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THE AMERICAN WILDLIFE INSTITUTE desires to express its gratitude and appreciation of the work of the Committee named, at the Institute's request, by The Wildlife Society to develop the program for the Technical Sessions of this Conference.

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GENERAL SESSIONS

FIRST GENERAL SESSION

Monday Morning—March 18

Chairman: HONORABLE HARRY B. HAWES

Former United States Senator from Missouri

CALL TO ORDER

The Fifth North American Wildlife Conference, held under the joint sponsorship of the American Wildlife Institute and the National Wildlife Federation, was called to order in the Grand Ballroom of The Mayflower, Washington, D. C., at 9:15 o'clock a.m., Monday, March 18, 1940, by the President of the National Wildlife Federation, Mr. David A. Aylward.

MR. AYLWARD: The Fifth North American Wildlife Conference will be convened. The first announcement I have to make I do with extreme regret. I have to announce that your friend and my friend, Frederic C. Walcott, is in a hospital in New York, having had a serious operation upon his eye. I know you all feel for him sincerely, as I do, and I know that with me you would like to express your sympathy and regret. With that in mind, we have drawn up the following telegram resolution that I am going to read to you and ask you to express your opinion.

"To The Honorable Frederic C. Walcott:

"The Fifth North American Wildlife Conference by unanimous vote sends greetings and our sincere sympathy is with you in our earnest wish for a speedy and complete recovery."

(A motion was regularly made and seconded that the telegram read by Mr. Aylward be sent to Mr. Walcott.)

I am not going to ask for a vote. I know it is the unanimous expression of those gathered in this meeting that we express this sympathy to Fred Walcott by wire.

I should express to you the greetings of the American Wildlife Institute and the National Wildlife Federation.

We have certain definite things on our program to accomplish. This morning's program is a sort of oldtime meeting. It includes the names of the Honorable Harold L. Ickes, Hoyes Lloyd, Dr. Gabrielson, Carl D. Shoemaker, Karl E. Mundt, and Albert M. Day. They have all been active in the movement over the years and have given their life's work to the cause.

While I dislike this job of opening these meetings and would much rather sit down with you and be comfortable, I am particularly happy this morning because it gives me an opportunity to pay tribute to one of the outstanding figures in conservation, a man who has carried the banner and carried it successfully, as I think you will agree when I note to you some of his accomplishments.

The Honorable Harry B. Hawes is an author. We all remember his black bass book, and his other contributions. Senator Hawes was the father of more conservation legislation than any other man in the Congress. The Upper Mississippi Wildlife and Fish Refuge is credited to him, and of course you all know about the Black Bass Bill. He and Senator Walcott jointly sponsored the Senate resolution for a Special Committee on Conservation in the Senate. (Incidentally, we hope that committee will be revived.) He was co-author of the Coordination Bill and the Duck Stamp Act and other legislation of a highly constructive nature.

It gives me pleasure to introduce to you the Honorable Harry B. Hawes.

ADDRESS OF WELCOME

HONORABLE HAROLD L. ICKES
Secretary of the U. S. Department of Interior

CHAIRMAN HAWES: *Late Saturday I was requested to take the place of our dear friend Fred Walcott, just for the morning, because nobody could ever take Fred's permanent place.*

The American Wildlife Institute requests me to introduce the Honorable Harold L. Ickes, Secretary of the Interior. The word "Interior" does not adequately describe his duties. The designation should be "Secretary of the Interior and Exterior." The manifold duties of his office include such a variety of activities that they take him under the earth, on the surface, and above the earth, and extend not only throughout the forty-eight states, but to Puerto Rico, the Virgin Islands, Hawaii, the Philippines, and Alaska.

Occasionally the Secretary adds to his official duties others that are not designated by the law. Recently he put diapers on Mr. Dewey and forgot to use a pin. He put a halo on our President, much to the displeasure of Mr. Hamilton. When he discovered the density of population in the Puerto Rican Islands, he suggested birth control. After a committee of Senators had visited the Virgin Islands he suggested a change of name. He was impressed with the thought that the early missionaries in Hawaii would not entirely approve of the hula-hula and grass costumes used to entertain and impress American visitors. Sixteen million democratic Christian Filipinos have come under his wing.

But what concerns us—I mean the six million sportsmen who take out hunting licenses and the six and a half million sportsmen who take out fishing licenses—is his recently acquired control over migratory birds, ducks and geese resting upon a migratory bird treaty with Canada, now supplemented by an additional treaty with Mexico.

Dr. Gabrielson, head of the Bureau of Biological Survey under his direction, is trying to solve the problem of the preservation and increase of migratory birds. I note these birds are being marked for their old four lanes of flight; it may be with the intent of educating them into taking one lane as a conservation measure for food and refuge on their cross country journey twice a year. But whether the ducks and geese can be persuaded into taking the one-lane flight is an unsolved question involved with the importance of open and closed seasons.

It is known that the Secretary is in favor of an all-year-round open season on Senators and Congressmen and we hope some modification of a limited closed season for ducks and geese.

Mr. Iickes now has control over the fresh-water fishes which travel many thousands of miles in our fresh-water streams and lakes. Then he reaches out 3 miles from shore in the Pacific, in the Atlantic, and the Gulf of Mexico to provide regulations for the salt-water relatives of the fresh-water fish.

I inquired of Secretary Hyde, who had charge of this work under Mr. Hoover, during a trip with me on one occasion, "What gave you the most trouble, Mr. Secretary?" And with great emphasis his answer was "Ducks!"

Of all the long line of Presidents we have had, none has shown a greater, more practical, more energetic interest in the conservation of our wildlife resources than President Roosevelt. When he transferred the forces of conservation to Secretary Ickes, he probably had in mind the foolish conduct of the cow that kicked over the lamp that burned the village of Chicago and gave an impetus to the building of the great central metropolis of our country.

We know that, coming from Chicago, Mr. Ickes is familiar with the fishing and hunting in the surrounding states and how that city has dumped its sewage into the Mississippi River.

MR. ICKES: *Yes, and we are taking it out.*

CHAIRMAN HAWES: *But he also had his bringing up in the environment of the Izaak Walton League, the American Game Association, and a group of sporting enthusiasts, men who tie flies, build rods, camp out, and give a large proportion of the twelve months to the outdoors.*

I am one of those who believes that he is a sincere friend of conservation, that with his energy and dynamic personality the movement for conservation, revived by President Roosevelt, will be pushed forward by him. He will give it the punch that has made Harold L. Ickes' name a synonym for fighting energy.

I have great pleasure in introducing the Secretary.

SECRETARY ICKES:

I might say to Senator Hawes that he needn't have concerned himself about getting me into trouble; I have a capacity for that myself.

This Fifth North American Wildlife Conference is of great importance to the citizens of three great nations whose representatives have come here to discuss problems and to promote plans concerned with the restoration and preservation of a resource that overspreads and knows not political boundaries. At this time, when millions of men under arms are striking at each other in other parts of the world, I find it especially gratifying to extend a cordial welcome to our friends from Canada and Mexico who are here, equipped only with kindly intentions, upon a neighborly and peace-furthering mission.

The First North American Wildlife Conference was called by President Roosevelt in 1936. That occasion was less distinguished by a spirit of optimism than is this upon which we are now assembled. That conference was for the purpose of ascertaining the status of the wildlife of the country. The President wanted to know whether the remnants of a once great heritage could be restored, and, if so, by what means. The meeting had something in common with that of a gathering of nephews and nieces eager to hear the reading of the last will and testament of a rich but sportive uncle. Everyone knew that uncle had plenty to begin with; but since he had spent most of his life racing horses and playing roulette and poker, there was a feeling of natural anxiety as to how much of the old man's wealth remained to pass on to his heirs.

The history of North American wildlife from the coming of the white man to these shores was such as to give little comfort or encouragement to those who realized the value of this resource and who understood its profound importance in the development of our civilization. There was abundant evidence of an awakening interest on the part of the public, but there was evidence also that this concern, great though it was, was not enough in itself to bring about the necessary reforms. There was no well defined national program designed to rehabilitate and protect our wildlife; the many organizations representing sportsmen, naturalists, farmers, and conservationists of all classifications had no effective means, even if they had the will, by which they might unite to achieve a common purpose.

Today we find this situation entirely changed. In the years since 1934 greater progress has been made toward the restoration of these resources than ever before. At last we are able to speak of things that have been done. We no longer need confine ourselves to wistful discussions of what should be done. Important legislation to benefit wildlife has been enacted; far-reaching programs have been adopted to restore and conserve the natural organic resources, and already results are apparent. We are well entered upon a new era of real conservation. This means much more than the mere preservation of our remaining resources of soil, water, forests, and wildlife. It means that in the future we will be able to use these things more abundantly, drawing for our needs upon supplies which, through our orderly management of them, will continue to increase even as they are used. Our organic resources are not now regarded as mere relics of a vanished glory that was ours. They are a living, growing part of the Nation, the vital foundation upon which the hopes of our civilization rest.

The first conference in 1936 had two important results. It marked the undertaking of a federation representing all of the kindred conservation interests, and it developed, for this country, the first national wildlife restoration program.

As far as wildlife is concerned, the previous policy of the Federal Government had consisted in recognizing an emergency some months or years after it had occurred, when the damage had already been done. Then—as was the case with the passenger pigeon, the heath hen, and several other unique and valuable species of American wildlife—it was often too late to do anything except to sing the requiem. The present program marks an end to that type of "husbandry" and in its place sets up one that projects its concern into the future and that attempts to solve conservation problems before they materialize in the form of immediate and unavoidable disaster.

The presence of our friends from Mexico and Canada reminds me that it is nearly a quarter of a century since the governments of Great Britain and the United States executed the migratory bird treaty for the protection and preservation of waterfowl and other valuable species of birds migrating between the two countries. In 1936 the governments of Mexico and the United States executed a similar covenant. I have heard these treaties referred to as "gentlemen's agreements," and so they are. They were not drafted under threats or compulsion, nor can even the seals and formal language of the official documents conceal their spirit of cooperation and good will.

The migratory birds of North America constitute a resource of major importance. At different seasons they are visitors in each one of our three countries. This circumstance of joint ownership could well have been a source of dissension among us, but it has not been so. If we translate the purpose of these treaties into homely, familiar speech it simply means that we neighbors are saying to each other: "I'll take good care of these birds while they are on my property."

These treaties do not signalize any profound diplomatic triumph; rather they are monuments to the friendliness and common sense of North Americans. In spite of our good intentions, however, in 1934 the migratory waterfowl—harassed by drought and overshooting—in numbers were at the lowest point in their history. In the opinion of many intelligent observers the ducks and geese of North America were already too far along the road to extermination to be saved. It appeared probable that we were soon to witness another tragedy similar to the wiping out of the passenger pigeon from the face of the earth. The emergency was met in this country by the Waterfowl Restoration Program. One of the main purposes of this is to reduce the killing of ducks and geese by drastic regulation of shooting. This step was necessary in order to conserve the breeding stock and enable the bird population to increase. It was a practical application of the natural law that consumption of any renewable resource must never be permitted to exceed the rate of production. That action saved these birds.

Since 1934 the number of ducks has been approximately doubled. I do not mean to say, however, that there is not now a shortage of ducks and geese. A shortage still exists that will continue until all of the areas on the continent suitable as habitats of waterfowl are carrying capacity populations.

