent for other purposes. Since 1941 there has been a continued increase in the percentage of soybeans harvested for beans. This practice is favorable to pheasants in providing extra food, but does not compensate for the loss in valuable nesting cover due to increased acreages of beans grown in place of hay.

Since 1936 there has been a decided increase in the combine method of harvesting small grains such as wheat and oats. The shift to the combine method of harvesting is more favorable because of the increased height of the stubble left as cover, rather than for any increase in the amount of waste grain left available as food.

## HARVESTING ACTIVITIES AS A MORTALITY FACTOR

Two developments in hay harvesting methods have had an appreciable direct effect on pheasants in recent years. These are (1) the increased use of high speed mowers, either mounted on tractors or pulled by tractors and (2) the night-cutting of alfalfa for dehydrating mills.

Extensive nesting studies conducted annually in several counties of the Ohio pheasant belt indicated that 28 pheasants (predominately hens) were killed or crippled for every 100 pheasant nests mowed over in hay fields by farmers in 1938. By 1946, the pheasant casualty rate had increased to approximately 45 killed or crippled pheasants per 100 nests. This increase of more than 60 per cent has been due primarily to the increased use of power mowers. The losses do not include the loss of unhatched chicks in the nests destroyed or uncovered due to mowing. Practically all of the nests, in which incubation of the eggs has not been completed at the time of hay mowing, are unsuccessful.

Usually no more than 20 per cent of the pheasants nesting in alfalfa have completed incubation of their eggs prior to the first cutting of this crop. In other hay crops cut later, approximately 40 per cent of the chicks have hatched prior to mowing. The widespread use of new hay varieties with earlier maturity dates would be detrimental to pheasants because of earlier cutting dates accompanied by higher pheasant casualty rates. An early maturing variety of timothy (Huron) is now being grown on a small scale in Ohio but is not thus far of much significance in the pheasant belt.

Night mowing of alfalfa for dehydrating mills is becoming more prevalent, resulting in much higher casualty rates than day mowing. In Wood County, alone, more than 26,000 acres of alfalfa, representing three cuttings, were harvested for six dehydrating mills in 1946. In general, these mills operated on a 24-hour basis, and slightly less than one half of the cutting was done at night. The cutting extended from May 1 to the middle of September in 1946.

Careful counts made in a sample of 590 acres of alfalfa cut for these mills in 1946 revealed 106 adult female pheasants and 74 juvenile pheasants which had been killed by mowers. In addition, five adult hens and two juveniles were found crippled. A total of 193 other vertebrates, including 37 cottontail rabbits, were also found dead. Details of the mortality occurring in the 590 acres of alfalfa are given in Table 3.

With the increased abundance of tractors equipped with lights, more clover seed is now cut at night to prevent excessive shattering. When hay crops are harvested for seed, the cutting date is late enough that most of the nesting has been completed. When the seed is harvested during the day, very little pheasant mortality results. However, when the seed is harvested at night, many adult females and their young are killed as they roost in the fields.

Observations made in 99.5 acres of hay cut at night and in 191.5 acres of hay cut during the day, in the same localities (1940 and 1946), indicated that pheasant mortality due to mowing was about five times greater per 100 acres in the night-cut hay than in the day-cut hay. Obviously, any extensive shift toward the night-mowing of hay will be detrimental to pheasants. See Table 4 for a comparison of pheasant mortality rates according to night and day cutting of hay.

While pheasant casualties in hay meadows have increased during the past 8 years, the casualty rate in wheat fields has decreased. In 1938, approximately 12 pheasants were reported killed or crippled for

TABLE 3. PHEASANT MORTALITY OCCURRING IN 590 ACRES OF ALFALFA CUT FOR ALFALFA MILLS IN WOOD COUNTY, OHIO, 1946

| Time of day when cut | Number of cutting | Number of acres | Number of pheasants found dead | Number of nests found | Pheasants killed per 100 acres | Other vertebrates found dead | |
|---|---|---|---|---|---|---|---|
| Day and night | First | 331.4 | 68 hens<br>30 juveniles | 146 | 29.6 | Rabbit .........<br>Bobwhite quail...<br>Meadow mouse ..<br>White-footed mouse ........<br>House cat.......<br>Miscellaneous small birds.... | 20<br>1<br>64<br>5<br>1<br>10 |
| Day and night | Second | 128.0 | 10 hens<br>29 juveniles | 4 | 30.5 | Rabbit .........<br>Meadow mouse ..<br>Bobolink .......<br>Frog (*Rana pipiens*) ...... | 1<br>6<br>1<br>2 |
| Night | First | 8.0 | 7 hens | 12 | 87.5 | Rabbit .........<br>Meadow mouse ..<br>Muskrat ........ | 1<br>17<br>1 |
| Night | Second | 11.5 | 1 hen<br>12 juveniles | 0 | 113.0 | Rabbit .........<br>Meadow mouse ..<br>Meadow lark ....<br>Toad (*Bufo*).... | 8<br>2<br>3<br>1 |
| Day | First | 49.0 | 19 hens<br>2 juveniles | 21 | 42.9 | Rabbit .........<br>Meadow mouse ..<br>Meadow lark ....<br>Starling ........<br>Woodchuck .....<br>Frog ...........<br>Garter snake ...<br>Norway rat ..... | 6<br>36<br>1<br>1<br>1<br>1<br>1<br>1 |
| Day | Second | 62.5 | 1 hen<br>1 juvenile | 0 | 3.2 | Rabbit ......... | 1 |
| Total | Both cuttings | 590.4 | 106 hens<br>74 juveniles | 183 | 30.5 | Other Vertebrates ... | 193 |

every 100 pheasant nests cut over in the wheat harvest. In 1946, wheat harvesting activities accounted for only 3 casualties per 100 nests cut over according to farmers interviewed in the extensive nesting study.

This decreased casualty rate has been due primarily to the increased use of combines in harvesting the wheat. In 1938, approximately 20 per cent of the wheat was combined, but in 1946, more than 80 per cent was combined. Thus, the decreased pheasant casualty rate in the wheat harvest was inversely proportional to the increased percentage of wheat harvested by the combine method.

When wheat is combined, the harvest date is about 10 days later than when it is cut by binder. The later date allows many hens to complete their incubation and escape injury or death.

In 1939, for example, only 57.3 per cent of the nests reported in binder cut wheat had hatched at the time of wheat cutting, compared with 75.0 per cent of the nests in combined wheat. In wheat the percentage of all nests that had hatched before the harvest date increased from 61.1 in 1939 to 79.4 in 1940 to 93.5 in 1946.

In addition to the later cutting date, when wheat is combined, the cutterbar of the combine is usually set much higher than that of

TABLE 4. COMPARISON OF PHEASANT MORTALITY RATES IN DAY VERSUS NIGHT CUTTING OF HAY

| Year | Type of hay | Time when cut | Number of acres | Number of pheasants found dead | Number of nests found | Pheasants found dead per 100 acres |
|---|---|---|---|---|---|---|
| 1940 | Sweet clover (seed) | Night | 80.0 | 22 | 33 | 27.5 |
| | Sweet clover (seed) | Day | 57.0 | 3 | 16 | 5.3 |
| 1946 | Alfalfa | Night | 19.5 | 20 | 12 | 102.6 |
| | Alfalfa | Day | 111.5 | 23 | 21 | 20.6 |

a binder thereby passing above the pheasants that ordinarily are killed by the binder.

The reported pheasant casualty rates in hay and wheat harvesting are shown graphically in Figure 1.

## EFFECTS OF MISCELLANEOUS AGRICULTURAL PRACTICES ON PHEASANT PRODUCTIVITY

Among other agricultural practices related to pheasant production are small grain stubble clipping and fall plowing. Considering the State of Ohio as a whole, the clipping of wheat and oat stubble fields has not increased appreciably since 1940 when approximately 20 per cent of the fields were clipped. However, at the time of the 1946 September pheasant roadside survey only 39.3 per cent of the stubble remained standing, whereas 34.2 per cent had been clipped and 26.5 per cent had been plowed in six pheasant belt counties. The net result in this area is a reduction in the amount of winter cover and food afforded by small grain stubble fields.

Stubble clipping also has a detrimental effect on the suitability of the fields for nesting the following spring, at which time these same fields are frequently in hay.

Nesting studies were made in 16 hayfields in which the grain stubble had been clipped the previous fall and in 19 fields in which the stubble had not been clipped. In the "clipped fields," 93.7 nests were

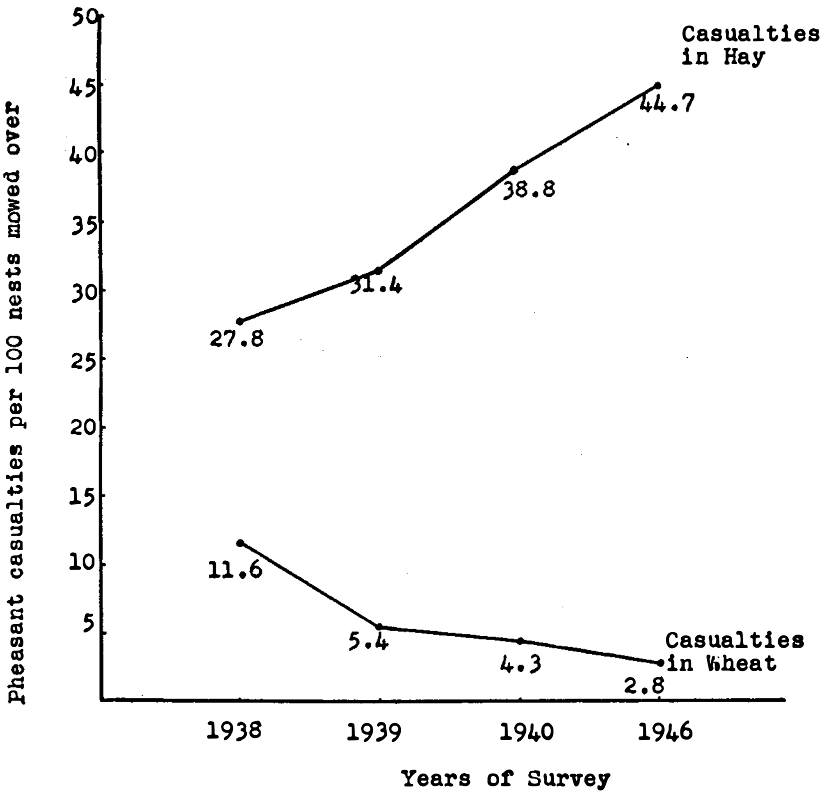


Figure 1. Pheasant casualties reported by farmers in cutting hay and wheat

found per 100 acres and approximately 34 per cent of all eggs laid were successfully hatched. In the "unclipped fields," 187.9 nests were found per 100 acres and approximately 45 per cent of all eggs laid were successfully hatched.

In 1946, all but one stubble field on the four square-mile study areas had been clipped prior to the nesting season. The exception was a field of 8.3 acres, only a portion of which had been clipped.

Eight nests were found in this field, seven of them occurring in the unclipped part, which constituted less than one half of the total acreage.

Fall clipping of the stubble decreases the amount of cover in hayfields during the early part of the nesting season when, apparently, the new growth of hay still lacks sufficient height and density to provide suitable cover itself. Stubble clipping also decreases the amount of nesting material available for building nests.

Pheasant nesting density and nesting success in previously clipped and unclipped fields are summarized in Table 5.

Along with the increased amount of small grain stubble clipping, the amount of fall plowing has also increased. Apparently, some of the 15.6 per cent increase in acreage of wheat is put into fields which previously would have been hay following the oat crop. Plowing of

TABLE 5. APPARENT EFFECT OF STUBBLE CLIPPING ON PHEASANT NESTING IN HAYFIELDS, 1940 AND 1941[1]

| Year | Fields clipped or unclipped | Number of fields examined for nests | Number of acres examined | Number of nests per 100 acres of hay | Percentage of nests successful | Percentage of eggs that hatched |
|---|---|---|---|---|---|---|
| 1940 | Clipped | 9 | 114.5 | 83.8 | 27.1 | 30.8 |
| | Unclipped | 7 | 52.0 | 194.2 | 35.6 | 38.3 |
| 1941 | Clipped | 7 | 69.0 | 110.1 | 38.2 | 38.8 |
| | Unclipped | 12 | 88.0 | 184.1 | 42.0 | 51.1 |
| 2 yrs. total | Clipped | 16 | 183.5 | 93.7 | 32.0 | 34.2 |
| | Unclipped | 19 | 140.0 | 187.9 | 39.5 | 45.5 |

[1]Clipped fields refer to those small grainfields seeded to hay which were clipped in the fall after the grain harvest, as compared with fields in which the grain stubble was permitted to stand. All fields were in Wood County.

these fields for winter wheat obviously does away with the winter cover previously available in the form of oat stubble as well as the next year's hay crop which otherwise would be available for pheasant nesting.

## CONCLUSIONS

Recent trends in agricultural land-use and harvesting methods in the Ohio pheasant territory are analyzed, and their probable effects on pheasant productivity are indicated. More food has been made available through increased acreages of wheat, soybeans, oats, and corn, and the increased percentage of the latter crop currently harvested by machine pickers. The increased amount of food, however, has not compensated for the loss of nesting areas due to a decrease of 24.4 per cent in hay crops and to a reduction in the number of idle fields formerly used for nesting.

Pheasant mortality rates in the hay harvest increased more than 60 per cent from 1938 to 1946 due chiefly to the increased use of tractor-drawn and power mowers. Night mowing of alfalfa for dehydrating mills is becoming more prevalent and, in study areas, resulted in about five times more pheasant casualties per 100 acres of hay than day time mowing.

The practices of "clipping" and plowing small grain stubble fields are becoming increasingly prevalent. Clipping the stubble reduces the amount of fall and winter cover available, decreases the amount of food and apparently decreases the attractiveness of the cover in the next year's hay crops for pheasant nesting.

Pheasant casualties in the wheat harvest are only one fourth as high as they were in 1938 due chiefly to the increased use of combines (20 per cent in 1938, 80 per cent in 1946). Combined small grains are cut later in the season than binder cut grains and higher stubble is left. The later cutting dates reduce casualty rates, and the higher stubble provides better fall and winter pheasant cover.

When balanced against each other, the trends unfavorable to pheasant production would appear to far outweigh the favorable trends, and undoubtedly have contributed, along with other factors, to the decline of pheasants in Ohio.

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## DISCUSSION

MR. BEN GLADING (California): Dr. Leedy, have you found any tendency for this killing of young chicks to be concentrated toward the last one or two rows of the field?

DR. LEEDY: No, they have been fairly well distributed throughout the field.

MR. GLADING: Is that true in alfalfa as well as clover?

DR. LEEDY: Yes.

MR. GLADING: The reason I asked, the results that you give are very similar to those that Mr. Howard Twining of our Pittman-Robertson pheasant study is finding now in alfalfa fields in California. He has noticed quite a heavy tendency for chicks to be caught in the third mowing. When they kill chicks there, they seem to be concentrated in the last row. The reason I bring that up is that it will probably give some clue to reducing this damage that we have never been able to reduce, particularly with high-speed mowers.

DR. LEEDY: That's very interesting.

MR. ELLIOTT S. BARKER (New Mexico): Have you experimented with the use of flushing bars to eliminate this?

DR. LEEDY: We have done very little with that. We believe that is our next step because when you think that perhaps 50 per cent of the hen pheasants nesting in alfalfa are killed, that is quite a serious loss, and we want to try to do something about it.

MR. EARNEST POWELL (Texas): What has been done to provide suitable nesting cover for the pheasants outside of grain and hay fields?

DR. LEEDY: Practically nothing.

MR. POWELL: Do you think that is a possible solution for this high mortality in mowing and in harvesting grain?

DR. LEEDY: That is one of our recommendations—to try to establish suitable nesting cover in the form of hay because that is one of the best nesting covers we know of. We want to do this even though it might mean paying farmers a little bit for leaving hay. We think it's worth while.

CHAIRMAN EDMINSTER: I would like to ask you, Dan, whether you have had experience in areas where intensive soil conservation work has been done. In farm planning for soil conservation they establish such practices as sod head lands, terraces, and diversion terraces which are in hay. They are ordinarily cut only once a year, and farmers delay the mowing of these outlets and water courses. In this way they do get a better distribution of hay cover that is less intensively mowed than regular hay fields.

DR. LEEDY: Unfortunately in Ohio in the better pheasant territory, very little work has been done along that line, but we think it would show good results.

MR. GLADING: My question is part in answer to the gentleman from Texas. Most of this agricultural land, I believe, in Ohio—I certainly know in California—is of such high value that to lease any portion of it for pheasant use is almost economically impossible.

If you are going to produce only a certain amount of pheasants per acre and that land is worth many, many dollars per acre, keeping any part of it for pure pheasant production will cost the farmer or state game department through the pocket a great deal of money, and it is a question economically: Are pheasants worth that much?

MR. HARRY D. RUHL (Michigan): I don't want to be discouraging, but we tried the flushing bar. So far we haven't been successful. I hope you are more ingenious than we are. Keep at it. If you get something, let us know. In Michigan there has been a great increase in unpastured areas which were not cut. We had a similar decrease in pheasant population there.

# MARYLAND'S COOPERATIVE FARM-GAME PROGRAM WITH SOIL CONSERVATION DISTRICTS

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In the past there has been much discussion on the degree of successes and failures of various farmer-sportsman cooperatives. This paper is concerned with how Maryland has accepted these successes and failures and finally evolved a workable program.

Many leading conservationists have pointed out at our wildlife conferences that farmer-sportsman cooperatives have in the main failed because of one or both of two basic reasons. First, cooperatives have been directed toward game benefits rather than toward the interdependence of farm resources. By and large, sportsmen have failed to show farmers that benefits from game management alone would be commensurate with the money and effort expended through the sale of hunting privileges, through the sale of produce and services to the sporting public, through the protection of the farmers' property rights, through any profound demonstration that game bird activities actually reduce the prevalence of weeds and insects, and many other such narrow margined incentives. Second, the farmers seldom have been full partners in the cooperatives, which in most cases lacked leadership or direction in management practices. Generally, the state has accepted the responsibility of setting up the organizational machinery, soliciting cooperators, furnishing the required materials, and quite often supplying services in posting, fencing, and patrolling. Invariably this practice has become too costly before any actual improvement has been done for game habitat improvement. Along with such costs have been expensive artificial propagation and importation of game with the farmer standing by, displaying no vital interest as to the results of such artificiality.

If these two reasons are the basis for the failure of farmer-sportsman cooperatives, then what are the essential requirements for a successful program? First, as Edminster (1940) has so aptly stated, "It must be a logical part of a broader conservation job, an action which is so fundamental to the farmer's future well-being that the permanency of the whole is firmly established." Second, it must tie in with an active farm organization interested in the conservation of farm resources; it must supply a field force capable of furnishing technical and practical knowledge concerning land-use and management practices. In synchronizing with this farm organization, the program must function at a low cost per acre for administrative expenses so that the expenditures of game funds may be applied directly to actual improvement for wildlife.

Those requirements are being applied in the Maryland program through cooperative agreements with soil conservation districts. Most of you know and appreciate the soil conservation districts program, but may I digress a moment and give a brief history of its movement in Maryland. In 1937, the Legislature passed the Soil Conservation Districts Law without a dissenting vote. That law provided for the setting up of a State Soil Conservation Committee under the Board of Regents of the University of Maryland and the Maryland State Board of Agriculture, and directed the committee to aid in the formation of districts by the farmers as legal subdivisions of the state. The committee was directed and does appoint two district supervisors who file application with the Secretary of State for a certificate of incorporation. An election is held at which the landowners in the district choose three supervisors to serve with the two district supervisors appointed by the state committee. The county agriculture extension agent, who is the accepted educational leader in organization and functioning of districts, usually acts as secretary. The board of supervisors is charged with the responsibility of formulating an over-all program for the district and may enlist the aid of the U. S. Soil Conservation Service, the Extension Service, the State Board of Natural Resources, representatives of the vocational agriculture department of nearby high schools, and any and all other agencies.

Thus, the Maryland Conservation Districts Law puts the job and the responsibility in the hands of the landowners and operators. It also provides a legally organized channel to coordinate the activities of local, state, federal, public and private agencies without duplication or overlapping and without waste of effort or funds.

With such democratic and active farm organizations in the various districts, Mr. Ernest A. Vaughn, newly appointed State Game Warden, realized that here rested the essential requirements for a statewide farm-game program. In April 1946, a memorandum of understanding was drawn up for presentation to the soil conservation districts whereby the Maryland Game and Inland Fish Commission would, consistent with statutory authority and available resources and in accordance with regulations, cooperate with and assist the various districts in carrying on wildlife restoration work. Such assistance was to be given in accordance with the plans, specifications, and estimates of Federal Aid Project Maryland 18-D (the Pittman-Robertson Act as applicable to the State of Maryland), or by other appropriate arrangements to be entered into between the districts and the Commission.

Of the 22 soil conservation districts, covering 21 of the 23 counties, 20 such agreements have been presented to the supervisors and approved. Upon approval, a wildlife technician is designated for the district and works side by side with the Soil Conservation Service technician and the farmer in formulating a complete farm land-use and management program. In consenting to carry out the wildlife phase of the program, the farmer agrees to cooperate in the development and maintenance of a food, cover, and nesting unit for wildlife on the lands described in the farm-district cooperative agreement; to allow the Maryland Game and Inland Fish Commission to close a minimum of 5 acres on his farm as a wildlife refuge for a period of 5 years and to permit hunting on the remainder of his farm under such rules and regulations as he imposed upon hunters prior to this agreement; to take reasonable care to prevent damage to the refuge area by fire and to prevent domestic stock from grazing on said area; to plant wildlife borders or food patches as recommended by the Soil Conservation Service and approved by the Game and Inland Fish Commission; to see that all acceptable den trees be preserved for tree dwelling animals and birds; and to aid in the fencing and posting of the refuge area.

To aid the farmer, the District and the Commission agree to furnish technical assistance and a wildlife management plan; to supply all seeds, vines, shrubs, and trees that are unobtainable from the Soil Conservation Service nurseries which may be required to be planted for wildlife food and cover; to supply refuge boundary line wire, posts, and signs; to furnish supervision and a portion of the labor required to construct boundary lines, erect fences, and establish wildlife plantings on the refuge areas; to assume entire responsibility for the protection of wildlife and patrol of refuges; and to do such stocking of birds and animals as may be necessary.

The assistance to the farmer is more technical and educational than it is strictly tangible. The main idea is to not remove the responsibility from the individual landowner or the community.

Including the wildlife conservation measures mentioned, the districts have employed over 30 soil conservation practices—which are directly or indirectly beneficial to wildlife—to fit the widely varying conditions of soil, topography, climate, erosion, and type of agriculture found in Maryland. Time will not permit discussion of all these practices; however, I would like to point out the more obvious ones and give a few figures on the amount of such work accomplished up to December 15, 1946, with the Game and Inland Fish Commission assisting since April 1946.

More than 4,000 farmers are cooperators with the soil conservation districts. They operate nearly 700,000 of the approximately 7,000,000 acres of land in Maryland, of which more than 4,000,000 acres are in farmlands. Those cooperators have put close to 2,000 acres into wildlife refuge and management areas, and nearly 3,000 acres in food- and cover-producing shrubs, grasses, and legumes on gall-spots, eroding field boarders, woodland borders, and gullies.

One of the activities of greatest importance to wildlife welfare has been the elimination of domestic stock grazing from over 24,000 acres of woodland and wildlife areas. This measure has been particularly impressive in the dairying section of central Maryland where the farmers have made it a practice to turn their cattle into woodlots and to overgraze steep hillsides. In addition, more than 17,000 acres of woodland improvement and harvest cutting have been done, especially in the mountainous section of western Maryland.

Strip cropping is another soil conservation practice that has greatly increased the interspersion of different food and cover types for farm wildlife. This operation is becoming increasingly popular in the dairy-grain area of central and the tobacco section of southern Maryland where more than 34,000 acres have been given this treatment.

Drainage of quality cropland is the main conservation problem on the eastern shore, and more than 2,000,000 lineal feet of ditches have been constructed. The spoil banks of those ditches have been developed to prevent erosion and to serve wildlife as a network of travel lanes over the many farms.

Landowners are giving considerable attention to the construction and development of farm ponds. Only 27 ponds have been built to date, but the measure is gaining momentum. The effect ponds will have on wildlife, if properly developed, is too obvious to need elaboration.

We believe that most of the soil conservation operations and others which benefit wildlife represent a great advancement. In themselves, however, they become too unstable over a period of years to produce annual wildlife crops. Therefore, the nucleus of the whole wildlife management program is centered in the farm-game refuge areas providing permanently for the conservation of the various forms of wildlife. Through this plan, we hope wildlife management will become as permanent a part of the farm program as is woodland management, contour strip cropping, and others.

Much more could be said about the many conservation measures. However, I hope that this brief sketch will give you an idea of how the cooperative program is being worked with the farmers.

In addition to working with the farmers, the districts are cooperating with the Commission in establishing demonstration farm-game refuges which are being sponsored by the various schools, 4-H clubs, church groups, Izaak Walton League chapters, and other conservation organizations. Those groups receive instructions and wildlife management plans from the Soil Conservation Service and the Commission's technicians, and subsequently put their knowledge to actual use in developing the refuge areas. Such projects are of tremendous educational value as well as getting a job done. The demonstration program has its greatest impetus in Montgomery County and has a tendency to become state-wide.

In conclusion, may I say that we are not able to give any large-scale results as yet—the program has just started. Nevertheless, we think we are on a solid foundation and are headed in the right direction. The Maryland Cooperative Farm-Game Program is proving successful because it is not a goal in itself, but a part of an integrated farm resources program; and because it is backed by active soil conservation districts, which have caught the spirit of real conservation—the desire to improve and increase all resources for the general welfare of all the people in Maryland.

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## DISCUSSION

MR. T. H. HOLDER (Arkansas): What motivates the farmers in Maryland to cooperate in this program? Is it the game? Is it restoration of soil conservation?

MR. KING: This is an integrated program. It has wildlife as one spoke in the whole wheel of an over-all conservation program and all phases of the conservation program that wildlife fits into are there. Of course, the farmers, some of them, may be interested in the wildlife phase; others may be interested in contour stripping and terracing farms—whatever it may be, I think what we have done in the past in the conservation movement is to try to force ourselves in the front door. Actually, we should use any program that gets the farmer in the conservation picture, start from that end and eventually work up to what we want.

# REVIEWING EIGHT-YEARS OPERATION OF A WILDLIFE EXPERIMENT STATION

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After a year of preliminary planning, land optioning, clearing titles, and securing possession of the first 765 acres, the Rose Lake Wildlife Experiment Station was established by the Game Division of the Michigan Department of Conservation in 1938. The over-all objective was to develop practical methods for the management of wildlife on the agricultural lands of southern Michigan. Since the implications of this objective are broad, certain phases were to be given special emphasis, and several definite minor objectives were set up as a goal toward which the station should work. The objectives were as follows:

1. To evolve economical techniques for increasing the harvestable game and fur on farmlands
2. To determine the true relationships of wildlife to farm crops and practices, and to provide remedial measures for crop damage
3. To establish management demonstrations on state land where their continuance could be reasonably insured, and to encourage wildlife management for the widest possible public use
4. To study the management of southern Michigan wildlife for its recreational value to the landowner and to the general public
5. To develop field techniques for determining population levels and making habitat analyses for farm wildlife on a state-wide basis
6. To provide a training station for field men in the use of management methods
7. To cooperate in every practical way with agencies and individuals interested in or working toward the better management and utilization of wildlife resources
8. To put the Department in the position of a farmer, and to appreciate and understand more fully the landowner's point of view, particularly the economics of suggested farming modifications
9. To test and evaluate action programs suggested by sportsmen
10. To provide yardsticks and factual bases for making regulations relating to state-wide wildlife management

Before examining our progress towards these objectives, a short description of the experiment station property and operation is in order. The station is located 12 miles northeast of Lansing and 9 miles northeast of the Michigan State College of Agriculture and Applied Science at East Lansing.

The area was selected after extensive soil and cover inventories, and with many considerations in mind. It was thought that selection of an area reasonably close to the Michigan State College and the central offices of the state departments would be desirable because their facilities would be accessible, and advice from the many state and college specialists could be obtained when needed. Experimental game facilities close to the College would tend to encourage graduate work on practical game problems and help instructors and students to understand the needs and opportunities of the wildlife profession. Accessibility to those visiting the College would tend to integrate the farm-game extension program with that ordinarily promoted by the county agricultural agent system.

The experiment station is located almost entirely on a glacial moraine, with the customary mixture of lakes, swamps, ridges, and hollows.

Small kames and eskers exist. The soils of the area are a complex pattern of sands and clays, with some peat deposits. Bellefontaine, Hillsdale, and Miami loams are characteristic of the rolling upland, with Carlisle and Houghton muck in the depressions. Secondary in extent are such types as Coloma sand, Washtenaw loam, and Brookston loam.

In its virgin state the area was of only moderate fertility.

The most advanced type of vegetation on the Rose Lake area is oak-hickory woodland. Black, white, and red oaks are common, with a scattering of bitter-nut, pig-nut, and shag-bark hickories. The lowland woods type in the depressions and stream bottoms is the usual black and white ash, red maple, and American elm. Undrained, or recently drained areas contain much tamarack.

Homesteading began here in 1837. Injudicious land-use practices followed soon, and many of the ravines and steep slopes were cleared of their protective forest cover. Curiously enough, many woodlots were allowed to remain on lovel sites with equally good soils where cultivated crops could have been grown most advantageously.

Soil fertility had been reduced by intensive cropping. Sheet erosion and gullying resulted from improper cultivation and overgrazing of slopes. As much as 3 feet of topsoil had been removed from the steepest hillsides. These methods of land use account in large measure for the generally reduced property values and rundown condition of many farms in the vicinity

One of the early readjustments after the station was established was to set up a new farming program. The U. S. Soil Conservation Service and agricultural authorities at Michigan State College were asked to suggest land-use practices which they thought should be employed on the main agricultural block of the station. A comprehensive 5-year program for land use was worked out which has been put into practice in so far as man power has been available for the purpose. Many of the geometrically-arranged fences were removed. The steeper cultivated slopes were set aside for future woodlots or other types of permanent planting. The intermediate slopes and poorer soils were allocated to a longer rotation involving semi-permanent pasturing. The level or gently sloping areas with fair to good soils were to be used for short-rotation, cultivated crops. Swales and woodlots were retained even though the land was suited for cropland.

Under these conditions, the average farmer probably should keep a large dairy herd and other stock, however, to reduce labor needed, yet accomplish the same land-use objective, a beef herd was substituted. A small number of horses and poultry are kept.

Under the original program, the central block of land, which includes most of the better agricultural soils, was to be operated as an efficient farm, with no special practices to aid wildlife, other than those which any farmer might employ without too much extra expense.