When the federal wildfowl shooting regulations for 1939 were announced it became evident that some of the duck shooters didn't like the idea of restoring the waterfowl any further. They said that there were enough ducks and geese already, and they even wanted the regulations modified so that they could kill more of them. Some of these people seem to think that unless the Department of the Interior stops this pernicious business of restoring waterfowl immediately there will be a 6-foot layer of mallards and pintails covering the entire continent. I cannot understand this viewpoint, for I have never heard of a duck hunter complaining of too many ducks, nor of an angler—except Jonah—who protested about too many fish. (If there are reporters present I want it understood that I am quite aware that the whale is not a fish—that was Jonah's idea.)

To me it seems wise to keep on with our present program until we have all the birds that the marshes can accommodate. We are approaching this goal, but we shall never achieve it if selfish individuals and organizations insist upon breaking open the china pig whenever we have managed to induce a few dimes and nickels into it.

The regulations allow reasonable shooting, and so I find it impossible to muster sympathy for the protesting gunner whose ration card doesn't allow him a boat load of ducks every day of the season, with perhaps even an extension of the season. Wildfowling is a royal recreation, but apparently there are those who indulge in it who have no concern either for the equal rights of others or for the maintenance of the resource itself. Those are not convincing advocates who appear in opposition to reasonable and necessary regulations to govern and perpetuate the sport.

The second objective of the Waterfowl Restoration Program is to establish a comprehensive national system of waterfowl refuges. An estimated seven and a half million acres are required to meet the minimum needs of such birds in this country. Approximately half of the total required area has already been acquired and set up as refuges that are administered by the Bureau of Biological Survey. These sanctuaries are located on the breeding grounds, on resting areas, along the great flyway routes, and upon the wintering grounds in the Southern States. Experts from the Biological Survey will tell you in detail how this great work is being done.

In 1934 the total area of all wildlife refuges and sanctuaries under administration by the Biological Survey amounted to 6,085,000 acres. This total included not only all refuges for waterfowl, but preserves for big and small game, and those established for other forms of wildlife, as well. Today we have nearly 14,000,000 acres set aside for these purposes.

These great projects mean much for wildlife, but they may well be of equal or even greater importance in aiding us in the solution of some of the Nation's soil and water conservation problems.

It is significant that all these areas have been put into various kinds of wildlife refuges without encroaching in any way upon the lands required for agriculture or industry. In many instances their establishment has been distinctly helpful in building up the natural water resources in drought stricken areas. By the simple expedient of coordinating all of the federal programs dealing with the use and conservation of soil and water and their products we have made a good beginning in repairing the damage done in the past when each agency pursued its own special program without concern for the harm that it might be doing to others.

The new order of conservation of the Nation's renewable resources has been in effect only for a few years, yet it has already become so thoroughly accepted and established in the minds of Americans that we wonder why a program so reasonable and sound could not have been undertaken long ago, in time to prevent the indiscriminate drainage of 77,000,000 acres of natural water reservoirs; in time to save our forests and the millions of tons of fertile soil that have been washed away by flood or blown away by the winds. One writer, with reference to the waste and destruction that prevailed in the era of reckless exploitation, has remarked that "the ravage of Asia was a slow process, one that required thousands of years to accomplish with the crude implements that early man had been able to invent. In less than four and one-half centuries the most fertile part of North America has been reduced to a condition so nearly comparable with the Asiatic scene as to be appalling."

Across the seas millions of men are now in arms in a deadly struggle for possession of the remnants of the natural resources of two ancient continents. We ought to have no feeling of complacency, but only of humility, that our own resources are still so abundant that we are not driven to the desperate expedient of war in order to obtain those things that are necessary to maintain our populations at a standard of living that would be more decent than it is if only we had become conservation-minded earlier and were more conservation-minded even now. We may be sure that our present comparative immunity from the conflicts that are consuming the wealth, culture, and vital energy of other nations is not ours because of any superior quality of grace that makes us more deserving.

We can never assure for America a future of peace and plenty until we renounce the role of squandering inheritors and become economizers and builders. In our handling of our natural resources for more than four centuries we were reckles spenders. Only during recent years we have learned to become earners. We have also learned that this is a nobler way of life.

It has been a great privilege to come and meet—what shall I call you, my new wards or my new brothers? I would like to say that you will always be welcome in the Department of the Interior, that our principal concern, our principal ambition, is with reference to conservation of our natural resources, and I hope that the Biological Survey and Bureau of Fisheries if allowed to speak will feel that they are able to tell you that in their work they are meeting the most cordial cooperation from every other bureau in Interior that has to do with cognate interests.

MESSAGE FROM CANADA

HOYES LLOYD

Superintendent of Wildlife Protection, National Parks of Canada

CHAIRMAN HAWES: *We are all pleased to have with us today the Chief of Wildlife Protection of the Dominion of Canada. We are protecting the ducks that come down from Canada, and I for one think you will all agree with me and are delighted to know that while we are getting Canadian ducks, England and the Allies are getting arms and ammunition and men from Canada; while we are fighting for the preservation of wildlife here, it delights us to know that Canada is fighting for democracy over there.*

This whole wildlife program rests upon what one might call an agreement between two gentlemen, between Canada and the United States, trying to do the sportsmanlike thing regarding wildlife. Recently Mexico joined in, but her part is much like ours—preservation. The home fires, the nests, the breeding grounds, are in Canada. Without the active support of the Canadian Government, its sportsmen and its conservationists, all our work is for naught.

I take great pleasure in introducing Mr. Hoyes Lloyd, an oldtimer, an understanding man, a popular man, a vigorous exponent of wildlife and democracy amongst ducks as well as democracy in Europe at the present time.

MR. LLOYD:

Again it is my pleasant duty to attend a North American Wildlife Conference as a representative of the wildlife conservation service of the Dominion of Canada.

These are troublous times in the world, but no one questioned my good faith upon entering the United States the other evening. Strange though it may seem—I entered on my face—that is speaking metaphorically of course. I hear that none of the conservationists who travelled from Canada to this meeting had any more difficulty than it takes to walk across the street and visit the neighbors. We appreciate having good neighbors and want to be good neighbors in return.

Fortunately for you my words on this occasion will be few. In wartime it may not be possible to do all the conservation work we should like to do in Canada, but our endeavor will be to hold ground already gained, to continue all essential conservation services, and to avoid any wasteful exploitation of the wildlife resources that are of continuing benefit to both countries. Although new plans and new projects may have to await happier times for their achievement, it is our sincere hope that in spite of any necessary retrenchment the all-important work of conserving our resources in wildlife will proceed with imperative actions receiving attention, and when we resume in full our ordinary peacetime pursuits, personnel and plans will be available to again advance with fresh vigor this worthy cause.

Needless to say the Migratory Birds Treaty, an agreement between your country and ours entered into twenty-four years ago, will continue to be observed in spirit and letter. This wartime measure marked a turning point in the awakening of North America to the need of protecting its migratory bird life, and progress has accelerated during the intervening years.

While here I may say that Canadians will be glad to see their United States friends come to Canada this year as in previous years. Everything will be made simple for them at the border. Exchange problems do not exist. As an example to illustrtate the point, I read in the papers that a United States visitor at a Canadian hotel paid for his breakfast with a ten dollar bill. His change in Canadian money was ten dollars and twenty cents. He commented that he liked Canada even though we were a little "screwy." Every visitor is assured by Canadian law that he will receive the full benefit of the exchange. If in doubt ask any of 3,300 branch banks.

I have a few circulars giving all particulars for anyone who wants them, and the Canadian Bureau in charge has more.

For those who desire a gilt-edged invitation to come to see us, whether for a holiday or for hunting or fishing, I have here a copy of a widely publicized invitation from the Prime Minister of Canada asking, on behalf of the people of Canada, that citizens of the United States come to visit us this year. They will be welcome.

So, in summation, in spite of war, we plan to hold our own in wildlife conservation, and are carefully guarding our wildlife assets. To work with you in friendship in saving the wildlife resources of our continent is a privilege and by our mutual efforts I am sure we shall keep for this continent some of the pristine charm of natural forests and waters and the wild creatures that inhabit them.

PLANNING FOR WILDLIFE RESTORATION

IRA N. GABRIELSON
Chief, U. S. Bureau of Biological Survey

In the progress of wildlife conservation it is well to pause occasionally, take stock of our gains, and try to forecast the future of conservation and restoration of this basic resource.

As we look back over the past few years it seems obvious that two or three ideas have become more widely accepted and more clearly understood than ever before, and because these seem to be basic and essential ideas, their more general acceptance denotes real progress. One of these is related to the growing understanding of the inter-relationship of all conservation programs. The other two constitute a pair of almost twin concepts: First, we can have wildlife only by providing it a suitable place in which to live, and—second—we must keep our annual wildlife harvests below the annual production. Add to the acceptance of these three concepts the widespread recognition of the need for basing all undertakings on the results of careful research, and I believe we have in general terms the sum of the progress of recent years in wildlife conservation.

As we look ahead, basing our plans for the future on our accomplishments of the past, it seems to me that we have three outstanding needs—a need for more basic information, a need for more land for wildlife, and a *great* need for a more widespread educational program that will get such information as is available into the minds of those who will use it or be influenced by it. Add to these three requirements the necessity for a certain degree of patience with sound though unspectacular measures, and I believe we have stated in general terms our needs for the future.

It is my purpose to discuss these gains and these needs.

The growing understanding of the interrelationship of all conservation programs that I first mentioned is of basic importance. The interdependence of water, soil, forest, and wildlife conservation is acknowledged in ever increasing degree by students of those subjects and by supporters of conservation programs. This understanding has altered somewhat our approach to these problems and has, I believe, resulted in a clearer and more wholesome understanding of all such problems. This understanding has also contributed to the growing acceptance of the two concepts that I mentioned as basic to any wildlife program. One of these relates to land. We can have wildlife only by providing it a suitable environment. The second concept, as I have already indicated, is that if we are to have game species, and those other species which man wishes to appropriate for his own use, whether they be trees, animals, birds or fishes, we must take no more than the annual production, so that there will always be stock left to grow, multiply and replace whatever we take.

These are basic concepts. I do not believe that we shall ever find by research or studies any way to alter or modify them. The migratory waterfowl program of the Biological Survey is based on these ideas, and it is succeeding. The waterfowl population has doubled in five years, and it can be doubled again and again by following the same sound program before it will overcrowd available and restorable environments. In analyzing the many successful state conservation programs it seems to me that they have built on the same solid basic ideas. Such programs will succeed only as they can be directed along sound lines, but there are many obstacles to such accomplishments.

To go back just a bit, let us analyze our program in the light of these two ideas and limit our discussion to the wildlife restoration program. One of the questions frequently raised is: Why, if these two things are fundamental and unalterable, do we waste time in further research and study of wildlife problems? It seems to me the answer is obvious. These two factors are basic. We must have suitable places for wildlife to live and reproduce itself, and we must limit our take to the annual crop, or to less than the crop, if we are trying to increase populations of that species. No amount of research will ever alter these two basic requirements. It seems to me they are as fundamental as life itself and that only by recognizing their fundamental nature and trying to work within that framework can we succeed in increasing the stocks of these valuable forms of wildlife. It seems obvious that this continent, so long as it is inhabited by civilized man, can never again produce as abundantly and prolifically as it did before the white man took over the country and utilized its resources to his own advantage and for his own purposes. We have taken, for crops, for cities and for all the multitude of purposes for which the white man uses land, huge areas that formerly produced wildlife. Some of it can produce none under existing conditions; some of it which has been thoughtlessly impaired can be made to produce wildlife again. So the chief purpose of wildlife management research is to get more accurate information as to how to improve and manage the available lands so as to produce more wildlife. The quest for more information to enable us to handle the problem intelligently is constant and unremitting. The conservationist can never assume that his knowledge is complete. The sign or symbol of progress in this field is the question mark.