A second area adjacent to the agricultural block was to be used for such things as special plantings, brushpiles, and artificial dens, regardless of whether or not they would be practical for ordinary farm usage. Outlying areas, mostly rough in topography, with inferior soils, were to be used in working out game-management measures applicable to large areas of submarginal land purchased for public hunting and recreation in southern Michigan. A long-term program for woodlot management was set up for woodlots on each of the areas mentioned.

Early in 1939 series of traplines were established over the experiment station area, and box traps have been operated much of the time since then. This work has provided a fair inventory of rabbits, squirrels, woodchucks, skunks, and raccoons. Man-drives and bird-dog censuses have been used for calculating pheasant numbers, and crowing-cock counts have been made in the spring. Routine observations have been made and recorded for nearly all types of wildlife, both game and nongame.

A system of camera points was established, and, except for the war years, pictures were taken four times each year to give a visual record of annual and seasonal changes for typical situations.

Since the final test of any game management program is the gain or loss of game taken by the hunter, the Rose Lake Experiment Station has been open to hunting during the legal season. No attempt has been made, as yet, to limit the *number* of hunters, although some attempt has been made to regulate the *distribution* of hunters. For convenience in handling the hunting situation, the station property has been divided into six hunting areas, using roads or line fences for boundaries in so far as possible. Each area is then posted with signs, uniform as to size, shape, and wording, but differing in color. All hunters must first report at the station headquarters and fill out a standard card. A hunter is allowed to choose the area where he wishes to hunt unless that area is crowded with hunters at the time, in which case he is assigned to another area. He is given a permit card colored like the area boundary signs and starts his hunt. He must not hunt on a different area until he has returned his completed report card to the headquarters and his game, if any, has been weighed, measured, and checked for such things as locality of kill, age, condition, and tag number. Then the hunter may start another hunt with a new permit if he wishes. In this way a record is obtained from every hunter as to the game seen or killed on each portion of the station, to supplement and complete the station records.

We have not experienced undue depredations or destruction of property by hunters, and we do not know of any instances where the use of the area by hunters, hikers, or nature lovers has seriously interfered with any of the experiments. A few minor instances of carelessness have been observed but they are not of any great significance.

We believe game hogs and violators are likely to avoid the area, preferring to hunt where there are more pheasants, fewer hunters, and less likelihood of apprehension than at the station.

Several thousand individual hunters have taken advantage of the Rose Lake hunting facilities for over 8,000 man-days of sport. They have killed 1,600 cottontail rabbits, 583 fox squirrels, and 974 pheasants.

Banding records show that about 1,400 cottontails, 1,400 fox squirrels, 400 pheasants, 196 woodchucks, 148 raccoons, 216 opossums, 115 skunks, 117 weasels, 5 badgers, 1 fox, and a considerable number of smaller animals such as chipmunks, spermophiles, mice, and voles, have been live-trapped, tagged, and released on the station area. Many of the banded animals have been retrapped.

One book and 17 other publications have been written by evperiment station personnel. In addition, many short magazine articles and newspaper items have issued from station sources. Some of these have been very well received by the public, and have, we believe, aided the Michigan Conservation Department in its work.

We are not, however, satisfied that we are attaining all of the objectives set up in the original program. We are not able to say to a Michigan farmer, "If you will do thus and so, at a cost of about so many dollars, you can increase your pheasants, rabbits, or fox squirrels by such a percentage, or by about so many individuals.'' Perhaps this is asking too much.

On many farms we can tell the owner how we think he *ought* to be able to increase wildlife, but we cannot show conclusively that a specific practice or installation alone has given measured results. Hence, our advice is merely advice, to be weighed and measured by the listener or reader alongside of advice received from other sources. Our advice *should* be better than average, for we have put in more work and study than the average, *but,* we cannot, as yet, offer definite proof and demonstration to nail down our statements unqualifiedly. We have not turned out all of the products hoped for, but we have accumulated much information and turned up a lot of interesting by-products.

Some of these by-products are of considerable importance, and perhaps a few examples will illustrate their value. Our investigators, after several years of watching the cock pheasants at Rose Lake take a terrific ''beating'' during the fall hunting season and still maintain a satisfactory sex ratio for the next spring breeding, are agreed that with any reasonable amount of hunting during an open season, *you can't shoot them out.* This holds for the Rose Lake area, which is characteristic of much of southern Michigan, and, we suspect, of many areas in other states as well. At Rose Lake we have a hunting pressure up to five times that experienced on surrounding privately owned farms where farmers and sportsmen often think that the pheasants are being overhunted. Yet, the Rose Lake pheasant sex ratio remains nearly the same, and the pheasant population remains about the same, as they are on the adjacent areas where the hunting pressure is one fifth as great.

This is very useful information to refute the complaint of hunters that ''all the cocks have been shot out and that cocks must be planted or no breeding will occur next spring.'' We can advise hunters to go out and hunt pheasants with a clear conscience. As long as they kill only cocks in season, they need not worry about eliminating their own sport through overhunting.

The Rose Lake pheasant harvest closely follows the pattern of 70 per cent of the total kill taken the first week, 20 per cent the second week, and 10 per cent the third week. This gives a guide for estimating the probable increase in pheasant kill if the season were to be lengthened.

It has been determined that half the nest boxes erected are used by fox squirrels. Brushpiles are readily used by rabbits, particularly in winter. We believe that the station has demonstrated that such devices will hold these animals on many areas, and that, in those instances, they probably raise the total production even though we cannot conclusively prove that some of these animals were not drawn to the area with corresponding reduction of population on adjacent lands.

For the last 8 years quail, which are completely protected, declined in about the same numbers at the station as did pheasants.

A 120-acre sanctuary consistently protected a limited number of cock pheasants. When it was opened to hunting in 1946, the total station kill did not materially increase. Since the yield on the sanctuary compared closely with that of similar adjacent areas which had been hunted heavily each year, we concluded that sanctuaries for pheasants under the Rose Lake conditions were not necessary.

The station work, together with reports from observers in other parts of the state, is the basis for our conclusion that it is not necessary to provide artificial feed or to put out food patches in order for pheasants to survive the winter, with the possible exception of a combination of unusually severe conditions which might be expected perhaps once in 20 years. During the operation of the station, at any rate, we have not observed such a condition. Yet we cannot prove that better feeding conditions through the winter might not permit birds to lay larger clutches, make a better hatch, or carry through more chicks to the fall season.

The scarcity of observed predations on game species in relation to the amount of opportunity for observation leaves an impression that predators are not a primary factor in causing the low pheasant population on the station. Perhaps it is what escapes attention that is more important. Our evidence, therefore, is not completely conclusive that predation is not an important factor.

A station study of the effects of grazing on woodlots in relation to squirrel populations indicated that grazing, perhaps for a 10-year period, might be beneficial to fox squirrels. Apparently, the reduction of heavy brush undergrowth tended to reduce the populations of red squirrels and chipmunks, and to increase the fox squirrel populations. It is evident, however, that continued grazing and normal fuel use of the farm woodlot would eventually destroy the woodlot. We have not, as yet, been able to determine on an experimental basis how to reconcile those two tendencies or how to combine them in some sequence or rotation which would increase fox squirrel production and also sustain the oak-hickory woodlands.

These are a few of the by-products which we feel are very useful in considering current suggestions and theoretical urgings of sportsmen. In many cases, some policy or attitude must be expressed by the administrator before there is time for further experimentation or testing. While we might desire to anticipate all such pressures and suggestions far enough in advance to set up satisfactory tests, we doubt whether that will be possible. Any backlog of specific, detailed, interrelated facts relating to such a question is of more value than its purely scientific conclusiveness would indicate.

The war and its accompanying economic disturbances certainly put the program behind schedule. Our biologists happened to be young, able-bodied men, and every one was taken into the armed services. We still find it difficult to compete with the high wages paid by near-by industries for farm labor.

During the war we were forced to reduce farming operations to an absolute minimum, seeding most of the fields to grasses and legumes. This, in turn, upset the wildlife program by changing the amount and proportion of the various crops.

The station has proved an excellent training ground for young biologists. Increase in the Game Division technical staff and the development of a district game supervisor system throughout the state has increased station personnel turnover. Continuity of personnel on projects and problems has been difficult to maintain.

We believe our disappointments are due principally to difficulties inherent in the job we are trying to do, and possibly to our lack of imagination in developing techniques to overcome these difficulties. For instance, we are not satisfied as yet with our methods of evaluating results obtained from each separate experiment. The scientific method *requires* adequate controls against which every experiment is checked. In wildlife management this has proved to be as elusive as a will-o'-the-wisp, and the Rose Lake Station is no exception to the rule.

Has the Rose Lake Wildlife Experiment Station sold itself to the Conservation Department, the sportsmen, the farmers? The Conservation Commission has changed membership considerably in the past 8 years, and some of the newer members probably are not entirely familiar with the station, its accomplishments and its objectives.

Leading sportsmen who read conservation literature or attend state meetings, as well as those who visit the station, generally are pretty well acquainted with, and in sympathy with, the station program. Many farmers either have never heard of the station, or are largely indifferent to it.

One might ask whether the purchase of nearly 3,000 acres of land in order to insure stability of farm-game research projects can be justified. Could the same money have been used more efficiently by conducting the same experiments on privately owned farm land so that the investment in land and equipment and any farm operating deficit would not have been necessary? We feel confident that public ownership of a nucleus of two or three thousand acres of agricultural land on which the long-time and expensive installations are tested and where continuity is insured is justified even though additional projects on private land are needed to supplement and round out the program.

We believe farm leadership may have confidence in the Department's game management suggestions which have been tested at the station because farming is also a station responsibility.

We see no reason to be discouraged. By facing our problems frankly, and by re-aligning our programs from time to time we can make the station still more useful to the people of Michigan. Much of the physical groundwork has been laid, fundamental ecological knowledge has been accumulated, routines of procedures in the field and in the office have been established, and trained man power will soon be more plentiful. We intend to intensify the effort to test and demonstrate the effect of many farm practices on wildlife and to develop usable methods of modifying farm habitats to encourage game.

## DISCUSSION

Mr. W. L. Johns: (South Dakota): We in South Dakota are very much interested in this particular topic. We have a lot of pheasants up there. I think last year we estimated that they took 7,500,000 birds out of our state and because of a poor hatch the last 2 years, we haven't so many birds left. But we do have sufficient for breeding stock.

There is considerable agitation in the state now for game farms; in fact, so much, one member of our legislature, which is in session now, has put in a bill that would make it possible to have some game farms in Sonth Dakota.

Now, we are open-minded up there. We don't know too much about whether we should have game farms or not as far as the Department is concerned, but we are very much interested in that phase of the program and if you folks have any information or if any of the audience here knows something about game farms, I would like to hear more about it.

We probably wouldn't follow the line this gentleman just explained, but more on breeding birds to replenish our stock.

Mr. Ruhl: We have a game farm I would like to trade you for a square mile of your prairie. I think it would be absolutely foolish and a waste of time and effort and words on your part.

I was out in your state. And, of course, you have many more pheasants than we have. Ours are down just as much in proportion as yours. We still don't believe in game farms.

I can't see any possible necessity for a game farm for pheasants in South Dakota. I can't see any justification for it. Of course, I am from Michigan.

Mr. Johns: That is swell. I presume the Department gets one of these transactions and when that comes up I will turn to that particular phase of the deal for my argument.

Mr. Ruhl: I feel it so strongly that I would be willing to put it in writing before that, if you want me to.

# SEASONAL MOVEMENTS OF THE BLUE GROUSE

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This paper will be confined to the general aspects of blue grouse movements. We hope to continue our study of the species and to give a detailed report at another time. For that reason, the paper will deal heavily in the published accounts of others and supplement them with data from our own studies only when advisable. Although we have found more than 300 references to blue grouse habits, only a score or so will be cited here.

*Winter range.*—The general geographical distribution of the blue grouse *(Dendragapus obscurus)* corresponds rather closely to the range of the Douglas fir *(Pseudotsugu douglasi)* but extends somewhat farther north as described and mapped by Beer (1943). It is associated with the firs and pines during most of the year but occupies open land in the foothills during the summer. It can, with some justification, be considered a bird of the forests, of the ranches, and even in part of the grasslands.

The winter range extends throughout high country rarely visited by man in winter; hence, blue grouse winter habits are practically unknown. In winter, at least, it associates with all firs and pines, especially Douglas fir. Keeler (1907) says of the blue grouse that it is "the only scratching bird of California which habitually frequents high trees." Its association with trees, especially high trees, has rarely been questioned, although Howell (1917) remarks:

> Although most of the published information pertaining to the Sierra Grouse gives one the impression that these birds haunt the pines and associations of scant undergrowth, my experience has been that they seldom resort to the larger conifers except to roost, and to escape their enemies by remaining motionless in the upper branches. At least in the locality under consideration, their favorite habitat is in the vicinity of dense aspen thickets, and the tangles of manzanita, hazel, and other brush on the dry hillsides and benches of the high Transition Zone, from which they flush to the timbered ravines.

Other writers follow the more general belief. Lawrence (1892) states that the blue grouse is "in winter rarely seen, as it lives in the tree tops 200 feet above the ground." Bates (1896) says that it frequents the high coniferous trees during most of the year. Saunders (1914) reports that it winters along the ridges of the upper

Canadian and Hudsonian zones, where it feeds on bearberries and juniper berries or on pine and fir needles when berries are covered with snow. Munro (1919) writes that they remain in thick stands of Douglas fir during the winter. Beer (1943) reports that the blue grouse "generally form loose concentrations well up on the higher mountains or on the tops of the high timber ridges" in winter. Marshall (1946) states that in Idaho the birds winter in the Douglas firpole, Douglas fir protective, and subalpine types above 6,000 feet.

*Winter habits.*—Although there seems to be general agreement that the blue grouse winters in the higher elevations, there are some differences of opinion on their winter habits. Mrs. Bailey (1904a) describes a winter roosting tree as follows:

> Near our camp at the foot of Pecos Baldy, Mr. Bailey discovered a winter roosting tree of the grouse. The tree was on a sheltered part of the wooded slope and was so densely branched that after a prolonged rain the ground beneath was perfectly dry. The earth was strewn with winter droppings, composed entirely of leaves of conifers.

Saunders writes in 1914 and again in 1921 that "the birds move up the mountain slopes to their winter quarters. On the high ridges the snow is usually blown away by the wind, and berries, which form the principal winter food, may be found in quantity. When the berries are covered, the birds feed on fir and pine needles and appear to thrive on such a diet in spite of the intense cold at these altitudes." Munro (1919) writes that:

> About the middle of October, the packs go into the thick stands of Douglas fir and remain there until the spring, eating fir needles exclusively, Their flesh becomes impregnated with the flavor of fir and is quite uneatable. If not disturbed too much they will remain in the same clump of trees all winter, not coming to the ground for days at a time. They sit very close and often will not leave the trees until one throws stones or branches at them. The ground under one of these roosting trees, in the spring, resembles a poultry yard with its accumulation of droppings.

Beer (1943) says that:

> The trees where they winter are usually thickly branched and afford an abundance of easily obtained needles; severe weather does not seem to bother them. Under such conifers, droppings may accumulate until a bushel or more lie in one place, especially

> under isolated and dwarfed trees near timber line. Where there are many grouse the quantity of droppings reminds one of a chicken yard.

Marshal (1946) also has found the tendency to spend the winter in certain trees, for he reports that droppings may accumulate to a depth of one half to one inch under certain trees.