There are still many factors that influence wildlife populations and abundance. If we understood these more thoroughly and completely we might alter them to the advantage of wildlife. Food, cover, and their relationships to each other, disease, interrelationships between species, the effect of predators on preyed upon species, the effect of parasites and lack of small but vital elements of food supply are only a few of the things we greatly need to know more about. We know all too little about the total volume of life that may be produced on a given section of land and we ought to know much more how we may alter that production to meet man's needs by working through nature and with natural processes.

The first great need, then, for the future wildlife program is more information, more dependable facts and less guess work. In other words, research must be continued and on an increasing and expanding scale. We need research into disease, into predatory relationships, into the intricate problem of parasitism, into the effect of man's activities on wildlife. We need to study drainage, cultivation and the harvesting of forests and learn how these things affect dependent animal populations. We need more adequate information as to the populations of important species, a subject which is very vaguely covered, if at all, for most forms of wildlife. For the past two years, for example, the Biological Survey has endeavored to correlate and compile information on major American big game species. I believe the chief thing we have learned from this compilation is the undependability of the information available and the lack of agreement among those who have furnished this information as to the number of animals in any selected territory. Now we are ready to devise more reliable methods, as from these comparatively simple studies we have learned the weakness of our present basic information. Several states have undertaken, with Pittman-Robertson funds, to make more comprehensive surveys of their wildlife resources than have yet been made. In the future, we shall need more and more to develop more dependable and accurate information on the stocks of wildlife and the harvest available each year. In other words, we must have a national wildlife inventory that may be taken at frequent intervals to help us manage this resource more intelligently. We need to build a mechanism for developing that information on an increasingly accurate scale. Along with it we shall develop increasingly accurate knowledge of the factors that influence those populations locally as well as nationally.

The second great need in the wildlife conservation field, it seems to me, is for more land upon which the production of wildlife may be made the primary enterprise. We can obtain greater production on conservation lands in only two ways—by the purchase of new land to be devoted to wildlife production, or by the further development of land now available. Both of these programs are now going forward in a rather slow but steady manner. Migratory waterfowl lands are being acquired with duck stamp funds and the national program of the restoration of marshes for the preservation of breeding stocks is about one-half completed. The development of lands for both migratory and upland game species is also proceeding under the Pittman-Robertson Act and will assume increasing importance as the years go by. I do not think it is possible to over-estimate the importance of this fact. Once a piece of land is obtained for wildlife use and put into production it can with a minimum of effort continue producing that wildlife while other problems are being solved and while other areas are being acquired and developed. The effect will be cumulative.

As a corollary to this, every conservation organization and group must oppose vigorously and intelligently the further destruction of suitable wildlife habitat. I do not mean to say that every drainage or water-diversion project must ultimately be blocked, for there are some perhaps which will contribute so much more to human welfare that they should go through. We have, however, the right and the duty to demand that such projects be amply justified before public moneys are spent. We should prevent the destruction of something that has a productive value unless it can be shown that a greater productive value will be created by it. The same statement is true of any other program that means further destruction of other valuable resources which we now have.

The third and greatest need is for the extension of education in many fields. It has always seemed to me that too much of our effort in conservation has been expended in efforts to educate ourselves and those who already had some understanding and interest in the program, and that we have not yet developed an effective mechanism for getting conservation understanding and information into the minds of those who do not yet know and appreciate its basic significance to future human welfare. It is my feeling that conservationists themselves are somewhat to blame for this. We spend too much time talking and arguing and differing over unessential details—whether it should be done this way or that—and not enough in discussing how much may be accomplished. We lose sight of the fact that to accomplish is after all the main purpose.

There are plenty of existing mechanisms for carrying out this education program if we can only hook them up with conservation ideas. Schools, clubs, and organizations of various kinds are interested or can be interested in conservation problems if we can only get suitable information to them. Whether we get conservation into the schools as a special subject or by introducing factual conservation material into already established courses of study seems to me to be of far less importance than getting it done by either method or by both of them.

There is one particularly fertile field for educational effort that has not been explored or at least has not been exploited to the extent justified by the opportunities available. There exists now in the many governmental agencies dealing with land and with people on the land a marvellous mechanism for projecting a correlated program. Many of these organizations are carrying on such programs but there is in some instances a lack of coordinate understanding between them. State agencies and federal agencies are attacking the problem from various angles. It seems obvious that we have yet failed to reach the individual private landowners in numbers sufficiently great to do the job. Some states, however, have done admirable work in trying to cultivate this field, and it is an important one.

It is not within the realm of possibility that we shall ever have available for the exclusive use of wildlife and for the production of wildlife enough land to meet the demands for the various forms which are useful and valuable to man. It is therefore going to be increasingly necessary to correlate the production of wildlife on many lands with other perhaps dominant uses. If we are to approach the problem from the standpoint of the fundamental needs of wildlife we must go beyond a straight federal or state owned land management program. We must promote in some way, in an ever increasing degree, the restoration and preservation of suitable conditions and suitable environments for wildlife on privately owned lands and this must be integrated with agriculture and other uses to which those lands must of necessity be put. A way must be found to encourage private landowners to consider the needs of wildlife when they plan their land use programs, and we must continue to educate the public to the idea that wildlife can be produced on a sustained yield basis if properly managed.

We have accomplished much in the past ten years by the expenditure of state, federal, and local funds in restoring and developing worthwhile wildlife projects; but we must never forget that wildlife is a product of the soil and that only through a sound system of wildlife production on lands used for other purposes shall we be able to produce the numbers needed by the American people. These state and federal programs demonstrate what can be done under proper managreement, but its general application will require a broad acceptance which can come only through an educational effort. Other agricultural programs have clearly demonstrated that permanent results can be accomplished only when research and education have prepared the way and public interest has been kept alive after a start has been made.

Game crops produced on farms now furnish the larger part of the game taken for sport and food by the hunters of this country. Eighty per cent or more of game and fur animals taken during the past few years have been produced and grown on privately owned land. The management of those lands spells success or failure for any farm game management plan. A very high percentage of the existing food and cover, or possible restorable food and cover, which limits wildlife production is on private lands. State game authorities assert that at least 80 per cent of the hunting and trapping licenses issued in the United States are used almost exclusively for the taking of game and fur animals produced on such lands. The records of hunting license sales are interesting from the standpoint of wildlife populations. In the eleven Western States, the so-called public land states (Washington, Oregon, California, Nevada, Arizona, Utah, Montana, Wyoming, Colorado, Idaho, and New Mexico), there are about 200,000,000 acres of public domain and more than 133,000,000 acres of national forest. Most of these areas produce some type of wildlife sought by hunters. Yet out of 7,524,720 hunting licenses sold in the United States for the hunting season beginning in the fall of 1938 and extending into 1939, these states, which together represent about 40 per cent of the land area of the United States, supplied only 1,110,752 or about 15 per cent of the total hunters. Contrast these figures with those from the farming areas. Sixty-six and two-thirds per cent of the total hunting license holders, or 4,966,699, were recorded from the twenty-six states east of the Mississippi River. Many of these states are so nearly agricultural that it is difficult to find any extended tracts of really wild land. Indiana had 389,092 licensed hunters who killed 85 per cent of the game taken from the 88 per cent of the land in the state which is in farms. Michigan, with only 50 per cent of the state in farm land, supplied 70 per cent of the game killed by 682,605 hunters from those agricultural lands. Ohio's 565,104 hunters took 85 per cent of the kill from the 87 per cent of the state which is in farms. Pennsylvania, 55 per cent agricultural, and New York, 61 per cent in farms, had to supply game for over 200,000 more hunters than the entire eleven western range states.

The problem facing the game administrators is definitely one of correlation and integration of wildlife conservation into the program of agriculture. During the past few years a greatly expanded research program has added much to our stock of knowledge on the management of wildlife but when a research worker discovers some new facts, his findings are of limited application because so few people learn of the results. We have no way of disseminating information about improvements in wildlife management to make sure that it will reach those who should have it and who are the only ones who can put it into practice—the farmers. As a matter of fact, it is difficult for the wildlife administrator himself to keep up with the developments in the research field. I wonder how much improvement there would have been in the agricultural production of this country through the past fifty years if the experiment stations had had no better means of disseminating information than we have in the wildlife field. The great gap at present is between the technician and the administrator and the owner and user of the land.

It seems to me that one of the most pressing needs facing us at present is an organization of well-trained specialists who can take the results secured by our research workers, translate them into common, everyday language that the landowner can understand, and then, working with the existing organization and existing mechanisms, pass the information on to those who want the facts and can use them.

The farmer can be the most important individual in the whole field of wildlife conservation. He owns the land on which the game grows and he has the means of providing suitable natural conditions. He is interested in wildlife and would like to know what he can do to produce it in conjunction with the regular farming operations. His chief difficulty is in finding out what he may do at a reasonable cost and we, as wildlife technicians and administrators, have no adequate way of getting this information to him.

My suggestion is that we secure congressional authority and adequate funds to provide Wildlife Extension Specialists, if we may call them that, to work with the Extension Service, the Soil Conservation Service, the state conservation commissions, the 4-H Clubs, the Future Farmers of America, the sportsmen, and any and all other groups who have the contact or the facilities to spread sound information to the landowners. In that way the needs of wildlife may be considered in every land-use program and the results of the studies made by our research and technical workers may be available to all who can or will use them.

A program based upon more knowledge by research and study, more restoration of environment, and more education sounds trite perhaps and commonplace. The work of strengthening our mechanisms for creating better understanding of conservation problems, the laborious and often painfully slow accumulation of more solid facts—facts to be used as tools in a better management program, and the patient waiting for improvement of environment on public and private lands, sound somewhat uninspired and uninspiring. For too many there is little thrill in forging laboriously ahead on a solid program compared to the adventure of following the will-of-the-wisp of the latest nostrum and panacea.

The willingness to leave tried and tested if unspectacular programs for some new cure-all is not limited to conservationists. It exists in all forms of human endeavor. We have tried every device prepared to show us a short cut to restoration of our wildlife resources. One after another we have worshipped at the shrine of plausible new gods only to learn that we were indeed following after gods with feet of clay and that they offered no pleasant substitute for hard work and common sense as means for attaining prosperity and success.

Restrictions in the take of game species, refuges, and artificial stocking, to speak of only a few, have all at one time or another been proclaimed to be the final and only answer to America's conservation needs. One after another each has been found to be not enough in itself to accomplish the restoration although each still has its loyal followers who believe in its universal curative qualities.

I do not mean that these things do not have values; they are all useful tools if properly used, but I emphasize that they are tools, not solutions. We need these tools and many others to help us make progress in such work.

It seems to me that America has now a better chance than ever before to choose the right path toward adequate wildlife restoration and wise use of wildlife resources. We have better conservation machinery, more and better trained men to operate that machinery, and a somewhat better popular understanding of the problem. In recent years we have actually made considerable progress toward restoration. As evidence of this progress I may repeat that the continental population of ducks and geese has doubled in the past five years and by continuation of the same sound program of environmental restoration and limitation of the harvest to less than the crop produced there is no reason why the existing and newly restored breeding areas cannot be eventually put into full production. Despite wishful thinking and stories of "more ducks than ever before," that time is not yet here.

Yet I am fearful that we will lose patience with this slow and unspectacular progress, fearful that the impatient demands of those who wish to exploit our wildlife resources for personal gain or who desire to take birds, mammals, and fishes for recreation and sport now—with no thought of the future—will break down the only programs that have ever promised success.