The only reference that I can find to a possible reversal of the usual blue grouse migration up the mountains (itself a reversal of the normal movement of animals to lower altitudes for wintering) is that by A. M. Bailey (1927) who writes of blue grouse in southeastern Alaska:

> In the early fall, many repair to the mountain tops with their broods, where they find ample cover among the dwarfed pines and dense alder thickets; then they drop to sea level during the cold winter months, and one will often see them below snow line, where the tide has cleaned the beaches. They feed on the hillsides, among the dead devil-club and berry bushes, and rarely fly when one passes. Although strongly tainted with the spruce, which makes up a great part of their food, the flesh of these birds affords a welcome addition to the camp-fare when one is afield.

This return to the lowland seems most unusual. The only comparable blue grouse habit with which I am familiar is the movement above timber line or to timber line in late summer followed by a return to the timber lower down with the coming of winter.

The strong tendency of the blue grouse to use dwarf or stunted trees, especially Douglas fir and white barked pine, near timber line, seems universal. It is reported by observers, but it is more frequently revealed by the heavy layer of droppings on the ground under such trees. I have noticed this in the northern Cascades, in the Blue Mountains, and in the Moscow Mountains. In the Blue Mountains the blue grouse use exposed Douglas fir trees on the upper rim of the Tucannon Valley at 6,000 feet. These trees are not stunted as so frequently the case; they are, however, growing in rather open stands and thereby form dense growth. The use of dense trees, whether dwarfed or not, may be physical—that is, it enables a 2 or 3 pound bird to move about and obtain needles more easily and more securely than in a spindly tree. It may very well be that the dense growth affords winter protection. On Mount Spokane, for example, blue grouse have been reported using dwarf trees completely or almost completely shrouded in snow. There may be also some nutritional differences between the various types of growth, but of this we know nothing.

Down from timber line, the blue grouse use large trees, which generally are firs, although other species may be used on occasion. In the Bitterroot Mountains of Idaho, I found them living in lodgepole pine under the tops of ridges. There were no Douglas fir or true firs *(Abies)* nearby. This area was covered with firs and spruces before the heavy fires of 1910 and 1919, and one wonders, therefore, if the habit of using lodgepole pine stands (themselves a temporary type) is an indication of the retention of a habit by "tradition." Perhaps these blue grouse are returning to the winter range habitually used by the species before the fires and before the change in ecological conditions.

Contrary to the frequently stated rule that blue grouse stay in the trees throughout the winter, I regularly find them on the ground during my Christmas census atop the Thatuna Hills (or Moscow Mountains) in Latah County, Idaho. Tracks in the snow indicate clearly that they regularly descend to the ground, where they feed upon *Pachystima* and pick off the ends of the twigs as well as individual leaves. Their feet develop the so-called "snow shoes" in winter, which would indicate an adaptation for walking on snow. An interesting sidelight on winter habits has come from some blue grouse that we kept over winter in pens. The birds fed on grains and other foods offered them, but deserted all for their normal food, Douglas fir needles, with the coming of a sudden drop in temperature to near zero.

Beer (1943) has covered the year-around food habits of the blue grouse in a carefully prepared summary. Stewart (1944) has also written of blue grouse food habits.

*The downward movement.*—The only writer who seems to have witnessed the migration of the blue grouse down to the lowlands from their winter range is Anthony (1903) who was fortunate to observe very extensive migrations to and from the winter range south of the Wallowa Mountains in extreme eastern Oregon. He reports that, on March 1, 1902, the first of the migrating grouse appeared along the edge of timber where the snow was 2 to 4 feet deep. The lower slopes were free of snow. Evidently the grouse had migrated to the edge of timber on foot, for Anthony reports, "The tracks on the snow bore ample testimony as to the manner in which the migration was made." He reports that the birds flew from ridge tops across the open valley and canyons to the slopes on the far side where they alighted and walked to the top of the ridge before proceeding onward. The birds were in groups ranging from a dozen to a hundred birds. Others who speak of the downward movement apparently have not witnessed the migration itself but report or imply that the birds arrive on the breeding grounds in March (Dawson, 1897; Munro, 1919; Beer, 1943; Saunders, 1914, 1921). Mr. William Richman of Troy, Oregon, reported to me that the first one he saw on his ranch in 1946 was on March 4; the first one heard hooting was March 12.

*Summer range.*—The summer range of the blue grouse in the Inland Empire occupies the lower foothills in the zone between grass and timber or grass, sagebrush, and timber. These are the areas where Ponderosa pines grow in parklike stands. There is some question about the approach of the blue grouse to the sagebrush type; the sagebrush may have spread into the grass areas owing to overgrazing, and hereby be an abnormal condition. Brush has also increased in the parklike areas because of overgrazing (especially in the growing season) and fire, both of which destroy grass more quickly than unpalatable or resistant shrubs. This zone is often taken up by ranches and small farms (sometimes of the type of farming commonly called "stump ranching"). In Colorado, Rockwell (1908) found the blue grouse summer range to consist of aspen hillsides and small glades or parks in the heavy spruce timber. Evidently the summer range varies rather widely—from grass and sagebrush to open timber or even heavy timber.

Good grouse range seems well watered, for in summer we rarely find broods far from water. Mrs. Bailey (1904b) states that blue grouse which she watched came down out of the trees in the middle of the day to get water from a mountain spring. Mrs. Blanchan (1902) writes "the nests are never far from water." Wing, Beer, and Tidyman (1944) report that the birds visited watering places frequently. Beer (1943) says that open water is not necessary, which seems likely to be the case on ranges with berries and other sources of moisture. Perhaps the presence of spring and water holes follow along with wet spots that supply enough moisture for desirable shrubs. There is, however, good reason to believe that on dry range water sources which dry up in August rather than June or July spell the difference between success and failure of the blue grouse. Once, for example, I walked back up Six-Mile Canyon near Orofino, Idaho, where an open basin formerly held about 3,000 grouse in summer. That year, 1944, it held only about eight. The only change seems to have been in the water supply. If this is the case, an important point would be improvement of water supply where feasible; on most areas, however, we must await an increase in the wet phases of rainfall cycles.

Birds nest in timber or the edge of timber, but broods regularly wander out into the open. Lee (1936) found a brood in an alfalfa field a mile from timber; the female may have nested near the spot, for the young bird that he found was about a week old. Lincoln (1920) writes that the female leads the brood down to the lower slopes in Colorado. Anthony (1903) says that the birds nest out in the open sagebrush plains in company with sage grouse. Skinner (1927) also found them out in the open grass and sage brush. This tendency of broods to move out of the timber and into the open areas has been remarked upon by many writers. It seems to be a definite characteristic. Perhaps a part of it is induced by blue grouse broods moving into the open in order to get insects, especially grasshoppers, when the chicks are small. We have noticed it repeatedly in our studies of blue grouse broods. Many blue grouse breed back in the mountains, however, and do not have an opportunity to move out into the open. Hence, moving into the open may not be altogether universal.

*Fall migration.*—The upward movement to the winter range covers a longer period than the springtime descent. Especially is this true on dry range. Along in midsummer a noticeable movement of broods and adults up the mountain slopes can be detected. Females with young birds, young birds unattended by females, lone males, and males in groups are found scattered throughout the forest and slopes. So far as I have been able to detect, the upward movement is a gradual trend that may begin in midsummer and last out until October. We have found an occasional blue grouse in the low country as late as early November.

Females with broods sometimes move above timber line, where they feed upon *Vaccinium* berries and grasshoppers until they return to the timber for winter. Grouse apparently move up-slope, as though in response to a geotropism, until timber line or ridge tops are reached. Ridge tops may be as low as 3,500 to 4,000 feet, and some timber lines may approach 10,000 feet.

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## DISCUSSION

MR. HARRY D. RUHL (Michigan): I have three questions I would like to ask. Some of the people in our upper peninsula think we ought to introduce the blue grouse hoping that it would be up when our ruffed grouse an dsharp-tails are down. I would like to have some suggestions as to what chance there would be of getting adequate stock. Second, if we did get some and could introduce them, what chance would they have of going anywhere in our peninsula. If they get going, would it be a good thing?

DR. WING: I could say this for chances of getting stock. It's very, very poor for the simple reason the blue grouse apparently fluctuates more than the ruffed grouse. It's way down now.

I will give you an example of that. Three years ago I went with one of the Idaho wardens up to what he said was absolutely the best blue grouse country he had ever known in his life. It was on the canyon of Clearwater River. We walked up the canyon a few miles, and it opened out into a little basin of possibly a couple of sections and there was a little rancher in there. The rancher said, "Yes, we have a lot of blue grouse. We did have. I figured it was about 3,000, but 4 or 5 years they started down. Now I think we have 8."

Your chances of getting the blue grouse is nil. As to the chance of raising them in Michigan, I would say that you have less chance of increasing the population of the birds than you would have of increasing the level of the ocean by spitting in it.

MR. RUHL: You didn't answer my third question. If we could, would it be a good thing?

DR. WING: I say no.

MR. RUHL: I agree with you.

MR. N. E. MCEACHRON (South Dakota): Harry asked a couple of questions I had in mind and I also got the answer to them. However, I am interested, of course, in our own state—the Black Hills section which has a terrain of between 3 and 5,000 feet elevation. What in your opinion would the chances of survival or propagation be for blue grouse in that area, Doctor? The Black Hills are on the extreme eastern edge of the blue grouse range. I believe there have been blue grouse in there in the past.

DR. WING: Not to my knowledge.

MR. MCEACHRON: I think they have. I am a former resident of the Black Hills. We have always had ruffed grouse. I think they have been found in there in the past.

DR. WING: It's on the extreme edge of the range and it's just like anything else. When you are at the margin of its range, your chances of success are very, very slight. Now, that may not be true at all, but you are at the extreme edge of the range there. They are found in Wyoming and I think there have been records found in the Black Hills, but obviously it is unsuitable in some way or else they would be there.

MR. W. H. TURCOTTE (Mississippi): I was up on Mt. Rainier in Washington and I believe I saw one of these birds you are speaking of. What I want to know is if they are considered any good as a game bird. I could have knocked a bird out of a tree with a stick.

DR. WING: Yes, it is. It is probably only excelled by the pheasant as a game bird in the Pacific Northwest. It's a very peculiar bird. Some birds you can go up and hit with a stick. Many of them will jump and fly away when you are within 100 or 200 yards of them. This is also true of the Franklin grouse. You get them on a mountain ridge and you have really got something. You come upon a bird and he will drop down 200 or 300 yards below. You swing your gun around at him and there is a big rock or hillside. So in that way it is just like ruffed grouse. You find plenty of ruffed grouse you can hit with a stick too. You hunt them a little bit and the ruffed grouse aren't so easy to get. It is just like that with the blue grouse. Incidentally, in the summertime you can walk upon them and touch them with your hand. That is not so in the fall.

# A BOBWHITE QUAIL IRRUPTION IN NORTHWEST TEXAS LAWER PLAINS TERMINATED BY PREDATION[1]

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Bobwhite quail populations were investigated in the Lower Plains of northwest Texas during the 3 years 1941-1943. During that time a bobwhite irruption occurred, was cut back by predation, and was followed by near failure of the survivors to reproduce.

Because the predation phase was, so far as the writer knows, unlike anything reported for the Southwest, the chain of events is briefly traced herein and tentative interpretations of causes are made, together with such suggestions for management as these interpretations may imply.

Type-areas for investigation were located in Cottle and King Counties. Both were within the overlapping range of bobwhite and scaled quail. The Cottle County unit was selected as typical of mixed land use at its best. Farm crops and livestock production are carried on. Grazing is light and attention is given to prevention of field erosion. Wide belts of ungrazed river-bottom vegetation are

[1]Part of Federal Aid Project, Texas 1-R.

marginal to fields of grain sorghums easily accessible to wildlife. Quail cover and food sources are relatively stable, even in adverse years. About 1,600 acres make up the unit.

The type-area in King County consisted of approximately 5,000 acres of grazed range, located within limits of one of the larger ranches of the region. It was selected because the plant associations and the usage given them characterize the mesquite-brush range which makes up much of the Lower Plains. Woody cover on this range is confined almost wholly to mesquite brush. The weeds and grasses affording ground cover are unstable and uncertain in occurrence from year to year. During the 3 years of investigation, wide extremes of rainfall were matched by as wide extremes in the quality of quail habitats afforded by Lower Plains pasture land.

Forty-two inches of rain fell in 1941 at location of work; 26 inches (the normal), in 1942; and 10 inches, during the growing season, March through September, of the last year.

Above normal rain in 1941 caused stands of annual weeds where the grass turf had been destroyed by grazing and drought in the '30's. Extensive areas were canopied with an unusually dense and tall cover of broomweed (*Gutierrezia* sp.). Part of this association carried over into the second year and was maintained by the normal rainfall of that season. More of it persisted in the form of debris and screens of the dead weeds protected from cattle by low growing limbs beneath mesquite trees. This was true of the broomweed cover, which did not grow again. Instead, motts of ragweed (*Ambrosia* sp.) came up.

After frost killed it in the fall of 1942, the weed cover was steadily thinned by the grazing movement of cattle. There was no replacement in 1943. From the first month of that year rainfall was light. Low temperatures prevailed throughout March retarding spring growth, and sandstorms dried out the soil. By end of spring, 1943, the grazing range had returned to its typical short grass, mesquite-park appearance.

The part of the investigation devoted to the type-area in Cottle County showed that while the quail environment was benefited here, too, by optimum rainfall in 1941, it did not deviate as widely or as spectacularly from the normal as it did on strictly grazed range, nor was deterioration appreciable in the following 2 years.

The March 1942 population consisted of 13 coveys totaling about 250 quail, approximately half of which were bobwhites. This represented a gain of two coveys over the past fall numbers, ingress of a covey each of bobwhite and scaled quail having occurred in midwinter.

During the 1942 nesting season, 19 nests were found on the area.

Despite failure of 15 of these, and other indications of high predation on nests, young broods were numerous by midsummer. The fall locations of 56 coveys were mapped and the number verified by repeated checks. Twenty-nine of the coveys were bobwhites. The number of quail on the 1,600-acre unit was set at approximately 1,200. About 435 of these were bobwhites, a density lower than that for the species on inferior ranges close by where the ratio of scaled quail was not so high.

Winter loss was low and apparently limited to predation by a few Cooper hawks. A March census showed coveys in practically all covey locations mapped the previous fall. The covey count dropped to 46 in the fall of 1943, but the status of this population was not determined. It may have represented the carryover of old birds in relatively safe habitat.

Little data were gathered concerning 1941 densities of quail on the ranges devoted wholly to grazing. In September of that year 100 man-miles of walking transects, measured for comparative purposes with a pedometer, showed 6 coveys in close proximity to pasturefield crop interspersions to 1 covey encountered in the larger ranches remote from field crops. No high degree of accuracy was credited to the method, but it did show definite difference in quail numbers in two situations of land use, with the higher populations on or marginal to cropland interspersions.

Nevertheless, the 1942 breeding season resulted in overflowing densities of bobwhites on rangeland throughout the Lower Plains.

Investigation was centered on the King County grazed-land unit in the last 3 months of 1942. Uniform character of the range made quail counts on sample quadrats possible. In December a 640-acre upland area was censused in one day while snow was on the ground. Early darkness may have resulted in missing some of the coveys, but 330 bobwhites and 55 scaled quail were counted. Another day 100 bobwhites were counted within limits of a 160-acre quadrat. Sixty-seven of these were trapped and banded.

Elsewhere, especially in best bottomland habitat and good cover adjacent to large fields of grain sorghums, bobwhite densities were believed to reach a quail per acre. No practical means of censusing areas like these were found after winter set in. The flight of one covey would often put several in flight. When the hunting season opened, a heavy harvest did not appreciably decrease densities in these habitats. In one instance approximately 100 bobwhites were taken from a 60-acre pasture with a winding brushy creek through it and fields of standing milo maize crowding on three sides. Influx followed each hunt and the last hunt was as successful as the first.