These programs depend for support upon sensible conservation-minded Americans, such as you who have gathered here for this Fifth North American Wildlife Conference, and on those who are not present but who believe and understand as you do.

We have a great opportunity and a great responsibility today. Encouraging progress has been made; we have more and better conservation organizations than ever before; every day we gain more knowledge—more facts on which we can build a restoration of our wildlife resources.

The question is: Can we continue on an increasing scale the task of providing land for wildlife and at the same time continue to exercise an essential self-restraint and wisdom in limiting the harvest we take? If we can as a nation say "Yes!" to that query, and mean it, then there is no valid reason why Americans cannot have wildlife with all its values for all time to come.

KEEPING TABS ON WILDLIFE LEGISLATION

CARL D. SHOEMAKER
Washington Correspondent, National Wildlife Federation

Your next speaker is a man who I believe is known to more of you personally than any other man in this audience—Carl D. Shoemaker. He has occupied a very strategic, effective position in our National Government, Secretary of the Special Committee on Conservation of Wildlife Resources of the United States Senate.

MR. SHOEMAKER:

Dr. Gabrielson has just given you one of the most illuminating discourses on the problems of wildlife restoration that I have ever heard. He strikes at the fundamentals. There are two very important factors in this whole program. One of them is the development, through education, of a program; secondly, the translation of that program into action, and quite frequently, most frequently I might say, that translation must be made through legislation either in state legislatures or through Congress. Without legislation the hands of wildlife administrators everywhere would be tied; they could not carry forward the things that they have set out to do.

The first real recognition of the wildlife problem in a national way came in 1900 through the Lacey Act. There wasn't much to it. It was fundamental, however, and is still one of the strong pieces of wildlife legislation on the statute books. That is the groundwork. It took about sixteen years, from 1900 to 1916, before the next great step was taken, and that step was the Migratory Bird Treaty with Canada. In the meantime there had been some fisheries legislation, legislation with reference to Alaska, a number of wildlife refuges established in the western country, but the second great legislative step was the treaty with Canada. Then for the next fourteen years a number of other steps were taken. Senator Hawes came into the picture somewhere in the twenties as a Congressman from Missouri. He fought for and finally got upon the statute books the Upper Mississippi Wildlife and Fish Refuge, and the Black Bass Act.

There was other legislation. I can recall, as most of you here do, the fight made in Congress to get the Norbeck-Andresen Act passed. When that was done, it was felt, "Now that the Norbeck-Andresen Bill is passed we have solved our problem." But it was not so. Why? The Norbeck-Andresen Bill was all right except that it failed to make the necessary appropriations to carry out the program. Appropriations were authorized, but they never were appropriated up to the full amount. Therefore, a great bill became almost inoperative simply because Congress didn't follow through with the necessary appropriations.

That and other considerations led in 1930 to the establishment of the Special Committee in the Senate on the Conservation of Wildlife. Senator Walcott and Senator Hawes jointly sponsored the resolution in the Senate calling for the establishment of this committee. This was definite recognition on the part of the Senate that wildlife problems were really acute. The establishment of that committee gave the necessary impetus and encouragement to the sportsmen and the conservationists of America to plunge into the decade of the thirties which has put upon the statute books more conservation legislation than has appeared in all the other history of the United States Congress. The Senate Wildlife Committee produced some highly important legislation. It initiated some and it introduced other legislation sponsored and endorsed by groups and organizations. The Senate and House Wildlife Committees have become the conservation focal point in Congress.

What has happened in this decade that has just passed? In rapid succession there went upon the statute books a number of conservation measures, first of which was the Duck Stamp Bill, an earmarked fund whose revenues cannot be taken away or used for any other purpose. Last year it produced for the migratory waterfowl restoration program a little over a million dollars. Each year has seen an increasing number of duck stamps sold. You have heard the story that in the last five years the duck population has been increased 100 per cent; in the next five years, if it is increased another 100 per cent, it is going to increase the sale of duck stamps greatly.

Next was the Coordination Bill, to which Senator Hawes has made reference. Gabrielson did not tell you of what vast benefit the Coordination Bill has been to him. All he has to do is to call attention to the fact that here is a bill in which Congress has directed that the several agencies of the United States Government must coordinate and cooperate with each other in the wildlife restoration program. All of the big dams that are being built in the West and the South have had to give recognition to the wildlife resources of the region.

We have heard a great deal about the Bonneville Dam in Oregon. If it had not been for the Coordination Bill and the leverage that that bill gave to the Biological Survey and the Bureau of Fisheries and the other conservation agencies, the engineers would not have spent in the neighborhood of eight million dollars in providing adequate fishways and protection for the annual runs of salmon in the Columbia River.

Another bill placed upon the calendar by the committee was Senator Robinson's Fish and Game Refuge Bill, a little piece of legislation, but it has done a significant thing. By Executive Order the President of the United States can set aside in any national forest, any area which is deemed necessary as a haven for the reproduction and protection of wildlife. It has been used many times and has done a tremendous amount of good. These are things that we do not ordinarily think about. We know locally that a refuge has been established in a certain national forest and we don't give it any national significance, but when we tie them all together all over the country they assume major importance and tie in with the whole program.

The Pittman-Robertson Act I do not propose to discuss. The Biological Survey's able administrator of this act, Al Day, is going to follow me and he will tell you all about it. In my estimation, this particular Act, over the years, will be the most significant piece of conservation legislation ever passed by Congress except the Enabling Act for the Migratory Bird Treaty.

We must not overlook the fact that each year somebody has to follow through the Appropriations Bills for the several wildlife agencies of the government. It is interesting to note that in 1930 when the Senate Committee was formed, the total appropriation for the Biological Survey that year was a little over $1,400,000. Everybody thought this was fine, that it was a grand increase. The present bill, the Interior Appropriation Bill which will be on the calendar in a few days, carries an appropriation for the Biological Survey of five million seven hundred fifty thousand-odd dollars, and let me say that $3,500,000 of that is earmarked. No matter what happens, year after year the Biological Survey is going to have $3,500,000 or more to carry on its operations.

The members of the Senate Wildlife Committee have always had a deep interest in wildlife problems. Other members of Congress do not feel the same way. Sometime in our history there is going to be a genuine, sincere effort to reduce the cost of governmental operations. It is in the air today. When that effort gets to the point where Congress actually begins to lop off appropriations here and there ruthlessly, those agencies of our government which are considered to be non-essential to the actual welfare of the American people are going to be cut off first. I hear constantly that "wildlife is a hobby, it is a pleasure, it is a sport—if necessary we can do without it"—and that is why the Senate Committee has worked year in and year out in order to earmark the funds for wildlife.

There is another little bill pending that seems insignificant and people do not pay much attention to it. It is Senator Pittman's bill to earmark for refuge maintenance and management the revenues that annually flow from the operations of logging, haying, grazing, furring, and what-not, upon the refuges. This money goes directly into the United States Treasury. A small amount, it buys lead pencils and notebooks for the stenographers, it doesn't amount to much now. It is insignificant in comparison with our regular governmental bills. But that fund, if earmarked, in the next few years will bring in about a million dollars more for the maintenance of refuges. That bill is going to be passed this session of Congress.

There are two or three other bills pending on the calendar. I am not going to talk about the Pollution Bill because Karl Mundt is going to tell you about that.

There is an old bill on the calendar in the House, or will be in a day or two, to protect the American eagle. It has been fought back and forth for ten or twelve years. It looks to me as though this time the old American eagle is going to scream for help for the last time; I think it is going to get Congressional help, and at least what are left of this species will have a better chance of surviving.

There is another bill pending on which a hearing was held last week. It is known as the Buck Bill to give federal aid to state fish restoration projects. The Pittman-Robertson Act does not apply to fisheries because the money earmarked in that Act comes from the excise tax on sporting arms and ammunition. By the way, while I think of it, the total amount appropriated this year for the Pittman-Robertson Act is $2,500,000. That is about $400,000 less than the total amount that will be realized from that excise tax. We hope that before the session ends the entire amount will be earmarked. When the budget is set up you cannot tell what the actual amount is, and therefore there is that discrepancy. The budget took no chance; it did not authorize three and a half million dollars and then slip back to three million; it said, "Two and a half, and maybe we can go up to three." The Buck Bill is a "Pittman-Robertson Act" for fisheries.

I know there are arguments on both sides of this measure. The Buck Bill, having been introduced at the last session of Congress, found no excise tax on fishing tackle because that tax expired by limitation of law on June 30, 1938, along with a lot of other nuisance taxes. The only excise tax retained was that on sporting arms and ammunition, and that had already been earmarked. So in order to get the necessary revenue, the Buck Bill imposes the old excise tax upon fishing tackle. Now the manufacturers of fishing tackle passed that 10 per cent excise tax on to the fellow who bought his fishing equipment. There has not been any decrease in the price of fishing equipment since the excise tax went off. A week ago last Friday the officers of the Fishing Tackle Manufacturers' Association (and they are all very good personal friends of mine) appeared at the hearing and when questioned by Congressmen said, "Of course, naturally we would pass this excise tax on to our buyers and in the end the sportsman himself would have to pay the bill, just as he is paying on the Pittman-Robertson Act, but we don't think this is the right time to pass this legislation.'' I am satisfied that we never can agree upon when the right time is going to be to pass that type of legislation.

Whether that legislation passes or fails depends entirely upon what you do about it. You are the people who can get that legislation passed if you want it. If you want to get about a million three hundred thousand dollars applied to a nationwide fishery restoration program, take the time while you are here to go up and talk to your Congressmen to urge them to see that a favorable report comes out of the committee. It is easy enough to say, ''Let the fellows down in Washington do the job.'' They cannot do it. All they can do is lay out the program, and see that it gets started. To get the bill passed depends upon ''you'' and ''you'' and ''you'' all over the country. If you will respond you can get real conservation legislation whenever you have the program and whenever you are willing to do the work. Unless you do that the Buck Bill and any other nationwide conservation legislation will fail.

I was interested in hearing Gabrielson talk about a wildlife extension service. The Senate Wildlife Committee has prepared its final report after ten years of study, research and labor. That report has a number of recommendations. Among the recommendations is one for an appropriation and a bill carrying out the very thought that Gabrielson expressed with reference to a wildlife extension service. This service can be carried on in this country for the paltry sum of $150,000 a year. That is a recommendation of the Senate Committee to the United States Senate. It is very possible that when the report is finally printed, a bill will be introduced in the Senate to carry out the very thought which he so ably expressed a little while ago. The bill will provide a wildlife service vitally needed today in the conservation field—it will get the message across to the great mass of American people and particularly to the American farmer, who is the first link in most of our conservation programs.

Another recommendation that the Senate Wildlife Committee report makes is for more federal game protectors. The job is increasing and increased responsibility makes it essential that more game protectors be employed.

Another recommendation in this same report is that more money be appropriated to complete the migratory waterfowl refuge program. It is about half done now. There ought to be further appropriations out of the general fund to take care of that situation.

The committee in its final recommendation urges the establishment not only in the Senate but in the House as well of a Standing Committee on the Conservation of Wildlife Resources. In the first session of the present Congress there were more than 300 bills introduced which affected in some way or another the wildlife interests of this country and the agencies which carry them on. That is altogether too many bills to be passed around to unsympathetic committees in both House and Senate.