Predator and prey populations were high. The cover of broomweeds the year before had apparently encouraged increase of rodents. Cotton rats and cottontail rabbits were at a point of cyclic abundance. Marsh hawks were constantly in sight, their low flights continually interfering with quail drive-trapping by causing coveys to freeze.

Drive-trapping and banding on the King County unit revealed a total absence of covey headquarters or territory in the accepted sense. The entire range was in use, so crowded that at many trap stations two and sometimes three coveys would be in view while the trap was being set up. Only two retraps occurred among the 490 bobwhites banded before January, despite the fact that the catches were made time and again at the same trap stations. Bobwhites had begun to feed on young winter annuals which appeared after December snows. Stands of these carpeted the open glades among mesquite trees where feeding quail were completely exposed. Yet predation was negligible even while snow covered the ground.

These were the conditions when work was discontinued to do necessary office work January 7, 1943. Between then and January 15, the bobwhite population was disrupted with explosive suddenness, and all but remnants of coveys were lost to predation. January 15-16 was spent in verifying the debacle. On the fifteenth, 19 miles were driven searching, and 45 trap stations visited where coveys had been banded and the station marked. Six coveys were found, two of them composed of six bobwhites each. This was on the same routes where earlier less than one third of the day's mileage had resulted in the trapping or attempting to trap of as many as 13 large coveys. Everywhere the ground was littered with evidence that predation had been recent and terrific.

Predation, while not on the same scale as before because of decline in prey numbers, continued until about March 20. Where large coveys had been common, they were exceptions until late in the period, when survivors again joined to form normal coveys.

Marsh hawks, redtailed hawks, and Cooper hawks were active predators. Of these, marsh hawks were believed to have been the only ones abundant enough to have destroyed so many quail. Pellets from the perches of horned owls showed no indications of quail remains until after nesting started in February. Then 55 pellets gathered from three nest locations showed quail remains in 25.

Twenty-one hawks were collected for examination of foods. Four of 18 marsh hawks had fed on bobwhite quail. Two others had fed on meadowlarks. One of two redtailed hawks had eaten a bobwhite. A single ferruginous roughleg had fed on rodents, as had the other hawks which had not eaten birds. It should be mentioned that at the time these collections were made, the remaining bobwhites were making use of the little cover available, and thus were somewhat safer, as well as numerically less available.

Strip counts were resorted to as a means of quickly arriving at an estimate of quail mortality. Previously, as many as 84 sites where quail had been plucked and eaten had been counted in a day of walking. Meadowlarks, too, had been preyed upon heavily. Significantly, evidence of predation on scaled quail was light.

Strip counts were completed in the week February 8-15. Twelve lines were surveyed with transit and rod. They were each 1 mile long and one third mile apart, so located as to cut all types of terrain. Locations where quail had been plucked and eaten were counted within 5-foot limits on each side of these lines. Recent kills were marked with white strings. Care was taken to record only those places where the amount and kind of feathers indicated that a bobwhite had been eaten. The average number of kills per strip was two. In terms of total areas, the count of kills on these strips indicated the incredible number of 1,000 bobwhites per 640-acre section. The figures are too high for probability; nevertheless, they tend to verify the movement of quail indicated by trapping and banding and support a theory that under severe environmental pressure, a flow of quail actually occurred across this area. A year later one of the banded birds was killed 10 miles distant from where the bird was banded.

March 15-19, the transects were again walked for a count of unmarked kill sites. Only two were found, a decrease in predation evidence of 90 per cent. The kill sites marked with string a month earlier were nearly erased by natural agencies.

Late March censuses of two 640-acre quadrats showed a remain-population of 1 bobwhite per 5 acres in river bottom, and 1 bobwhite per 15 acres on upland.

On the King County grazed-land unit cessation of predation of adult bobwhites did not arrest the decline. During the nesting season of 1943, 34 nests were found, 30 of which failed. Coyotes robbed 11; snakes, 6; small mammals, 5. Three were deserted, one was destroyed by cattle, and two were robbed by unidentified agents. May was the month of heaviest nesting. Of 13 nests found after July 1, only 2 were functional, and these had been started in June.

Drought and torrid temperatures set in, and bobwhite quail apparently renested to a limited degree only. Rainfall for the months, March-September inclusive, measured 10 inches on the area. From July 15 to September 8 (56 days), only a sprinkle fell. The means of the daily temperature for July averaged 82° F. and for August, 90° F. A temperature of 112° F. was recorded August 12.

Bobwhite parents were frequently seen with one or two young. No nests had been studied where so small a fraction of the clutch hatched, and it was assumed that mortality was high among the young broods.

Fall density on the King County type-area was estimated at not more than 1 bobwhite per 30 acres. Under difficult conditions, 63 were trapped for banding. These bobwhites showed a ratio of 1 young bird per 2 old, indicating a bobwhite population which for the breeding season had not been successful in maintaining itself through reproduction. The irruptive population of the year before had revealed a ratio of 4 young birds per 1 old.

The crash decline outlined here was general for the Lower Plains grazing range and was similar in rapidity. In various widely separated parts of the region, heavy predation by hawks was noted. Elsewhere, the mechanics of the decline was not ascertained. Landowners and sportsmen generally attributed the sudden disappearance of quail in early 1943 to "migration." While the underlying cause of the decline in numbers was undoubtedly caused by the pattern of rapid changes in climate and vegetation, the direct agencies of reduction may have differed.

## CONCLUSIONS

The losses to quail populations described here are attributed to simple predation on a top-heavy population projected, in the time sense, into an environment of deficient cover, and on the eve of a drought.

It is believed that neither weakness from lack of food or disease could have been a contributing factor, since in the course of handling approximately a thousand bobwhites only two were found in poor condition. The fact that meadowlarks feeding in the same locations as bobwhites were also decimated bears out this conclusion.

The causes of the sudden onset of predation are not clear. Indirectly, cover failure may have increased the quail predation by driving rodents under ground. They were still available, to some degree at least, as shown by pellets and examination of the stomach contents of hawks. Their numbers may have declined to a point where it was simply easier to take bobwhites. Once toppled, a bobwhite population seems pushed down until from the predators' standpoint it has reached the point of diminishing returns.

It is doubted that management of the Lower Plains cattle range to insure high winter survival of quail is practical. Under periodic conditions of 10 or 15 inches of annual rainfall, it does little good to point out the disadvantages of overgrazing. Any grazing at all is overgrazing.

Contrary to established principles of quail management, the irruption of bobwhites which occurred in 1942 was brought about by a background of drought and hard range usage. Mesequite brush came in after the advent of grazing, and more recently, the drought which began in 1934 resulted in grazing to the point of destruction of the grass turf. The weed growth of 1941 was essentially a tillage succession, not less so because it was produced by hooves of range cattle rather than the plow.

It is suggested that maintenance of refuges of the most stable habitat available constitutes the best type of practical quail management in the Lower Plains. In adverse seasons, these would serve, if adequately distributed, to maintain breeding stock. Irruptions of bobwhites on to ranges normally clothed in short grass and mesquite brush should be regarded as a bonus and harvested heavily. They are doomed anyway by almost certain reverses in climate.

In critical years, farm refuges in the best habitats should not be hunted. In practice, the reverse is often true. One sees vast ranches posted and kept inviolate when there are not enough bobwhites to tempt hunters; meanwhile, small units of best habitat and feed lot and barnyard concentrations are known to the hunter and take the heavy harvest.

In the Lower Plains drift of quail over large areas deficient in cover is seen as lethal. This is probably the underlying cause for the paucity of results, or even information, which has attended the release of Mexican bobwhites in the Lower Plains. One hears the most demand for these when catastrophe has overtaken native bobwhites. The absence of bobwhites from ranges normally occupied indicates conditions which would make futile the release of imported stock.

## DISCUSSION

VICE-CHAIRMAN BAUMGARTNER (Oklahoma): I am still puzzled by the very definite difference in the predation as it affects bobwhite and blue quail. Is that due to the difference in the habits of the bird or how would you account for that?

MR. JACKSON: Dr. Baumgartner, I havn't fully accounted for that myself. I might add that the blue quail disappeared from that range even though the evidence of predation was slight. The disappearance of blue quail was just as spectacular as was the disappearance of bobwhites.

I did mention that observations of behavior from attacks from hawks might offer a clue. The blues kept their heads down and ran in under shrubs and the hawks would usually light at the base of that shrub and walk around the bird. The blues wouldn't move. They didn't get excited easily. With no place to go, the bobwhites were apparently confused and easily driven out from the woody cover which did not have the support of the grassy undercover. Therefore, the bobwhites were more easily driven out. The predators didn't drive the bobwhites into the bushes. Before it began, it was the favorite location for them.

VICE-CHAIRMAN BAUMGARTNER: One other comment. We had a somewhat similar situation on a much less spectacular scale in north central Oklahoma on the prairies in 1940. It was complicated by a long period of very severe weather conditions. I was interested in your comment in which you said you had a heavy build-up of rats and other rodents that attracted the hawks. Even so, the bob-whites seemed to be normal in weight. Isn't it possible that there was a food shortage of some kind that may have materially lowered the resistance of those birds. It just occurs to me that certain necessary elements in the diet may have been lacking. That's just a possibility.

MR. JACKSON: Of course, there are more unanswered questions here than there are answered ones. That is an episode that I think most quail men should be familiar with. Is there anybody who was part of a pattern of such a disaster in the Southwest? There are some other observations not mentioned in the paper that tend to refute that. For instance, although we did not make strip counts of the predational meadowlarks, they were preyed on almost as heavily, and in the weeks that followed, the disaster clearly overtook a good many of the predators too.

It makes me tend to think that probably the thing came unhinged when somewhere in the wildlife period, something else became deficient. The road runners were also decimated in that area too. During this period in which quail were lost, barn owls suffered heavy predation, apparently from horned owls. Our cottontail rabbits disappeared that spring. And it changed drastically the food habits of our predators. That's just a thought.

VICE-CHAIRMAN BAUMGARTNER: This is exceedingly interesting to me because almost without exception the same condition prevailed species to species with this one apparent difference. The tremendous population of owls moved southward out of our area rather than staying and suffering predation. We found no evidence of dead hawks and owls during the period and we had a minimum of evidence of this. They did move southward out of the storm belt and into an area where more food was abundant because the cotton rats died out almost to extirpation in that area during that snow period that occurred in January of that winter.

MR. CHARLES C. SPERRY (Colorado): I would like to ask regarding the density of marsh hawk population during this height of predation for that period, that season, as compared to the same season of the previous year.

MR. JACKSON: I can't answer that question because for one thing I haven't ever found any way of estimating density of marsh hawks in range where visibility of such a low flying species is probably 50 to 200 yards, and too, I wasn't forewarned that this was going to happen, so I didn't make population studies that I would have made otherwise .

Incidentally, our marsh hawks left, of course. Our cotton rats are gone. That nesting season following the spring of 1942 there were only two pairs of nesting horned owls and their food habits showed a great change from the preceding year.

VICE-CHAIRMAN BAUMGARTNER: I might mention the fact that during this period, working in the prairie where we had plenty of visibility, it wasn't uncommon to see 25 marsh hawks to the square mile. We captured nearly 100 barn owls on a trap line set on fence posts about a half a mile long. Obviously there was a tremendous pile-up of migrating hawks and owls as they came south that winter, but all the data indicated that those birds moved out of the area and apparently south when the cotton rats and other small rodents died off very abruptly.

CHAIRMAN EDIMINSTER: You concluded that refuges would be a part of the solution to alleviate any of these drops. I don't follow how refuges would help. Of course, the basic cause was climatic which also leaves the value of refuges in doubt in my mind.

MR. JACKSON: I did not handle the two type-areas in parallel. Where conditions were stable, its population during this corresponding time dropped from 56 to 46 coveys and predation did not occur there. So that leaves the whole thing up to cover, even though the disappearance of cover might not have been the first thing that caused the loss of the quail.

My thought is that in farmlands such as Lower Plains farmlands usually are on the best soils. Through management of their soils they could protect a limited number of quail under those situations.

MR. BEN GLADING (California): I wonder if the speaker thinks that it would be possible to control the drop of that irruption in an extremely local place where you had a managed preserve, by intensive predator control.

MR. JACKSON: Why, yes, I suppose so. You could control that particular agency of destruction, but the quail were doomed anyhow on that particular range that makes up most of the Lower Plains. It is about 75,000,000 acres. I wouldn't see any point in predator control there because you would be condemning the quail to some other agency.

MR. GLADING: You think they would have hit a complete low anyway? I am not talking about this matter of practicability over any larger area, but say a few wealthy men had a fairly well-confined shooting preserve they wanted to keep from hitting absolute bottom. Do you think predator control under such conditions would have aided in in the preservation, or do you think that population was doomed?

MR. JACKSON: You mean if the predator control had been carried on, would the quail not have dropped to the same low level?

MR. GLADING: Yes.

MR. JACKSON: I think they would have.

MR. GLADING: We have some significant observations. Of course, the climatic conditions in California are entirely different and tend to be very uniform in the area in which our observations occur. In two regions with very heavy management including very intensive predator control on a small area with supplementary feeding of birds, they were able to keep the valley quail population in excess of 5 birds per acre. That is astounding. You would have to see it in order to believe it. They stopped the management at the beginning of the war. They lost the man power and they couldn't get feed. The next census after losing the man power showed that their population had dropped to 1 bird per 4 acres. We feel that was a result of the cessation of this management since the population had been building up previously over a number of years. However, there is a question on both sides.

However, we do know that with the start of such management in late 1945, the population, with only one breeding season of the predator control management, has increased several fold over that low of about 1 bird to 4 acres.

MR. JACKSON: Of course, you haven't seen my quail range. I haven't seen yours. I think it would be difficult for any one to appreciate the extent of the change in cover that took place on the Lower Plains grazing range.

It was at the end of 1944, and still is, a short grass range. There were mesquite trees on it, and for the most part of that range, if you found a bobwhite quail out there, he would have about as much chance of survival as if he were on the street down here. There was that drastic a change.

Under the conditions, I doubt if they could have survived there anyhow.

# THE HOOF AND MOUTH DISEASE

I. B. BOUGHTON
*Superintendent, Texas Agricultural Experiment Station, Sonora, Texas*

This is an impromptu affair. Mr. Dodgen called me last night about 5:30, and asked me if I could come down and talk about hoof and mouth disease as a—well, not as a big game problem, but as a potential threat.

I really do not know what to say to you folks. I thought a very short description of it and its potentialities would be good. Now, please understand that there is not any foot and mouth disease in this country. From the best information I have been able to get, it is about 300 miles below the Rio Grande border in Mexico. I think there is one suspected herd a few miles north of Mexico City. The thing we ought to emphasize is that as long as the disease exists in Mexico, it is a potential threat all along the border, that is, in Texas, New Mexico, Arizona, and California.

Now, the disease itself is primarily a disease of cattle, but it affects any cloven-hoofed animal.

From the game standpoint, of course, that means deer, antelope, and bighorn game sheep. As far as is known, birds themselves, whether they be game birds or more or less domesticated birds, are only mechanical carriers. They, themselves, are not subject to it. If a buzzard happened to be feeding on the carcass of an animal dead of the disease, he could carry it across the border on his feet or on his beak.

The thing to remember is that it is the most rapidly spreading disease of cloven-hoofed animals we have. In other words, hoof and mouth disease of cattle can spread to these various other cloven-hoofed animals very rapidly. The outbreak we had in this country, for instance, in 1914 and 1915 and I believe in 1916, broke out in the stockyards in Chicago. Within about 3 weeks, it was found in 22 or 23 states—all the way from Chicago as far east and south as the District of Columbia. That gives you an idea of how rapidly the disease will spread. And as long as it remains in Mexico it is a threat not only to Texas, but to the whole country because once it gets in Texas or New Mexico or Arizona, if it should get in the game there, if it should get in the cattle herds or sheep flocks or a flock of goats—anything of that sort—and unless prompt measures were taken, it would inevitably spread to other states in a very short period of time.

The disease is a virus caused affair. Most of you men probably know what I mean by a virus. Some of our worst diseases of animals, of man, and of plants are virus propositions. Roughly a virus is something so small that with an ordinary microscope we cannot see it. Some of the viruses have been seen through electronic microscopes, but they are too small to see under an ordinary microscope.

As to the severity of the disease—the mortality rate doesn't run high. I would like to emphasize that fact. The various articles we see in the papers give us the idea that an outbreak will kill most of the cattle herds; that is not so.

The mortality runs low. Maybe one half of one per cent to 3 per cent. Occasionally more or less malignant outbreaks occur in which mortality jumps up considerably, but by and large it is not the mortality, it is the morbidity—the large number of animals affected and how rapidly it spreads.

The policy in the United States has always been not to try to treat the disease, not to try to vaccinate for it, but to eradicate it as soon as it is found. In other words, we do not want the disease in this country. It costs too much money to let it establish a foothold and live with it as they do in Europe and have for the past century. The only way to eradicate it is to kill the affected animals, that is, those that have recovered, those showing the disease, and those that have been exposed.

First they establish a quarantine zone (which the Mexicans have done)—a very rigid one, prohibiting movement out of the zone of animals, cattle, hay, vegetables, or anything that can carry the virus. Next, recovered, infected, and exposed animals are slaughtered and buried and the premises disinfected. After a period of time, I believe it is about 30 to 60 days, susceptible cattle are put on the property where the other animals have been killed and which has been disinfected and examined closely at intervals for signs of the disease. If the animals remain healthy after about 60 days, the property is considered free of the infection and the quarantine is lifted.

In California for instance, in the outbreak there in '27, '28, and '29, it came in originally, as near as they were able to trace it, in garbage thrown off a boat and washed ashore in southern California. The garbage was eaten by hogs. The hogs contracted the disease which spread rapidly and finally got into deer in the mountains. In eradicating the infection, more than 20,000 deer were killed in a period of 2 or 3 years.

You can see what a threat this disease, existing in Mexico, means to the cattle industry and to you game people. Luckily, as I said before, there is about a 300-mile band of protection from the farthest north point in Mexico to the United States border. But since the virus is extremely active and can readily contaminate manure, hay, etc., it is readily apparent how easily it can be transferred mechanically—on clothing, or shoes of people, by horses, on hay, straw, by birds, etc. These are all possible means of carrying the disease north and introducing it into this country.

The disease affects the epithelial tissues. It attacks the mucous membranes of the mouth and the skin around and between the hoofs.

The virus is not very resistant. Ordinary antiseptics, particularly the alkaline antiseptics such as lye, will kill it very quickly and easily. But if the virus is slowly dried and gets on other materials—hay and things of that sort, or even old carcasses where buzzards are apt to feed—it can remain virulent for a month or two months or three months.

One of the primary symptoms regardless of whether it happens to be a cow or a sheep, a deer or an antelope, is lameness. The lameness, usually the first symptom noticed, is not particularly characteristic. It is simply that the animals' feet are sore. When they walk, they don't walk the way they should but "crouch"along. In both cattle and deer, you usually find the feet affected. Examination shows "blisters" and inflammation on the skin around the hoof-head and between the hoofs.

Later the game animals, deer and antelope, show these same type sores in the mouth. Characteristically, the animal will refuse to eat simply because they have these blisters. They are more or less analogous to a fever blister with which you are all familiar. The foot and the mouth has that same general appearance and while these blisters form, and until they break, the animals carry a temperature and are sick. They have a fever; the milk production goes down. It may cease entirely. The animal is sick and listless and won't eat. Then, after these blisters break, the animals really become infectious. In other words, the virus is contained in the little blisters on the lips and down on the hoofs. They break and release this virus. Anything the virus touches becomes infected. If it happens to drop on the shoes of a man handling cattle or deer, such as the game warden, or it gets on the hands, they could transmit it very easily.

I would suggest, particularly along the border here, if any game warden or anyone who has anything to do with game sees stiff animals and animals that can't walk (ordinarily, of course, deer, from what I know of them, take off the minute they see a man), I would say to shoot them and get hold of a representative of the Federal Bureau of Animal Industry, and find out whether or not it is hoof and mouth disease.

Everybody in this country, livestock men and those interested in game of any sort, should be on the alert and in case anything suspicious comes to their attention they should get immediately qualified authorities to make a diagnosis as to whether or not it is hoof and mouth disease.

There happens to be a couple of other diseases that simulate hoof and mouth a good bit. As a matter of fact, to make a diagnosis, a laboratory procedure is involved; but as long as this disease exists in Mexico, the only thing we can do is to try to stay a step ahead of it and take no chances.

Incidentally, Dr. Darby, Inspector in Charge of the Bureau of Animal Industry in Texas, told me something interesting. They want to push the idea of erecting a 9-foot wire fence starting at Brownsville, and running along the border clear through to the Pacific.

Now, that may sound a little foolish to some of you people. It will cost a lot of money, take a tremendous number of men to patrol it it constantly, but they want it high enough to prevent any game such as deer or antelope being able to jump it, and prevent any wild or domesticated animals from wandering anywhere across the river. If we get the hoof and mouth disease established in this country we will pay through the nose like the livestock man has paid on the continent of Europe for the past hundred years or more.

The thought I want to leave with you is that the disease is not here. We don't want it here. If it ever gets here it will cost a tremendous amount of money to get rid of it.

As long as they keep it in Mexico it is potentially a threat in this country, not only to the cattle industry, but to game industry as well.

One of the newspapermen asked me a while ago if people, that is, the human animal is susceptible. They are, but only rarely does such infection occur in man.

## DISCUSSION

MR. PHIL GOODRUM (Georgia): If that disease runs that course, how long will it take?

DR. BOUGHTON: I should have mentioned that. Normally it runs a course of about 3 weeks, the infected animal recovering in this time.

As I told you, it is not the mortality—the actual death loss from the disease that is so important. That is not high. But indirectly it might be. We have, I suppose as a good many of you know, the famous screw worm fly which lays its eggs in wounds where the resultant larvae develop. Hoof and mouth disesae would afford a good opportunity for this fly to infect the sores of the lips, the inside of the mouth, and the feet. That might increase your mortality a good bit.

But the disease, if it is uncomplicated, runs a course of about 3 weeks' time. The animal recovers and is pretty much immune to that particular strain. So far, three strains of hoof and mouth viruses have been found and an animal recovered from one is still susceptible to the other strains.

MR. GOODRUM: I was thinking about a general area. Suppose you are able to confine it to the area that is infected now, a general area will probably cover as much as five or six counties, and suppose you make no attempt to eliminate it, how long would it run its course in a general way in that locality?

DR. BOUGHTON: I get the idea. We really don't know in this country. We have never given it a chance. They have tried that in Europe and they can't do it. The virus is slippery. Sooner or later it gets out. Conceivably if it would spread through the area of five counties and all animals in there became infected within 10 days or a week, in about 6 weeks the whole thing would be over, that is, theoretically. Practically, that doesn't work out. The virus is so slippery, despite the best quarantine, it breaks out. We have never given it a chance to do it in this country. We knew the danger. We killed everything infected in that area. Like the surgeon does to the cancer, he takes the cancerous tissue and an area of normal tissue alongside of it to get all the cancer cells. The same idea is used in hoof and mouth disease, killing everything that has it and everything conceivably capable of carrying it.

DR. W. B. DAVIS (Texas): Have they ever tried to make serum?

DR. BOUGHTON: Yes, they have. It has been used in Europe. They have two things, one which is fairly practical in Europe—where they live with the disease after it is established. They take the immune serum (sometimes simply blood from an animal that has recovered, or a convalescent animal and separate the serum) and inject it into the exposed animals to establish a sort of cordon of immunized animals. That immunity, however, only lasts about 3 weeks.

With other vaccines they have tried to immunize the animals by giving them a light case of the disease and stimulate active immunity in the tissues. It does not work too well. There have been various claims, but all claims have fallen very flat. The idea of vaccination in this country has not been considered. We don't want to let it get here.

DR. D. L. LEEDY (Ohio): If the virus is carried by birds, do you think building a fence would be practical?

DR. BOUGHTON: While there is the possibility that birds will carry it, such possibility is minimus. After the first World War, the disease appeared in England, spreading from the Continent by means of livestock, returning troops, etc. The British eradicated it the best they could. They wanted to investigate the disease. They established their laboratory on a boat in the Channel between France and England. Very soon they found the disease appearing sporadically in England. They established a guarantine not allowing livestock, dogs, etc. to come across from the Continent. Despite that they were having hoof and mouth disease. Finally they found out it was carried by birds from the Continent alighting on the laboratory boat and then carrying the virus back and forth from the boat to England.

No, this 9-foot fence will not stop the birds, but the bird idea is not nearly the threat that your walking cloven-hoofed animals are.

MR. IRVEN O. BUSS (Wisconsin): Is this fence that is to be constructed from Brownsville to be of the kind built in Florida which successfully held out deer by employing the use of electricity and also to be used for excluding rabbits?

DR. BOUGHTON: If you will ask the gentleman right back there, Dr. Darby, of the Federal Bureau of Animal Industry, he can tell you more.

DR. H. L. DARBY (Texas): That fence has been talked about for 15 or 20 years. That fence was authorized by an Act of Congress quite a number of years ago, and it had nothing to do with the hoof and mouth disease. It had nothing to do with keeping out predatory animals or anything of that kind. It was authorized for the purpose of keeping stray and smuggled cattle back on account of tick fever. They had spent, as some of you men know, millions of dollars for eradicting ticks way up in northern Oklahoma on down to the Rio Grande River. That river is nothing but a boundary. It is no barrier. Cattle stray back and forth across there bringing ticks over here.

They had already appropriated $150,000 before the hoof and mouth threat came up. Senator Connally just a little bit ago introduced a bill for $600,000 for this fiscal year and $2,000,000 for the next. I don't want to go into that.

What was the point that you made?

MR. BUSS: Whether it is to employ electricity. That worked well in Florida after repeated failures.

If a Florida man is here, he probably can elucidate on that point. I know it worked well.

DR. DARBY: Frankly, they haven't gotten far enough along to know exactly the type of international boundary. They did ask for bids on a 9-foot fence—heavy, woven wire fence—which would cost $10,000 a mile. I think it would be somewhat similar to that put around war plants, with that diamond business on top.

Now, when the fence was first advocated, no one said anything about predatory animals. Later the predatory animals came in and they said they wanted to build a fence to keep them out.

We feel, so far as Texas is concerned, from Brownsville up to Devils River, the fence will be well worth its money if it keeps back the cattle carrying those ticks.

Now since this other threat came up, for these cattlemen, this fence is their No. 1 project.

DR. BOUGHTON: Regulations on hoof and mouth disease have not prohibited the movements of people. I am still advocating that we have a horseback patrol, not fellows riding in automobiles like I do on highways, but a true horseback patrol. Another thing, any people that cross at regular ports, if they have on clothes that indicate they have been working around livestock, they should take those outer clothes off and put them into disinfectant. A man should not be allowed to wrestle around with hoof and mouth disease down there and come up here.

MR. BEN GLADING (California): The gentleman emphasized the fact that birds can carry this disease. Wouldn't the fence have to be high? There woudl have to be heliocopter patrol to keep the disease out.

CHAIRMAN EDMINSTER: The birds were a lesser factor.

MR. GLADING: It only takes one. Wouldn't it be a lot cheaper to get along with the disease?

DR. BOUGHTON: You are not a livestock man or you would know better than that. It doesn't pay to get the disease here. I have seen it in Europe too much. The average practicing veterinarian in some European countries figure that 50 per cent of his income comes from hoof and mouth disease alone in some years. If you know how much it takes to run livestock in this country, you know we don't want more expense piled on top of present costs. We don't want it any more than we want smallpox or infantile paralysis. Do you think we want something like that started if there is some way of eradicating it?

CHAIRMAN EDMINSTER: Is the policy of the Mexican Government on this likely to be headed off by that Government?

DR. BOUGHTON: They are working on it now. You ask me something I do not know much of anything about.

CHAIRMAN EDMINSTER: That should be important.

DR. BOUGHTON: The disease is in Mexico and we can't do anything about it other than advise and urge them to do something, as I understand it. They are working on it. They have the area located where the disease is. They are trying to block it off.

Incidentally, they have a strict quarantine at the Rio Grande. Cattle, livestock, hay, and some vegetable products are not allowed to come across. That was established in December. They are doing their best.

I want to emphasize the fact that we want to lend the Mexican Government all the aid we can, and we want to recognize the fact that if it ever does break loose it can raise hob in the United States. It hasn't yet and we have a 300-mile barrier from the nearest case of it in Mexico up to the border.

When Mr. Dodgen called me he said he wanted to emphasize the fact that potentially it is a threat. As I say, there is no use of getting hysterical.

MR. MERLIN MITCHELL (Texas): Of course, you are aware that tens of millions of white-winged doves roost in Mexico and feed in the United States. How far down do they roost, Bob? Do you know that?

DR. BOUGHTON: No sir, I don't. I am not a wildlife man.

As I said, that is a threat. It is not as bad a threat as cattle or deer or antelope, but there is that possibility that birds can bring it over which is all the more reason that they should get it out of Mexico—eradicate it as fast as they can.

MR. MITCHELL: Is it actually a known fact that birds do transmit it?

DR. BOUGHTON: Yes. It is hard to prove. In a good many cases where birds have been accused they have found out it is not so. There are actual cases—this English case, for instance, in the Channel. They were thoroughly convinced the birds did it.

MR. C. RAY KNIGHT (California): I was wondering if it might not be more effective and possibly cheaper to attempt to form a cooperative group with the Mexican cattlemen, and if necessary to put the fence across the isthmus and attempt to eradicate the disease in Mexico thereby preventing the natural migration across the line.

DR. BOUGHTON: Well, now, I don't know. That's a thought. Present and past experience simply shows that when it does appear, eradicate it. The only trouble with doing such a thing as that is, after it is eradicated in Mexico, the people will lose interest in it. In too many disease outbreaks, after the disease is over, folks forget about it.

MR. KNIGHT: What ever effort they are making, I believe that they would have a great deal more success with our financial and scientific cooperation in eradicating the disease.

MR. A. E. BORELL (New Mexico): I am not arguing against the fence. There may be very good reasons other than hoof and mouth disease for building the fence. We do want to think about this: The fence will do no good until the disease gets within a few miles of the border, and when it does that, it is almost sure to come across because no fence will be made that is going to stop a great deal of trespassing including the birds. Small insects and rodents go back and forth and one question might be thought about in that regard. Maybe those million of dollars that it will cost to build that type of fence could be used more profitably in fighting the disease on the Mexican side or on this side after it gets here.

I was in California in 1920. I want to comment that it is not only the rancher and the game people who are going to be affected. Many of the counties in California were completely quarantined. There was no trespassing without very definite reason. Back and forth across the county lines, even along the main highways running up and down the San Joaquin Valley the same as any well-travelled highway, there were checking stations at each county line.

Every car had to drive through troughs. Every person had to get out of the car and walk across a mat treated with disinfectant and then have all their clothes sprayed.