If you feel that such a standing committee is justified you know what to do. All you have to do is to write to your Congressman and Senator and tell them that you favor this program—and if you don't like it tell them so too—they want to know how the folks back home feel. Don't make any mistake about it, your Congressman wants to know how you feel and when he knows that he is in a better position to act, and until he hears from you he cannot know.

I have not told you very much about keeping tabs on legislation. If I told you about that I would be telling tales out of school. I don't like to do that. If I told tales out of school maybe you wouldn't feel so well satisfied about some of the things that have to be done or why it takes so long, sometimes, to do things. I have in mind that just about three weeks ago I had a matter that had to be taken up that particular day. It had to be completed, closed up. At nine-thirty I appeared at a certain Senator's office. I waited, I waited and I waited. Occasionally the Senator would pop out and say a word to somebody and pop in again, wave his hand at me, "I'll see you soon." At five-thirty that afternoon I was still sitting in his office and finally had the opportunity to get to him, and then it was all right, it was done instantly. But if I tell you many such things you might not believe them, and perhaps you would think it crazy to do them; but that is what you have to do. Senators and Representatives are not at your beck and call; you are at theirs, and they are more than willing to cooperate and help at all times, I have found out.

In 1928 when I first came back here and went around Congress it was hard to get an audience for wildlife; nobody wanted to talk to you about it; they would laugh and wave their hands and say goodbye and that was all there was to it. Today wildlife has a dignity and a respect around Congress because the members have seen the evidence of what has been going on the country over in the wildlife field. State administrators have improved, state wildlife programs and the national wildlife programs have gone far beyond any of our expectations. It is easier today to get wildlife legislation considered. Congressmen and Senators know that back home there is an organization or a dozen organizations, perhaps one in every county or every town, interested in this program, and when they hear from you they sit up and take notice. I have gone around with different groups to different offices when a campaign was on, when some particular piece of legislation with reference to wildlife was on, and the stacks of letters coming in showing the interest were enormous. There has been an increased interest in wildlife throughout the country. Look at this hall today—

filled. A few years ago you could not have gotten a corporal's guard here the first morning.

In concluding I want to say that keeping tabs on wildlife legislation is a lot of fun; it is a lot of hard work, too. The only compensation is that you meet a lot of fine people, you know a lot of splendid people throughout the country, men and women who are unselfishly giving of their time and their money to a cause which is dear to their hearts. All glory to them.

POLLUTION ON THE RUN

KARL E. MUNDT
United States Representative from South Dakota

CHAIRMAN HAWES: *Your next speaker is a young Congressman from South Dakota. As you probably know, there are 345 Congressmen. Any man who during his first term can dot an "i" or cross a "t" on a piece of legislation has "gone places." Mr. Mundt did more than that. He has put something practical in the great subject of pollution. A young man in Congress who put his mark on a great piece of legislation during his first term in Congress will now tell you what he is trying to do. Congressman Mundt.*

MR. MUNDT:

I heard Carl Shoemaker lamenting the fact that in 1928 when he first came here to represent conservation on the legislative front, there was little attention being paid to wildlife in Congress. Then he went into quite a harangue about the presumed degeneracy of Congress, because, he said, "These days, anybody up on the Hill talking about wildlife gets a ready and willing welcome at the door of any Congressman." I hope, although I am not sure, that he was talking about the wildlife of fur and fins and feathers rather than the more exciting type of wildlife represented by girls, gin and gasoline. His statement possibly is equally true under either definition!

I have been attending wildlife conferences for a great many years. I think I probably have given as many and heard as many talks on conservation and on anti-pollution as anybody else in the country, of my age at least. I have heard particularly the subject of pollution discussed time after time, in meeting after meeting. I have read books about it and heard compelling orations delivered against the vice of pollution, and I am consequently mighty happy today that you and I can meet here and discuss for the first time something which has actually been done to curtail the vice of pollution. We have talked about it, I believe, as much as anybody ever talks about the weather and certainly have done as little about it, and it is my hope that out of the inspiration of this particular conference being held here now will come the necessary additional impetus, the last stretch of strength which is necessary in order to complete the job which has been started in the 76th Congress in this matter of pollution.

It was the splendid cooperation, the gallant fight, the continuing effort of sportsmen throughout America that enabled us to change a wicked, noxious bill to promote pollution into a bill which if passed as now amended will represent the greatest forward step in history from the standpoint of controlling the practices of pollution. It was because so many of you did that thing that Carl Shoemaker stressed, wrote letters to your Congressmen and Senators, wrote letters to newspaper editors, conducted little meetings and gave speeches, organized groups, so many pople working collectively on the same line of attack, that gradually the Members of Congress were convinced that the temper of the American people in 1940 is such that they did not propose to have written onto the statute books a bill which virtually encouraged pollution rather than discouraged it. Consequently when the effort was made at the right time we found that the Members of Congress and the House of Representatives by a vote of virtually two to one wrote into the Barkley Bill as it had come to us, provisions which made of it an anti-pollution control measure which if faithfully and diligently and sincerely carried out I believe is going to represent all of the anti-pollution legislation this country will ever need.

I want to say right now that it has been the assistance of groups like this one here today, groups like the Audubon Society and the National Wildlife Federation that have accomplished this. I want to pay a special word of tribute to the Izaak Walton League of America, which was out in front throughout the fight and carried forward nobly the banner of clean streams and anti-pollution legislation.

I don't think I need to spend much time with an intelligent group of conservationists like this reviewing the pollution legislative situation up until the 76th Congress. Suffice it to say that in 1934 following the Dern-Lonergan Conference there was introduced by Senator Lonergan a bill to control pollution. Following that bill came many other bills, and then in the 75th Congress there was passed a bill under the label of pollution legislation but not in any sense a pollution control measure. It was simply a bill criticizing and then condoning the age-old practice of pollution. Happily for all of us, the President vetoed that bill, because it violated certain budgetary practices; vetoed it, so said the House Committee on Rivers and Harbors, because the Izaak Walton League and other sportsmen had piled many telegrams on his desk urging him to veto it. I care not what was the reason. I rejoice in the fact that that particular backward step was stopped by the veto of the President.

Why do I call it a backward step? Because when we are confronted for a century and a half with the nefarious practice of permitting industrialists, literally, to spit in their neighbors' drinking water; when we have for a century and a half permitted municipalities to dump raw sewage into their drinking water, to the point, if you please, where in the debate in Congress a Representative from Ohio said that in Cincinnati the people are pumping the drinking water out of the same pool in the river into which they dump their sewage, it is a sorry situation. Now if the City of Cincinnati wants that kind of advertising that's all right with me, but the pagan practice of white people drinking the excretions of each other should be brought to an end in modern America, and it cannot be done by a bill which criticizes pollution and does nothing about it.

Such was the bill which was happily vetoed in the 75th Congress.

At the beginning of this session of Congress two types of bills came into the legislative hopper. One closely paralleled the bill which was vetoed, to study the problem, to criticize the problem, to call it bad names, and do nothing about it. The New York kids down in the lower East Side say that "Sticks and stones may break our bones, but tough words never hurt us." There were a lot of tough words in the legislation represented by the original S. 685, introduced by Senator Barkley, by request—a lot of tough words about pollution, but nary a stick nor a stone, nothing to stop it, nothing whatever to clean up the streams of America.

I am not criticizing Senator Barkley, because the bill was introduced by request. I don't know who wrote it. The Cincinnati Enquirer said it was sponsored by the Cincinnati Chamber of Commerce. In the hearings before the committee of Congress it was said by a gentleman sent there to lobby in favor of that bill and to oppose mine, that the bill was written by the Cincinnati Chamber of Commerce. That is all right with me. I belong to a chamber of commerce myself, I believe in chambers of commerce, but I doubt whether in the final analysis the best kind of anti-pollution bill in the world is going to come from the pens of members of chambers of commerce.

There was another bill sponsored by conservationists throughout America which it was my privilege to introduce—a *stop pollution* bill, not just one to study the problem, but one to do something about it.

Those two types of bills, the one which would study and the one which would stop pollution, found themselves immediately in conflict with each other, and they went through a rather interesting process of evolution.

I have here S. 685 in its original form in which it passed the United States Senate. We have, on the other hand, the original bill in which the sportsmen believed; the conservationists sponsored it, and I had a part in drafting it and it was my privilege to introduce it—H. R. 4170, the *stop pollution* type of bill. These two were discussed before the two committees of Congress, the Senate Committee and the House Committee on Rivers and Harbors. Hearings were held. S. 685 then passed the Senate.

It is interesting to note in that connection that S. 685 had the support not only of the gentleman who said it was written by the Cincinnati Chamber of Commerce, but of the big tanneries of America, which were suddenly interested in a pollution bill. I wondered at the time why high-priced lobbyists should be sent to Washington to testify in favor of a pollution bill, but as I read the bill and as I am going to read you certain passages of it as it passed the Senate, I think all cause for wonderment can cease.

Along with those groups I have mentioned came also representatives of the petroleum industry, representatives of the wood pulp industry, representatives of a variety of polluters in America, and they testified, mind you, yes, not only against my bill, but in favor of this one. Now when the polluters of America spend hard-earned money sending lobbyists to Washington to testify in favor of an anti-pollution bill, you and I as conservationists had better read the bill with a high-powered microscope. As we read it I am sure we are going to find reasons why the polluters came here not opposing all pollution legislation, but opposing the conservationist type of bill and favoring the passage of the other bill.

The evolutionary process continued. People said the House Bill was too drastic. Possibly it was. I will admit that I am an enthusiastic conservationist and I am enthusiastically against pollution and I would like to see it stopped, I would like to see it corrected. I don't believe that it ever was intended that the clean streams of America should become what they are. House Document 155 was written by a committee appointed by the President to study pollution, to provide the background from which the Senate Bill was drawn. House Document 155 says, "Rivers are nature's sewers." I don't believe that, and because I don't believe a river is intended to be a sewer, I wrote a bill which tried to make a river something more than a sewer. Those who were in the business of making sewers out of rivers said it was too drastic. Probably it was because an enthusiast is frequently likely to write legislation which may work a hardship on somebody violating the particular ideals which he has in mind.

We rewrote the bill and introduced H. R. 6723, in which we softened the approach. We provided for five-year intervals in which polluters could come before a board and show cause why they should be permitted to make sewers out of rivers. We especially softened the approach from the standpoint of industry and said that industries would have a two-year breathing spell and after the two-year breathing spell, in stages of five years if they could show cause why it was economically impossible for them to correct their practices or why it was scientifically not feasible for them to correct their pollutions, then they could continue for another five years, at which time they must return and show cause why they couldn't stop it.

The folks on the other side were having a process of evolution too. Too many speeches had been put in the record asking too many questions about why the polluters wanted this bill passed, so its contents began to change, and as it was reported out of the Rivers and Harbors Committee in the first instance it was a much better bill than it was when it passed the United States Senate, and that was back on May 10th.

Well, the process continued. People said the bill that I introduced was still too drastic, so we wrote a new one, H. R. 7971, and we softened the blow some more. We said to municipalities: "You too, while there isn't any question about anti-pollutants, science having discovered a way to correct municipal pollution, we recognize are in many instances in serious financial straits. We do not want to force any city through bankruptcy, we do not want to force any undue financial hardships on any town," so we gave the cities the same right to show that because of their financial situation they were unable to correct pollution, they could in five-year stages have time in which to get ready to correct pollution. Every five years they would have to come back and show cause why they could not correct the situation. Part of the cause which they could not show was that they were spending their money for other municipal improvements. They were not to build stadiums, they were not to build city halls, they were not to invest a lot of public money in other public improvements until they had approached the pollution problem.