If all of the people coming out of San Francisco had to be sprayed, I can assure you the ladies wouldn't like it. If it ever gets here, the same type of quarantine will be put in effect. The big cities are going to be affected as much as other people.

DR. BOUGHTON: In some of our big eastern cities, they tell me they have to take cattle, horses, sheep, and goats around to the schoolhouses to show the children what they look like; yet this disease can affect that population, indirectly at least.

MR. H. B. HICKMAN (Louisiana): This gentleman was talking about the effect way up in California. We do that at the border coming into Louisiana. They started that a year ago—the last couple of years we have been running them through dipping vats.

I think the reason they tolerate it in Europe is because over there they are so close to all their stock. They catch it in time. It is especially so here in Texas that on the ranges all these cattle grow up and go to market and no one ever sees them during that time.

DR. BOUGHTON: They found out that, economically, eradication wouldn't work in Europe. It costs too much money there to get rid of it.

MR. HICKMAN: I was just thinking about that.

DR. BOUGHTON: That is a good point. The wild ranges—and that occurs more in Texas than other parts of this country—are all out in the brush,

That is the reason it is very much of a threat in Mexico. If it gets into that type of country (rough, brushy range), Lord knows where it is going to stop despite all possible precautions taken.

MR. HAYWOOD MCDANIELS: (Texas): Has this disease been constantly prevalent in Mexico or was it very sudden?

DR. BOUGHTON: No, sir. Supposedly, to the best of anybody's knowledge, they had, I believe, a small outbreak in Mexico in '26, about the time we had the outbreak in Texas along the ship channel below Houston, but that was eradicated and so far as I know this present one was found and definitely put on quarantine in December.

There were two separate bunches of bulls, I think you will remember, shipped up from South America—Brazil, I believe. There was a good bit of hullabaloo about those shipments and a quarantine was clamped on Mexico along the border. It was lifted in October because they had been unable to find hoof and mouth disease in any of these bulls. Some of them were scattered over Mexico. Some of them, from the first shipment, came into this country where they have been under constant observation. They haven't so far found any hoof and mouth disease in the bulls in this country. The period of danger is passed if they had brought it up with them from Barzil. So far as anybody knows this outbreak in Mexico is about 2 months old.

DR. LEEDY: Is there any danger of this disease coming into the country from animals imported from Europe where the disease has been for years, and also in birds and animals now being brought to zoos, frequently from South America?

DR. BOUGHTON: There is very definitely if the animal happens to be susceptible.

DR. LEEDY: Throughout this area, is there anything to regulate that?

DR. BOUGHTON: There are some regulations. They want to strengthen them. Air travel has spread during and since the war, and could constitute a means of spread—not only to hoof and mouth disease, but other livestock and human diseases. You know how careful they are to search for disease-carrying mosquitoes hiding out in planes. Animals coming from Europe have to undergo a certain period of quarantine before they are admitted into this country. They are held offshore on an island or at ports of embarkation for a stipulated quarantine period before they are allowed to come ashore. Hoof and mouth disease is considered as well as other diseases.

England, for instance, has been free of rabies, hydrophobia, since the first of the early 1920's. They had a good bit of outbreak after the first World War. After that outbreak was stopped they established a 6-month quarantine for every dog coming into England from the Continent or this country or anywhere.

MR. MILO L. COX (Texas): Is a period of sufficient length on the quarantine of hoof and mouth disease known?

DR. BOUGHTON: Well, yes, they make it longer than the investigative work shows may be actually necessary to be sure they are on the safe side.

MR COX: Could you tell us approximately what that length of quarantine would be—how long the virus lives at outside temperatures?

DR. BOUGHTON: Well, the virus is normally not resistant to disinfectant or drying. The hot sun, for instance, will kill it within 24 hours. If it is dried slowly in the shade, on hay or something or that sort, it may live for a month or two months. I believe they hold an infected premise under guarantine 60 days after slaughter and disinfection. Then they put the susceptible animals on the premise and hold them 30 to 60 days. If they remain healthy, the property is turned loose.

MR. COX: Since we do have what is called a 300-mile safety zone between the Rio Grande and the farthest north known case, at this time of year or very shortly, we should be experiencing quite a migration of waterfowl back from that area all over the United States. I was wondering what the possibility of that would be in carrying the disease.

DR. BOUGHTON: Your estimate or guess is just as good as mine. As I say, this bird thing is a debatable question. It is a possibility, but as to just how much threat, how many of these birds, for instance, that could conceivably carry the virus up, how many of them winter in the area where the hoof and mouth disease is prevalent in Mexico—

MR. COX: The point I was making, the 300-mile area might just as well be two.

DR. BOUGHTON: That's the idea exactly. That is why we should recognize the potential threat and keep our eyes on it.

DR. WALTER P. TAYLOR (Texas): I remember, during the California operation, that part of it took place during migration and there was abundant opportunity seemingly for the hoof and mouth disease to spread by birds. Every case of infection over there could be explained far more easily by some other means than by the agency of birds. The impression that we formed at that time was that if birds do carry it, it must be extremely rare. So that for all practical purposes if we can shut off the other possible carriers, we won't have to worry about the birds in my opinion.

DR. BOUGHTON: That is my idea exactly. It is almost negligible. It can occur. There is no use getting hysterical. If we take care of the ground livestock, that is the main idea.

MR. BORELL: According to the papers the first outbreak was near Vera Cruz. Now you make the statement it is definitely known within 300 miles of the border.

DR. BOUGHTON: I say I got this from a newspaperman this morning. I was talking to a bureau man, directly in charge of hoof and mouth in this country, who said there were about a million cattle exposed and infected. There was under observation one herd in a small town a little north of Mexico City.

DR. TAYLOR: That's farther than 300 miles.

DR. BOUGHTON: I don't know. It may be, but now that herd, as I understand, is under suspicion, but nothing definitely has been found.

MR. BORELL: The point I was getting at, as far as you know, definitely, it is still restricted to Vera Cruz and Mexico City, or is it definitely spreading and new outbreaks appearing in various places?

DR. BOUGHTON: There is an area roughly, I think 200 kilometers long and 100 kilometers wide north of Vera Cruz and Tampico, and that's where the million cattle are. Theoretically, those are the cattle exposed or which have it. As far as they know, that is the focus right now of the disease.

How far is Mexico City from our border?

MEMBER: 850 miles.

MR. JEFF F. KENDALL (Oklahoma): Is the Mexican Government participating in the cost of the proposed fence along the United States?

DR. BOUGHTON: I don't know any more than you do.

MR. KENDALL: The gentleman from Louisiana answers no.

DR. BOUGHTON: I would assume it would not. It would be on United States territory. I assume that would be Uncle Sam's burden entirely.

# SUMMARIZATION OF THE TWELFTH NORTH AMERICAN WILDLIFE CONFERENCE

ALDO LEOPOLD
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Only a fool or an angel would attempt to summarize this Conference. I need not tell you in which category I belong.

Let me disclaim any pretense of completeness, impartiality, or balance in this presentation. For one thing, only half of the papers reached me before leaving home, and my two ears unfortunately do not separate, as they should do for a good job of listening to simultaneous sessions.

Since this summary is incomplete, biased, and unbalanced in any event, I have taken the liberty of adding some points which were *omitted* from our program here. A good wildlifer always watches for what is absent; it often tells a story.

With these admonitions, I proceed to tell you what I think the score is.

## WILDLIFE AND THE LAND

This Conference has reaffirmed, through half a dozen speakers, the basic interdependence of soil, water, crops, forests, wildlife, and people. We conservationists have heard this before, but let no man forget that the average American has not heard it yet. To prove this, I need only cite the thousand miles of sick land we have crossed to reach San Antonio.

I must confess that the session on wildlife and the land left me with mixed feelings. I was sad because we still fail to distingush between paper progress and land progress. On paper, we have done wonders; on the back forty we have done so little and only an official optimist can see it without a microscope. I for one am grateful to Melvin O. Steen for challenging our chronic optimism.

On the other hand, I was heartened by the wider mental horizons evident in many papers. What speaker, two decades ago, would have ventured to assert that human health, as well as wildlife, depends on soil fertility?

Our program here has given scant recognition to the "Battle for the Public Lands.'' Perhaps it couldn't, for the opening gun was fired only a month ago. I have this to say:

1. It is perhaps the biggest conservation battle since the Ballinger Controversy.

2. Let no man think that the issue is a western affair of no consequence to other states. The defeat of public land conservation in the West would be felt by every state.

3. Let no man think that this is a grazing district fight. Disrupt the public domain, and the national forests will follow; disrupt the national forests, and the national parks will follow.

4. It is pure evasion to say that the states, or the private owner, could practice conservation on these lands. Neither, by and large, had demonstrated either the capacity or the wish to do so. To organize the practice of conservation on large areas takes decades of hard work.

5. Now is the time for a critical self-examination by all federal land bureaus. Professor Wagar's paper adds weight to this assertion.

## THE WATERFOWL CRISIS

One of the most encouraging events of the year has been the new policy of the Fish and Wildlife Service to defend the ducks and geese, rather than to defend its own past attitudes and methods. Everyone, I think, respects and honors the Fish and Wildlife Service for this courageous change of front.

In my opinion one of the forceful papers of this Conference was given by Albert Hochbaum of the Delta Waterfowl Research Station in Manitoba. He has made it crystal-clear that:

1. Many small marshes were duckless in 1946 for lack of breeders.

2. The Canadian kill is increasing, partly by reason of American hunters. Some breeding marshes in 1946 killed far more ducks than they raised.

3. The line of ''burned out'' marshlands has crossed the border and is moving toward the Arctic.

To this I will add two more points because I have access to the facts:

4. The black duck marshes of the Maritime Provinces, where drought, drainage, magpies, fires, and botulism are absent, show a 1946 depletion parallel to but even more severe than that of the Prairie Provinces.

5. Local breeding stocks south of the border are in some cases nearly extinct, due, I think, to the barrage on ''locals'' on opening day.

The whitebill epoch has indeed arrived, and may stay unless we do something about it.

To offset the gloom induced by the 1946 duck counts, let me cite two papers bearing good news. One is Cottam's report that eel grass is coming back. The other is Sperry's report on botulism, which holds out definite hope that this disease can be controlled by the manipulation of water levels. Curiously enough it is stabilized levels which appear to be the most dangerous.

Sperry's technique is one of a dozen new waterfowl techniques ably summarized by Jesse Low.

The most important of all waterfowl techniques is counting breeders. Lyle Sowls has given this Conference a convincing outline of the proposed new method of counting sample marshes during the territorial period. Incidentally, Sowls brings out one new idea of potential importance to future breeding ground management: the "par" breeding capacity of a given marsh depends not only on its food and cover pattern, but on the territorial intolerance of the duck species. Thus a given marsh may carry more pairs of the tolerant teal than the intolerant mallard or pintail. This is potent stuff.

To sum up: I have attended this Conference for 20 years, but this is the first session that ever was unanimous on waterfowl. Misfortune is a great leveler.

## FARM AND RANCH WILDLIFE

Until very recently, one of the weakest points in farm-game management has been the absence of serious research in the regions of maximum abundance. Until Kimball's group began to work, no one studied South Dakota pheasants; until Lay began, no one studied Texas quail, and to this day no one has studied the Hungarian partridge in the Prairie Provinces.

Jackson's paper on Texas quail is one of the substantial contributions to this Conference. It is welcome news that Texas is now banding and aging, as well as counting.

For 20 years there has been a running debate about whether valley quail need water. Ben Glading has settled this argument by showing that these quail summer on dry range only when succulent foods exist, and only in small numbers. He presents a new design for water-catching which looks promising and valuable. Glading's "guzzlers" seem to be a spectacular success.

Despite 20 years of game research, there are still gallinaceous species about which little is known. Wing's paper on the blue grouse summaries our meagre knowledge of this bird.

Here is another news item on grouse: Gardiner Bump's book on ruffed grouse researches in New York State is now in page proof, and will shortly be obtainable from the New York Conservation Department.

The most urgent farm-game problem of 1946 is the decline of the pheasant during the last 3 years. This outstanding question draws only one paper: Leedy and Dustman on "The Pheasant Decline and Land-Use Trend in Ohio." Leedy says the tractor mower may have affected pheasant nests adversely. But the rub is that the decline extends from New York to Montana, and perhaps farther. It is hardly likely that these farming changes, or their equivalents, extend across the continent. Evidently we must dig deeper.

Just how to proceed with digging deeper is suggested in Irven Buss' techniques paper. Let me express in one sentence the new idea on which Buss and the Wisconsin group are working. It is the simultaneous application to a sample population, through a period of years, of census, banding, sexing, aging, weighing, predation studies, food and cover studies, nesting analysis, and physiological measurements such as endocrine and nutritional assays. Thus, and perhaps only thus, can basic population mechanisms be discovered.

Michigan's Rose Lake Wildlife Experiment Station has applied to the pheasant, and to other farm-game species, virtually the same principle of simultaneous attack from many convergent angles. The first 8 years at Rose Lake are summarized in Harry Ruhl's paper.

In this summary I have used the word "decline" with the implied assumption that the population is capable of recovery. I fear that we must now face the fact that this assumption is sometimes false. We have had too many cases of complete or partial "decay" of gallinaceous populations. This is a development of the first magnitude.

The first instance was the decay of Oregon pheasants in the 1890's. There are still pheasants in Oregon, but they lack the explosive Dakota-like vigor which they displayed during the 1800's.

The second instance was the decay of pheasants in New England. John C. Phillips always insisted that the early vigor of the New England plantings was later partially lost.

New York pheasants declined in 1936, and in parts of the state have not yet recovered. Is this another case?

Lake States Hungarian partridges have been declining for nearly a decade, the oldest plantings going first. Is this another case?

Finally, the prairie chickens of northern Michigan and Wisconsin flared to a high in 1935, but are now going or gone. If this were an ordinary cycle, there should have been a high in 1945, but it did not materialize.

It is significant that all of these instances of decay apply to transplantations or invasions, i.e., to new range.

If decay is a fact, it is a blow in the solar plexus to future sport.

## FISH MANAGEMENT

I feel presumptuous in saying anything at all about fish, for I know from my own experience that one must really know details in order to appraise justly so immense and important a field. I do not know the details, but I am directed to summarize the Conference, hence I must do the best I can.

To my mind, the most significant feature of the fish program is the effort made to get some one to speak on "aquatic esthetics." Unfortunately, this effort came too late to find a speaker. What is meant by "aquatic esthetics?" I can only give my own guess. In the game field, policy has resulted from the contentions of two opposing groups: the gunpowder group and the binocular group. The binocular group is a composite one consisting of ecologists, ornithologists, zoologists, mammalogists, protectionists, and artists. It seems to me that these viewpoints are weakly represented in fish management. Fish management is too utilitarian, too "practical," too short on ecological inhibitions.

As an example, I cite Cahalane's paper on the national parks. In the parks, he points out, we not only go fishing, but we have mongrelized the fish fauna. We have introduced exotics, and sometimes exterminated natives. Equivalent policies in park mammals and birds would be shouted down. It is this disparity in view which I wish to emphasize. Both professions, to be entitled to public respect, must be something more than producers of wild meat.

Perhaps the most valuable contribution which fish managers have made to conservation is the idea that predation, instead of being the enemy of good management, is in some waters essential to good management, the angler being just one of the necessary predators. That this same idea may apply to some terrestrial game has been demonstrated repeatedly by Errington, and in a special case by Cartwright in 1944. It is also being demonstrated on a continental scale by all irrupting deer herds. At this Conference, further augmentations of evidence are presented by George Bennett (Illinois) and Willis King (North Carolina).

This Conference seems to have disclosed great inequalities in the advancement of fish research. James Gowanloch has emphasized the fact that one of the neglected areas is our southerly doorstep—the Gulf of Mexico.

## FUR MANAGEMENT; RODENT CONTROL

Charles Vorhies of Arizona has presented to this Conference an able summary of new techniques in these fields. Among the more important are censusing rats by bait consumption, controlling reinfestation by destroying ground squirrel burrows, protecting birds from poisoned grains by dying the grain, stabilizing beaver colonies by controlling density.

Vorhies does not mention one technique which is new and, to my mind, of basic importance. This is the classification of the fur harvest into young and old animals. Only by this means can we be sure of what we are producing. Thus Horicon Marsh, in 1946, produced two young muskrats per adult, while the Lake Erie marshes produced five.

Aging is of great importance, especially to those states which have reflooded marshes in the hope that fur will pay the upkeep.

Not reported at this Conference, because it is not yet in print, is the discovery by James Beer of Wisconsin that muskrat pelts can be classified for age by the priming pattern.

The Canadians continue to lead in the organization of individual trapping allotments for which the individual is responsible. That good fur management and free-for-all trapping are mutually exclusive seems to be the gist of Canadian experience, as reported by Harrison Lewis.

## WILDERNESS AND WILDERNESS GAME

The program of this Conference is silent on what, to me, is the most vital of all our problems: the accelerating destruction of wilderness wildlife and wilderness habitat.

The Alaskan Highway started the acceleration; while the highway is momentarily closed to tourists, it is easy to foresee Tom, Dick, and Harry bombarding every peak and canyon in the Canadian and Alaskan Rockies.

The development of hydroplane mining camps in the Canadian Arctic gave it a big shove, and the Arctic Institute now foreshadows the industrialization of the Arctic seas and islands, as well as the tundra and the land of little sticks. A mining railroad into the Labrador is in the offing. Need I dwell on the probable fate of the caribou, the musk ox, the barren ground grizzly, and perhaps even the walrus and polar bear?

One cannot blame the Canadians for this; it is the logical consequence of our American dogma that nothing is as important as more industrialization. (I, for one, can think of many things much more important to me, and the survival of the wilderness is one of them.)

Nor is the invasion of the wilderness confined to Canada. Hydroplane fishing resorts have seriously disrupted the Quetico-Superior International Wilderness Area, and promise to spread indefinitely northward. A cattle industry is spreading over Kodiak, apparently with the blessing of the conservation bureaus. Ski-resorts and ski-tows are making free with many wild mountaintops, whether or not previously dedicated to wilderness use. Last but not least, a veritable epidemic of new TVA's, river authorities, flood controls, and impoundments for irrigation or power is spreading over our river systems, and will surely invade their headwaters. A wilderness area more or less, a salmon fishery more or less, a mountain valley more or less, an Indian reservation more or less—such things are peanuts to the elephant.

A decade ago we considered sky-line drives and fire roads quite a danger to wilderness. They seem like minor irritations now.

The news from Mexico is bad. The survey recently completed by Starker Leopold shows three Mexican big game mammals on the skids—antelope, bighorn, and tapir.

Viewing the whole wilderness field, one cannot escape the impression that conservation of wilderness and wilderness species is by way of becoming merely a pious wish.

## UNGULATE IRRUPTIONS

It is now common knowledge that deer, elk, bighorn, and antelope are threatened not so much by decimation of the herds, as by slow exhaustion of the winter ranges. Only the Southeastern States are still exempt from ungulate range troubles. In the West, livestock complicates the range problem.

This threat to the winter ranges is quite as dangerous as the former threat to the herds themselves. Herd depletion had the advantage of being visible. Range depletion is apparently invisible to sportsmen, except when livestock does the depleting. In any event two decades of experience show that sportsmen in most states lack the foresight and courage to forego easy hunting now for the sake of permanence and quality in the future big-game crop. Like the timber barons and the livestock kings of unhappy memory, deer hunters are quite content to clip coupons paid out of capital account. The present forage and the future forest are the capital from which coupons now too often are paid.

No indictment holds true for a whole class, state, or nation, and this one has its happy exceptions. In deer, it is the buck-law states that are in trouble. Among the buck-law states, the western ones are showing more foresight than the eastern ones; reductions by controlled shooting are now standard practice in many Western States. While the Eastern States debate whether, the Western States are learning how. The professional skill exhibited in the planning and execution of ungulate reductions in the West is one of the bright spots in wildlife management.

Let me here venture a digression which is perhaps not wholly irrelevant because it deals with the techniques of ungulate reduction. At least two professional societies offer an annual award for outstanding contributions to wildlife literature. Too often the only contributions considered are full-blown books and bulletins. Sometimes a gem of technical thought and achievement gets buried in some transactions and goes unnoticed for years. Such a one, in my opinion, is the paper by W. L. Robinette and the late Orange A. Olsen called "Studies of the Productivity of Mule Deer in Central Utah" (9th N. A. Wildlife Conference, 1944, pp. 156-161). I wish we had more such papers to deposit in the intellectual savings account of the wildlife profession.

This question of ungulate reductions deserves, I think, a larger proportion of this program. Some good papers were given but they are few in number. Einarsen shows that even the notorious Murderer's Creek, in eastern Oregon, is capable of rapid recovery in both browse and grass when completely protected from both deer and livestock. Unfortunately the area so protected was only one experimental area.

Buechner's paper shows that Texas cowmen are getting restive about too many antelope in the Trans-Pecos country. These ranges are privately owned. Should the public compensate the cowman for the antelope's keep? Here is an important and unsolved problem.

Cowan's paper shows clearly that the Jasper Park bighorns are being eaten out by excessive elk. Shall the Park let these excess elk continue? If so, it may lose the more valuable of the two competitors. Here is a poser.

Everybody is talking land use, but are we getting down to cases? It is very hard for wildlifers to modify agricultural abuses of land, but when game itself abuses the land, the problem lies in our own "back yard." Our performance so far in reducing overlarge game herds is slow and poor. In my own state I suspect excess deer have already destroyed half of our deer carrying capacity. You and I will not live to see the recovery of the overbrowsed deer ranges.

# REGISTERED ATTENDANCE AT THE CONFERENCE

## ALABAMA

Don Drennen, Tom Ford, A. M. Pearson, C. H. Sawls, H. L. Simms, H. S. Swingle

## ARIZONA

William Graf, C. T. Vorhies

## ARKANSAS

Joe Hogan, Mrs. Joe Hogan, T. H. Holder, Mrs. T. H. Holder, T. A. McAmis, J. P. Miller, Harry M. Smith, Mrs. Nell Taylor

## CALIFORNIA

E. H. Ahlstrom, W. M. Chapman, F. P. Cronemiller, F. R. Etchen, Jr., Ben Glading, Harvey E. Hastain, C. Ray Knight, Starker Leopold, J. W. Moffett, Emil J. Ott, Jr., J. R. Parker, Tracy I. Storer, Alan C. Taft, Mal Xavier

## COLORADO

A. H. Carhart, C. N. Feast, Ralph R. Hill, R. H. Hubbard, Gilbert M. Hunter, Edwin R. Kalmbach, Herb C. Kelly, Samuel H. Lamb, K. A. McCaskill, T. C. Pender, H. F. Quick, Allen G. Smith, Charles C. Sperry, J. V. K. Wagar

## CONNECTICUT

R. H. Coleman, Gail Evans, R. P. Hunter, F. C. Walcott

## DELAWARE

William Baxter, Jr., T. E. Doremus, Clarence S. Foster, Harley G. Hastings, Henry N. Marsh, Wilbert Rawley

## DISTRICT OF COLUMBIA

Philip Barske, Jack Bell, Henry Clepper, Malcolm Crooks, Mrs. Malcolm Crooks, Albert M. Day, Edward H. Graham, C. R. Gutermuth, Mrs. C. R. Gutermuth, Michael Hudoba, Mrs. Michael Hudoba, Charles E. Jackson, M. C. James, Ethel M. Quee, John S. Rose, Carl D. Shoemaker, Mrs. Carl D. Shoemaker, Lloyd W. Swift, D. J. Thompson, Lyle F. Watts, R. W. Westwood, Mrs. R. W. Westwood

## FLORIDA

John F. Dequine, O. A. Frye, I. M. Kennedy, Merlin Mitchell

## GEORGIA

F. W. Fitch, Mrs. F. W. Fitch, Phil Goodrum, Mrs. Marian Goodrum, M. D. McRae, C. W. Watson

## ILLINOIS

Frank C. Bellrose, Jr., George W. Bennett, Victor H. Cahalane, Clarence Cottam, W. E. Crouch, Joe Davidson, Charley Gillham, R. E. Griffith, N. W. Hosley, Lynn H. Hutchens, Floyd A. Johnson, Mrs. Floyd A. Johnson, Oscar H. Johnson, Emil Klass, Fred Maly, Robert Mann, Lloyd Meehean, L. A. Parker, Kenneth A. Reid, Mrs. Kenneth A. Reid, Nancy Reid, R. M. Rutherford, G. A. Swanson, W. N. Wendell, Ray Wells, Lee Yeager

## INDIANA

Tommy Dee, Phil Goodyear

## IOWA

J. D. Armstrong, Mrs. J. D. Armstrong, Kenneth D. Carlander, Mrs. K. D. Carlander, George O. Hendrickson, Fred J. Poyneer, T. G. Scott, Mrs. T. G. Scott, L. P. Shaffer, B. F. Stiles

## KANSAS

George A. Montgomery

## KENTUCKY

Harold Alexander, M. E. Clark, Fred Hardy, Frank Phipps, Frank Pat Phipps, Jack Tom Phipps, R. A. Pierce

## LOUISIANA

E. L. Atwood, Mrs. E. L. Atwood, Bryan A. Bateman, James Brown, Mrs. James Brown, Isaac D. Chapman, V. L. Childs, S. P. Cousin, LeRoy Giles, A. C. Glassell, James N. Gowanloch, Mrs. James N. Gowanloch, Earle R. Greene, H. B. Hickman, Joseph King, John Lynch, Mrs. John Lynch, Norman Meiners, L. S. Montgomery, Mrs. L. S. Montgomery

## MAINE

John M. Dudley, John Dyer, J. S. Gashwiler, Merwin A. Marston, Howard Mendall

## MARYLAND

J. Hammond Brown, Herbert L. Dozier, M. E. King, E. A. Vaughn, Howard Zahniser

## MASSACHUSETTS

David A. Aylward, Richard Borden, Dorothy Gleeson

## MICHIGAN

Mrs. Allen Beard, W. W. Chase, Ken Dahlka, L. F. Eagan, H. H. Frisinger, Jeanne Harrington, Ray Harrington, Mrs. Ray Harrington, Paul Herbert, Jim McKenna, Perry J. Mann, Mrs. Perry Mann, H. W. Ruhl, Harold Titus, Mrs. Harold Titus

## MINNESOTA

R. E. Johnson, Verne E. Joslin, Ted Keating, George McCullough, George MacKenzie, Mrs. George MacKenzie, William L. Reavley, Robert H. Smith, E. R. Starkweather, Dr. J. R. Sturre

## MISSISSIPPI

R. M. Freeman, S. T. Thompson, W. H. Turcotte

## MISSOURI

Aden C. Bauman, Rudolf Bennitt, I. T. Bode, R. A. Brown, F. O. Capps, M. Kim Clark, Paul D. Dalke, William Elder, G. D. Gibbins, G. B. Herndon, Bettye Hornbuckle, Edward K. Love, Sr., Mrs. Edward K. Love, W. G. Nagel, Carl Noren, Mrs. C. R. Noren, Asbury Roberts, R. Gary Schmidt, Melvin O. Steen, E. Sydney Stephens, Paul Tulenko, Owen Turnbull, Ray Wells

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M. S. McMurtrey

## NEW HAMPSHIRE

H. R. Siegler, Douglas E. Wade

## NEW JERSEY

Reuben Cain, John Hugg

## NEW MEXICO

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## NORTH CAROLINA

John D. Findlay, W. L. Hammnett, Dennis Hart, Willis King, Fred Mahan, R. J. Wheeler, Jr.

## OHIO

John Anderson, Vernon Carter, Mrs. Vernon Carter, William De Laney, Ollie E. Fink, Mrs. L. L. Kinsey, Lou Klewer, Thomas A. Langlois, D. L. Leedy, D. V. Orrison, George A. Petrides, Lee Roach, John N. Shepherd

## OKLAHOMA

F. M. Baumgartner, F. G. Beckman, John F. Caldwell, Earl W. Craven, Frank Cross, L. G. Duck, Ernest J. Greenwalt, Gordon E. Hall, Jeff F. Kendall, Mrs. Jeff F. Kendall. L. Lee, Seth H. Low, Mrs. Seth H. Low, Juanita Mahaffey, O'Reilly Sandoz, E. E. Sisney

## OREGON

Richard M. Bond, R. E. Dimick, Arthur S. Einarsen, Paul Scheffer

## PENNSYLVANIA

Logan J. Bennett, W. G. Conklin, Frank C. Edminster, P. F. English, Richard Gerstell, Seth Gordon, C. C. MacDonald, Colin Reed

## RHODE ISLAND

H. E. Childs, Ruth M. Gilmore

## SOUTH CAROLINA

V. E. Davison

## SOUTH DAKOTA

Dave Harris, W. L. Johns, N. E. McEachron

## TENNESSEE

Charles J. Chance, R. W. Eschmeyer, C. D. Pierle, Mrs. C. B. Pierle, A. H. Wiebe

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# CUMULATIVE INDEX

TO THE

# TRANSACTIONS

OF THE

# NORTH AMERICAN WILDLIFE CONFERENCE

## Volumes 1-12, 1936-1947

AND

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# INDEX TO THE TRANSACTIONS

This Index to all printed Transactions of the American Game Conference, 1928-35, inclusive, and to its successor the North American Wildlife Conference, 1937-47, inclusive, is contributed by The Wildlife Society, with aid from the Fish and Wildlife Service and the Wildlife Management Institute.

The need for easy reference to these 19 volumes of important literature on American fish and wildlife has long been recognized. In 1946, the Wildlife Society contributed the brief index for volume 11 of the North American Wildlife Conference Transactions, and assumed responsibility for indexing the preceding volumes of this series together with volume 12. The undersigned Committee was appointed by the President of The Wildlife Society to do the work. At the time of the Twelfth North American Wildlife Conference at San Antonio it was decided by officials of The Wildlife Society and the Wildlife Management Institute to add the seven printed volumes of the American Game Conference, so that both series could be used simultaneously.

The main objective of the Committee has been to prepare a usable index. The arrangement followed is the simplest that could be devised, and will be apparent upon examination. It should be remembered by the user that two series of Transactions have been combined, and that the volume numbers for the American Game Conference begin with 15 and end with 21; those for the North American Wildlife Conference run from 1 to 12, inclusive. Thus, no overlapping occurred and any volume may be designated by number alone.

It should be added that the Committee was forced to operate under the difficulties of time and distance. For this reason it was not possible to clear every point by discussion and the Chairman thus arbitrarily assumed certain responsibilities. For this reason he wishes to absolve other members of the Committee for any shortcomings that may be detected in the Index. He wishes also to acknowledge the assistance of Dr. P. F. English and his wildlife students, who prepared author cards for the American Game Conference Transactions; of Dr. Gustav Swanson and C. R. Gutermuth whose interest and encouragement was helpful; and of Rae Shimojima and Hiroko Baba, who assisted faithfully in the laborious task of filing and manuscript preparation, thus making it possible to meet the deadline for completion.

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