This was the final version of that bill moderated considerably from the original, but still it was a *stop pollution* bill because it said: "After the passage of this bill there shall be no new discharges of new sources and types of pollution into the navigable waters of America."

The processes of evolution continued, too, on the other type of bill, and those who were the parents of it were not so proud of their offspring any more. Like Topsy, it had started to grow up, and it began to take on new life and new vigor. The House Rivers and Harbors Committee (power and praise to it; I am happy for the fine type of statesmanship which it began to evidence on that point) rewrote everything in the bill except the enacting clause and gave us a different pollution bill. And well they might, because I want to go back to this first bill now so everybody will know why the polluters were in favor of that bill, not just opposed to the bill which I introduced.

In the original bill (page 5, section 6) is this interesting clue to authorship: "Any person discharging or building works which will discharge untreated or inadequately treated sewage or waste in character or quality sufficient to be deleterious to the navigable waters of the United States or streams tributary thereto is," asked to stop? Not at all! Assessed a fine? Not at all! Discouraged in the practice? Let me read you what it says: "Any such person, etc. . . . is hereby declared to be eligible to federal aid in the forms of grants-in-aid or loans for the construction of sewage disposal." Think of it! Not a municipality, not a city. Any person, any corporation, any industry which will pollute the streams badly enough, if this bill had continued as it passed the United States Senate, shall then be eligible to receive a gift from Uncle Sam to build pollution control. You don't have to wonder any more about the lobbyists coming here and saying, "That is a mighty good pollution bill. We are for it." Of course they are for it! Somebody close to them must have written it. We couldn't have asked for a farther step backward in the whole course of pollution control legislation. There isn't any wonder why the conservationists began seeing red.

This may not be the time to pass anti-pollution legislation, but by all that is good and holy, this isn't the time to begin putting on bonuses for the practice of pollution! We got that thing stopped in the Rivers and Harbors Committee.

They were so enthusiastic over their bill that their glee sort of bubbled over at the christening! Let me tell you the name of the bill (Section 15, page 16) as it passed the Senate: "This Act may be cited as the Water Pollution Act." That is a good name for a bad bill! If there ever was a name written in history to increase and encourage and stimulate pollution, there it is.

Well, the fight went on. I want to say that the Members of the House of Representatives and their Rivers and Harbors Committee, after these things were repeatedly brought to their attention, began realizing that this certainly wasn't much of a bill to be passing, and so in the third stage now, in this evolutionary process, it came before us. To it was added the so-called "Mundt Amendment," which is simply this: it took this revised Barkley Bill, which had deleted these nefarious clauses, which had taken out the bonus on pollution, which had eliminated the giant bureaucracy of a $750,000 slush fund to be sent out to state health bodies to study a problem which for 150 years has been studied and studied and studied, and the Mundt Amendment proposed a rather simple, easy thing which was written in the bill and is in the bill today, it is the law of the land as far as the House of Representatives is concerned.

Subsection (d) of Section 2, found on page 17 of the Senate print of the bill: "After the date of enactment of this Act, no new sources of pollution, either by sewage or industrial waste, shall be permitted to be discharged into the navigable waters of the United States or streams tributary thereto until and unless approved by the Division of Water Pollution Control." And secondly it says: "That the discharge of new sources of water pollution without review and approval of the Division as required under the foregoing provisions is hereby declared to be against the public policy of the United States." Think of it, fellow conservationists, 150 years, and it was not until the first day of March this year that Congress ever declared pollution to be against the public policy of the United States. It goes on to say that pollution is a public and common nuisance.

Now as amended we have what I consider a right good anti-pollution bill which does five things: first, it provides for the making of interstate compacts. All of the bills did that; it is a nice gesture. I believe in states' rights. So do you. But in addition to believing in states' rights I believe in a corollary thereto; I believe also in the rights of states as well as states' rights. I believe that a state such as Pennsylvania which wants to make an honest effort to correct pollution has a right to insist that other states should make the same effort. I think that is a right which we should consider as conservationists which is just as important as states' rights. The interstate compacts are fine if and when they are made, if and when they are enforced, but they bear this conspicuous fault, that any state in the compact which fails to ratify nullifies the whole compact, and Gresham's old law that bad money drives out good money works in conservation too—bad conservation laws drive out good conservation laws; bad pollution legislation drives out good pollution legislation. That is why I am so much in favor of the enactment of legislation which will protect the fine black bass. When you permit black bass to be sold in one state you jeopardize the king of fish in every state. That is why we have national regulations of bag limits and hunting seasons, because the worst law of the land came to be the universal law. That is the trouble with an interstate compact. It is a beautiful thing to contemplate, but it seldom if ever gets results because you tend to penalize the good state, the honest state, the anti-polluting state, in behalf of the polluter.

The second clause provides lower interest money through the RFC. The difficulty with that is that S. 685 didn't set up the RFC. S. 685 cannot write the laws for the RFC. S. 685 simply authorizes the

RFC to loan money to industries and municipalities at low interest rates to correct their pollution.

The third thing is $250,000 appropriated for the age-old practice of studying pollution. We have put the stethoscope on Old Man River for years and years but no one has yet offered a prescription, so we give them $250,000 more worth of stethoscopes to continue to listen to the heartbeat of the Old Man while he slowly and surely dies of pollution!

The other two things I have mentioned: to stop new sources of pollution and to define pollution as against the public policy of the United States and as being a public and private nuisance.

I think S. 685 as amended is a great constructive act of conservation. It means that from now on in many industries, a great many would-be polluters instead of always being on the side of stopping pollution control legislation will get interested in stopping pollution itself, because they may find their competitors engaging in their habitual practice of polluting streams, and the law says, "You cannot discharge new sources of pollution. So, this time, they help us enforce pollution regulations. You know and I know that the common law in practically every state in the Union is strong enough and good enough to stop the pollution in this country if public opinion were sufficiently marshaled behind its support. But as long as fishermen and hunters and idealists and conservationists are the only ones interested in it we haven't made much progress with common law, although in my own state of South Dakota we have practically eliminated pollution by enforcing the common law. The Izaak Walton League of America, of which I am a member in South Dakota, interested certain farmers below certain cities, and certain industries, in filing suit against the polluters, and we provided the litigation, the talent, and the finances, and never lost a suit. You don't lose many suits when you file them against a polluter!

If industries become interested in helping to correct pollution, as they will with this legislation, we are going to find that those engaging in pollution now are going to have difficulty in continuing their nefarious practices. A steady, sensible method can be worked out for correcting pollution where it now exists to a deleterious degree.

I don't think anybody need argue about the question of pollution being an interstate problem requiring a national law to correct it. I mentioned Gresham's law of money; that applies to pollution.

On February 22nd I read into the Record an account published in a paper down in Lynchburg, Virginia. The legislative session was being held in Virginia; they were discussing pollution legislation of a state nature. The mayor of a certain town was head of the commission. He made his report and came back and said: "I believe something should be done about the pollution situation, but it should be handled carefully and diplomatically." And then this great Virginian said: "This legislation must not work a hardship on the industries in Virginia or on the cities either. The commission has been interested in getting new industries in Virginia and hopes to induce more to come, so we can't be too hasty about the matter." In other words, Virginia is advertising to the world: "If you can't pollute at home come down to the Old Dominion, dump it in our rivers."

That is what happens to state anti-pollution legislation; it happens every time.

We are confronted with a real challenge of American statesmanship, of Congressional sincerity, on the matter of pollution. The bill is now in conference. The Senate has disagreed to some of the amendments of the House; they haven't said which. I have got a suspicion of my own but I am not going to mention it. The House by a two to one vote said, "If you are going to stop pollution the only way to stop is to begin to stop."

One of my colleagues in this debate on the floor of the House said, "I have been fighting pollution for twenty-one years trying to eliminate it, but this Mundt Amendment is too drastic, it stops new forms of pollution." Now, my friends, you can't be any less drastic than this Mundt amendment and be anything less than hypocritical on the matter of pollution. It is time we began thinking clearly and talking plainly about this matter.

I want to echo everything Carl Shoemaker said about the importance of you folks calling on your Senators and Congressmen before you go home and telling them you want the bill to pass as it has been amended by the House, you want it in its present form. If the conferees take out the prohibitions against new pollution, if they take out the definition that pollution is against the public policy, that it is a public and private nuisance, then you want that hypocritical subterfuge to reward pollution buried knee-deep in "No" votes; let's not have any bill at all if we are going to have a bill which places a premium on pollution, which tells the world that to get a bill through Congress it must be a bill of polluters by polluters for polluters.

I hope you will talk to your Senators. I can't imagine anybody wanting to go home and tell his friends that he voted for a bill like that which passed the Senate in its original form. If he tells you that he knows the subject better than you do, let him point out what he voted for last time. Tell him this time he had better listen to a little conservation guidance. Let's have a bill that will do something about the problem, something that is worth while.

I have not been in Congress very long, but I have been there long enough to know that the story I heard about Congressmen and Senators plucking from the goose that squawks the least isn't the greatest fairy story in the world, unfortunately. If you want to get plucked it is all right with me, but I am awfully interested in having this pollution bill preserved and saved now that it has passed the hurdle of the House. If they lick us this time, then they are going to try to pass S. 685 in its denatured form with nothing in it but bad language about pollution, virtually acknowledging to America that we encourage pollution because by a record vote we went down the line saying: "We don't disapprove of new pollution." Congress has that issue to face. Help make it tough to vote in favor of pollution. I think we can win the fight this time if everybody does his part.

DISCUSSION

MR. EDWARD P. RINEHART (Isaak Walton League, Columbus, Ohio): Ladies and Gentlemen: We know that there are a lot of things that we have heard on this program this morning that need no action of any kind, but I wonder whether the Mundt Bill should be passed over lightly. Mr. Mundt and Mr. Shoemaker both advised us that we should contact our Congressmen and our Senators especially on this Mundt Amendment while we are here. After looking over the program and looking it over carefully, I am of the opinion that very few of us want to get away from here; we want to hear the good things that have been prepared for us. We also heard Mr. Shoemaker say that he sat in a Senator's office and waited until five-thirty. I am sure you wouldn't hear many sessions if you did that. I am wondering if this won't help. If it is possible, if it is not against the rules of this body (I know they have never done it in the past except on very rare occasions), I would like to offer this motion, that this body adopt the following resolution:

"RESOLVED, That the Fifth North American Wildlife Conference recommend to the Joint Conference Committee of the Senate and the House of Representatives that the anti-pollution bill, S. 685, be favorably reported in the form and with the amendments as it passed the House of Representatives on March 1st this year. Be it further

"RESOLVED, That if this bill is not so favorably reported, that it is the sense of this Conference that the bill should be defeated."

I make that in the form of a motion, Mr. Chairman.

(The motion was regularly seconded, put to a vote and carried.)

MR. SETH GORDON (Pennsylvania): It has been suggested that it might be wise for this body to express its sentiments relative to the desirability of continuing both the Senate and the House Committees on Wildlife, not as special committees as they have been, but as standing committees of both bodies, and if it meets with the approval of the Chairman and of this body I would like to move that this Fifth North American Wildlife Conference go on record as favoring the establishment of both the House and Senate Committees on the Conservation of Wildlife Resources as permanent committees in Congress.

I move the adoption of that resolution.

(The motion was regularly seconded, put to a vote and carried.)

HOW GOES THE PITTMAN-ROBERTSON ACT?

ALBERT M. DAY
U. S. Bureau of Biological Survey

CHAIRMAN HAWES: *Ladies and gentlemen, your next speaker is Mr. Albert M. Day. He is from Montana. Years ago my friend Ed Love of St. Louis sent me a copy of the book The Virginian. The Virginian used to hunt in that vicinity, and one day somebody called him a dog, and he said, pulling his gun, "When you call me that name, stranger, you laugh." That is the state this next speaker comes from—where they laugh when they call men bad names. He has spent some twenty years in the Biological Survey. He has been picked to speak to you and to specialize on the Pittman-Robertson Act, and I take pleasure in introducing him as an earnest member of the Biological Survey who comes from the center of the Great West and grew up with the problem there before he studied it in its technical aspects. Mr. Albert M. Day.*

MR. DAY:

I welcome this opportunity to present a brief summary of how the Pittman-Robertson Federal Aid to Wildlife Restoration Act is operating and to review some of its accomplishments in the field of conservation during the year and a half since the law was enacted.

The basic principle of the Act is to assist the states in the restoration of natural conditions conducive to the production of wildlife. It provides for the acquisition of areas of land and water suitable for wildlife needs and for such development as will improve the natural environment, as well as for research on problems of wildlife management. Instead of setting up a new federal agency or enlarging an existing bureau to accomplish these things directly, the Pittman-Robertson Act requires the states' own game departments to execute the program and provides for their reimbursement from the federal funds for 75 per cent of the cost. By this means, the program is bound to remain close to the local groups which are, in reality, furnishing the finances, since federal appropriations are made in amounts not to exceed the annual returns from the 10 per cent excise tax on sporting arms and ammunition, and the state funds are derived from the license fees paid by hunters. This provision has probably had a major influence in the wide acceptance of the act and on the almost total lack of criticism to date.

The tax on arms and ammunition amounts to about $3,000,000 a year, but Congress has not yet appropriated the full sum. On July 1, 1938, $1,000,000 was made available, and on July 1, 1939, $1,500,000. The Appropriation Bill for the Department of the Interior, now pending in Congress, includes an item of $2,500,000 for the fiscal year beginning July 1, 1940. Each appropriation is available for a 2-year period, after which unobligated balances become available to the Biological Survey for use in the national waterfowl-restoration program. Federal funds are apportioned to the states on the basis of land area and the number of hunting-license holders, and are so matched with state funds that the Federal Government bears 75 per cent and the state 25 per cent of the cost of each undertaking.

All work is performed through projects submitted by the state game departments to the Biological Survey outlining the proposal and including work plans and estimated costs. If the project is found to come within the provisions of the act, it is approved, and the state carries on the work under periodic inspections by the Bureau to insure conformance with the plans and specifications. When the work is completed, all lands and equipment become the property of the state.

The Act requires that each state give specific legislative assent to its provisions, and forty-three of the forty-eight states have already passed such laws. Only Montana, Nevada, Florida, Georgia, and Louisiana are ineligible to participate.

All of the forty-three eligible states have submitted projects. These total 232, of which 180 have been approved to date. The others, most of which deal with the acquisition of lands, cannot be cleared until valuation appraisals are made and options taken. The projects submitted to date will obligate all but about a half-million dollars of the federal and state funds available. The state game departments have until June 30, 1941, or another 15 months, to obligate most of this money, so apparently little of it will revert.

Some fine work is being accomplished . Time does not permit a recital of what each state is doing, but a few examples will illustrate the type of good, sound, practical accomplishments that this Act has made possible. Taking submarginal lands out of agricultural production and devoting them to the needs of upland game has been a part of the state programs in Washington, Utah, Pennsylvania, West Virginia, Tennessee, Kentucky, Minnesota, Missouri, Illinois, Michigan, Wisconsin, Maryland, North Dakota, Colorado, and Wyoming. These units will provide badly needed winter range for deer, elk, moose, and bighorns; and food, cover, and sanctuary for grouse, turkeys, pheasants, quails, Hungarian partridges, ruffed grouse, sharptails, rabbits, and other species of birds and animals. Projects for the purchase of areas to restore conditions for waterfowl and fur bearers in Iowa, Minnesota, Missouri, Indiana, Ohio, and South Dakota are being considered. The construction of cabins and headquarters sites, and the fencing, posting, and otherwise improving of state and other publicly-owned lands have been accomplished in several states. North Carolina is constructing roadways, and surveying, posting, and improving an area of 90,000 acres of state-owned pocoson-type lands to provide better patrol and protection.

Utah, with the aid of a side camp from the Biological Survey's Bear River CCC Camp, has developed 3,000 acres of fine waterfowl breeding and feeding grounds on the Weber River. Recently, a full-strength CCC camp was assigned to the Biological Survey for reassignment to this Federal Aid project for the next 2-year period. This is the first of several camps that we hope will be made available to the states to facilitate the program. Maine undertook an extensive project to revegetate several of its natural lakes and watercourses. Oregon is reseeding the Tillamook burn swept clean by forest fires.

Animal populations have been on the move as a result of Federal Aid. In Idaho, Oregon, Colorado, and Utah, beavers have been trapped in agricultural areas and moved to mountain streams. Texas and New Mexico have trapped and transplanted to depleted ranges 315 antelope, at a cost of less than $10.00 each, and with a death loss of only nine animals. Deer-stocking projects have been in operation in Virginia, West Virginia, and Mississippi. Virginia, Mississippi, Texas, and Arizona have reestablished turkeys on old ranges from which they had been extirpated. Ruffed grouse have been captured in Wisconsin and Canada and shipped to Missouri and Ohio to become reestablished in suitable sanctuaries. Projects to fence small acreages of desert range below cleaned-out springs and water holes to provide water and cover for sage grouse and other desert forms have been submitted from Oregon, California, Colorado, and Idaho.

Work has not been confined to the purchase and development of lands. About a third of the projects approved to date provide personnel for conducting much needed investigations to furnish the game departments with information on which to base administrative action. Statewide wildlife surveys to determine populations, trends, and conditions have been prominent in the Federal Aid programs in Texas, Missouri, Arizona, New York, Delaware, Colorado, Vermont, Oklahoma, Idaho, and Alabama. These surveys are the foundation of future Pittman-Robertson programs in these states. Fur-resource studies are under way in North Carolina, Illinois, Pennsylvania, and Michigan, while other investigations deal with special problems affecting deer, elk, grouse, turkeys, doves, rabbits, and squirrels. Studies dealing with farm-game problems are in progress in Michigan, Missouri, Illinois, New York, North Carolina, Texas, and Oklahoma.

The Pittman-Robertson Act is not only helping individual states solve local problems, but is also serving as a vehicle for group action in investigations of regional scope. Colorado, Wyoming, Idaho, and Utah are all interested in bringing back the Rocky Mountain bighorn sheep. Instead of each attempting to attack the problem singly, these four state game departments have formed an interstate committee, including representatives of the Forest Service, National Park Service, Biological Survey, and the universities of the four states, to assist in the conduct of the study. Meetings are held periodically to compare findings and keep everyone informed of the progress of the investigation. The Biological Survey's Federal Aid regional representative acts as coordinator in connection with his regular tours of inspection to the states.

In the Northeastern States, deer frequently cause considerable trouble by their depredations on orchards and crops. New York has Pittman-Robertson men assigned to the task of developing effective repellents. Instead of surrounding states setting up similar studies, arrangements have been made for New York's investigator to spend some time in the other states, with expenses charged to the funds of the respective game departments.

These are some of the tangible, visible accomplishments of the Pittman-Robertson program, but there are others that will become increasingly important in the administration of wildlife conservation as the years go by. One of these is the large number of technically-trained men placed in responsible positions in state game departments in the past 18 months. Of more than 100 employees added to the staffs of twenty-six state departments, 85 per cent are college graduates, most of whom are trained in wildlife management or the biological sciences. In addition, graduate students have been employed part time. At the request of the game commissioners themselves, when the regulations were being framed, provision was made that employees would be selected on the basis of competency only and would be required to perform their services in a manner acceptable to the Biological Survey. Therefore these men are not subject to the same influences that remove about 25 per cent of the state administrators and their key employees each election year.

No state that permits a diversion of its hunting-license fees from the administration of the state game department is eligible to participate in the benefits of the Federal Act. This provision has forced several states to discontinue diversions and has prevented several other contemplated raids on accumulated game-license funds. It also recently brought a halt to a plan in one state to set up another state department as the administrator of the game resources on lands under the control of that agency.

Rumors have recently reached us that stories are being circulated to the effect that the Biological Survey in administering the Pittman-Robertson Act is attempting to dictate seasons and bag limits on lands purchased with these funds. I wish to take this opportunity to emphatically deny this. We have carefully refrained from any action that we felt could be construed as encroachment on the right of the state to regulate seasons and kill, and we intend to continue this policy. The Act restricts approval of projects to those that are substantial in character and design and that are capable of restoring conditions suitable for wildlife. When we have satisfied ourselves that these requirements have been met, we feel that our responsibility ceases.

All in all, we in the Biological Survey who are charged with the administration of this program feel optimistic over its possibilities and potentialities. If the fine spirit of cooperation between state and federal agencies continues and if the game departments confine their activities to those of the caliber undertaken during these early stages, Pittman-Robertson will, in truth, become, as its sponsors predicted, the greatest legislative boon to wildlife conservation since the passage of the Migratory Bird Treaty Act in 1918.

SECOND GENERAL SESSION

TUESDAY MORNING—MARCH 19

Chairman: HONORABLE KEY PITTMAN

U. S. Senator from Nevada

The second general session was called to order at 9:25 a.m. by Mr. David A. Aylward, President of the National Wildlife Federation, and opened with remarks from Hon. Key Pittman, Chairman of the Senate Committee on Wildlife Resources.

THE CCC IN THE WILDLIFE PROGRAM

CHARLES H. TAYLOR
Civilian Conservation Corps

MR. TAYLOR:

When I talked to the members of the North American Wildlife Conference at Baltimore two years ago, I reviewed briefly the major accomplishments of the Civilian Conservation Corps as they related to wildlife. I will try to bring this review up to date in as few words as possible, because I believe all of you are familiar in a general way with the work we have done and are now doing for the improvement of conditions for fish and game, at least in your own section of the country.

I plan also to tell you generally of our plans for the future, because a program such as the CCC's is a continuing program. What gains we have made in conserving forests and fields and in helping wildlife must be consolidated and carried out in accordance with long range plans if the Nation is to get the maximum return on its investment in the CCC.

Shortly after the CCC was established in April, 1933, an extensive wildlife refuge purchase program was begun. At the end of the last fiscal year 7,760,000 acres had been acquired for wildlife refuge purposes, increasing the national refuge area to 9,357,000 acres containing 238 separate refuges. In them vegetation for food and cover has been planted, dams, dikes and other devices have been built to control the water flow, nesting islands, shelters and feed hoppers have been constructed.

I don't want to burden you with too many figures on what the CCC has done for our feathered, furred and finny friends, but I must give you a few. CCC camps are now located in thirty-four game refuges operated by the Bureau of Biological Survey. These are scattered from coast to coast in twenty-five states along the principal routes of migratory fowl. Thirty-two of these are migratory waterfowl refuges and the other two are antelope refuges in Nevada and Oregon.

Within the wildfowl refuges are nesting islands, food and protective cover, dams, dikes, feeding hoppers and shelters. Within them, Mr. and Mrs. Mallard and the rest of their relatives are safe from the guns of sportsmen. The refuges are kept as free as possible of rodents and pests who make the lives of nesting birds miserable and destroy a great deal of the food cover.

In all, the CCC has carried the work load in the development of forty-four of the largest game refuges of the Biological Survey and has also worked in most of the two hundred or so others. This is in addition to considerable wildlife protection work in state and national parks and recreation areas, including a large number of fish hatcheries.

One big factor in the improvement of our wildlife problem has been the better observance and enforcement of "No Hunting" and "No Fishing" regulations. This is partly due to the presence in state and national parks and forests of CCC enrollees and partly by the consciousness of sportsmen that moderation on their own part in the use of gun and rod will aid greatly in preserving a healthy supply of birds, game animals, and fish.

The decimation of the wildlife population by human hands was equalled or exceeded by the destruction of feeding and watering areas. Along the western flyways where migrating birds settled each fall and spring, to feed, water and rest, drought intensified by agricultural usage and other causes ruined many of the water holes, turning them into barren areas. Game animals that for unnumbered years had frequented the areas disappeared, many dying before they could find other water and food.

It was to aid in relieving this condition that the CCC stepped in to aid wildlife. Virtually every camp in the CCC makes a contribution to wildlife. Not only the camps directed by the Biological Survey and the Forest and Park Services, but those under nearly every classification contribute directly to the welfare of wildlife through soil and timber conservation. One of the main jobs of the Grazing Service camps is to restore the water holes and to revegetate the range areas. The Soil Conservation Service Camps build hundreds of check dams which conserve the water supply and plant trees and cover on eroded lands. The Bureau of Reclamation has done much to improve the water supply in the Western States where it operates.

Improvement of forest protection systems, resulting in fewer and less disastrous forest fires, has made an immense contribution toward increasing the wildlife population both by protecting the birds and game from flames and preventing the destruction of their food supply.

The Civilian Conservation Corps also has been assisting in game restocking of national forest areas, transferring birds and game from heavily populated sections to forests having little wildlife. The Corps, too, has cooperated with the U. S. Forest Service and state forestry organizations in conducting game censuses and studying game habits and food supplies.

The work of the CCC in national and state parks parallels closely the work of the Forest Service CCC camps as far as wildlife is concerned. The enrollees have built bird sanctuaries, fish hatcheries, cared for distressed wild game and in general tried to make parks a little more attractive to their natural inhabitants.

Perhaps the biggest single wildlife project accomplishment of the last fiscal year was the virtual completion of the Elk River Fish Hatchery near Athens, Alabama, consisting of seventy-seven ponds with 111 acres of water surface and one of the largest in the world. There are many other fish hatcheries that owe their existence to the CCC. The Corps has placed nearly three-quarters of a billion fingerlings in American streams, and its work in clearing and improving streams has contributed greatly to improve the living conditions for aquatic life.

Winter activities of the Corps include the care and feeding of wildlife when heavy snows or frozen streams prevent it from finding natural food and shelter. Last January, when the snow belt extended deep into the South, James J. McEntee, the Director of the Corps, sent general directions through the Departments of Interior and Agriculture to all CCC camps to cooperate whenever possible with local wildlife organizations in the care of birds and game. This practice has been followed each year since the Corps was established.

The care of wildlife, as far as it concerns the CCC, is just one part of a wide program of conservation. This program includes conservation of the youth of America as well as conservation of our forests that had been depleted, our ranges that had been over-grazed and our farms that had been over-cultivated.

In the course of dovetailing all these objectives into a single program, the conservation of wildlife fitted in automatically. You can't improve a forest without improving the living conditions of the birds and animals that inhabit it. A spring or water hole cleaned out and made fit for domestic animals is as readily available to their wilder relations. It was just a step to make wildlife care and propagation a specific and natural part of the whole program. And it was natural for young fellows still in their 'teens or just past them to have a love of animals and birds as part of their natural liking for the outdoors. Even if we hadn't made it a definite part of the CCC program, the enrollees themselves would have made it their hobby.

May I digress a moment from a wildlife discussion to tell you something about these young fellows who make up the bulk of the Corps? They are operating perhaps the biggest work organization in the world, using 50,000 pieces of automotive machinery. A total of approximately 340,000 men are engaged in the enterprise and the CCC kitchens serve approximately a million meals a day. A single year's accomplishment will include the planting of 300,000,000 trees, building of 10,000 bridges and other structures, construction of 10,000 miles of roads and the same mileage of telephone lines.

In this setting a half million young men learn each year how to work. Prior to entering the Corps they weren't able to find employment largely because no work opportunities were available. With many of them, deficiencies in education and training served as an additional handicap. Some did not know how to read and write. Others had quit school in the elementary grades. A smaller percentage reached high school, and a scattered few had gone to college.

They joined the CCC, a group of boys frightened and bewildered, and in many cases embittered, by a world that passed them by unheeding and unmindful of their plight. Camp officials talked to them individually to find out where each boy's talents lay. Did he like to cook, or drive an automobile, or tinker with the radio? Was he fond of flowers and wildlife, did he like to build things, what were his pursuits before he joined the Corps?

Under the American system of specialization, there is a variety of jobs in any community of 200 persons such as a CCC camp. Somewhere in the wide range of CCC activities there invariably is a job to fit the aptitudes of each enrollee. Once he has been trained in it he is better equipped to face the world and get private employment. That we have been successful in this vocational fitting is evidenced by the increasing number of private employers who look over our camp crews when they have jobs to fill. Some have gone into aviation and automobile mechanics, others with contracting and engineering companies, some into teaching, some have saved their money and gone into business for themselves. The training in field and forest has equipped many for later jobs with the government or private groups in forestry and soil conservation work. A vast majority of them have learned to get and hold a job. And some are holding jobs paying well above the average wage.

Many of you may have sons in their late 'teens. If you have, you can appreciate the job we are trying to do. It's a job of education, both of body and mind, and a job of steering this education in the course that best fits his aptitudes. You may be a doctor but your son will never be one for the simple reason that he doesn't care for that type of work. He probably would much rather spend his spare time taking down and reassembling the radio, or building model airplanes. If his leanings are in that direction, you can be pretty sure you'll never make a very good doctor out of him, but by cultivating his particular talents you can help him achieve success in his own particular line.

That's what we try to do in the CCC. We offer no fixed course of study—in fact, the enrollee isn't required to attend any classes. But more than 90 per cent of them do, because they are anxious to improve themselves. Our camp instruction is adapted to meet the needs and talents of the boy. It is our desire to direct his training toward the vocation in which he is most likely to be a success in later life.

If you have been in contact with CCC enrollees or ex-enrollees, you know what we are doing for them and what they are doing for themselves. I'll just let it go by saying I personally am very proud to have had a part in the whole program of the CCC.

As to the future of the CCC, you have a fairly good picture of what has been done and what is needed to be done. Only a start has been made, when you consider the tremendous acreage of rich farm lands that are wasting away through erosion, the wide sweeps of forests that still are in need of improvement and care, the hundreds of streams that must be improved in the interest of flood and erosion control and wildlife, and the improvements already effected which must be maintained by continuing care. And, above all, the ever-rising generation of youngsters who never had an opportunity to learn how to do a job.

I must not close these remarks without paying a tribute to the fine officers of the Regular Army and of the Reserve Corps, who have helped in this great work. The Army, as you know, has been the housekeeper for the Corps. Through the Departments of Interior and Agriculture we have the cooperation of the Forest Service, of Agriculture, and the National Park Service of the Interior, together with the Soil Conservation Service of Agriculture, and all the other bureaus engaged in conservation work.

They have all done their bit, ungrudgingly and without regard to extra work and time they had to put in to make it a success. They haven't done it with the primary consideration of the plaudits accruing to their respective departments, but with the thought that they were doing something worthwhile for the whole nation.

Therein lies the future of the CCC. Its twin objective is to make this country a better place to live in from the standpoint of the people with whom we live and the environment in which we live.

THE RELATIONSHIP OF COMMERCIAL AND SPORT FISHERMEN

CHARLES E. JACKSON
U. S. Bureau of Fisheries

MR. JACKSON:

I come to discuss with you today a rather controversial question, nevertheless it is one of growing importance and one which can no longer be ignored. In fact, I notice among the audience distinguished generals from both sides of the famous striped bass war of New Jersey, and what the Bureau of Fisheries is interested in doing is to try to get these powerful armies out of the valleys on each side on a plateau with us, the Bureau of Fisheries and the state organizations, to join our efforts to fight for fish conservation together rather than against each other.

A noted American sports writer, who is also a devout game fish angler, recently referred to "the commercial-minded Bureau of Fisheries." Executives of commercial fishery firms have frequently charged the Bureau with over-emphasizing the recreational features of its work, to the detriment of our more important responsibility—conservation and utilization of food fishes. I like to think that both groups are right; for therein both charges are answered—conclusive proof that the Bureau of Fisheries divides its responsibilities about equally between food and game fishes.

The Bureau of Fisheries is not commercial fish-minded, it is not game-fish minded, but it is *fish conservation-minded;* and the term *conservation* means, in our definition, *wise utilization,* whether it be for recreation or for food uses. This has been the policy of the Bureau since its founding and remains so today—three-quarters of a century later. It is more especially a binding policy now, since we have come under the aegis of a Department whose Secretary, Mr. Ickes, has declared himself irrevocably bound to carry out a program of conservation of all our *national* natural resources. It gives me particular pleasure to say that the Bureau has had not only the fullest cooperation of Mr. Ickes, personally, but that of all the assistant secretaries, as well as the heads of every Bureau of the Department.

I have analyzed our 1939 expenditures and find that the Bureau, out of its total appropriation, spent about $50,000 *more* for game fisheries than for the commercial fisheries. I can easily understand, however, that a cursory review of our annual report on the propagation and distribution of fishes at the Bureau's fish cultural stations may leave a reader with an erroneous impression. For instance, we boast of an annual production of eight billion fish and eggs. In the breakdown of varieties, however, we show seven billion commercial species and only one billion game species, leaving the sportsman with the impression that we produce seven times as many commercial as game species.

The facts are, actually, that commercial species, with the exception of lobsters, are all planted in the fry stages, are not fed in our hatcheries, and in most cases are planted when only a few days old. The cost of production, therefore, is insignificant when compared with game fish which are distributed as fingerlings, in 6-, 7-, 8- and 9-inch sizes, necessitating expensive feeding, large water areas, and a long period of holding in our production units.

The cost of producing commercial fishes averages \$21.00 per million, while the cost of producing game species averages \$6,146.00 per million. A billion planted game fish in fresh waters of the country come nearer meeting the demand than seven billion commercial species planted in commercial waters. About eight-tenths of our fish culture appropriation is expended for the production of game species.

Our figures are, therefore, easily misinterpreted, and merit a closer analysis by the sport fisherman in order to get the true picture. As a matter of fact, practically every variety found in the coastal and inland waters is sought at some time or place by the hook-and-line fisherman for recreation. The hatchery contribution to recreation, therefore, really consists of billions of semi-game as well as strictly game fish.

The charge of favoritism to commercial fisheries comes from the sport fishermen, an ever-increasing army of citizens whose strength in influencing public opinion far outweighs that of the commercial group. For instance, our figures for the past five years show no material increase in the total number of commercial fishermen, now numbering about 130,000. The number of anglers taking out fish licenses, however, has shown a remarkable increase during the same length of time —jumping from 4,858,059 in 1933 to 7,436,177 in 1938.

This great army of anglers does not include the salt-water game-fishermen except in California, nor does it include small boys and girls, many thousands of hook-and-line fishermen, women anglers, and many other groups who are exempted from taking out licenses in various states. It seems to me that a conservative estimate of anglers in the United States would easily reach fifteen million; and, even if only one million of these are organized into active clubs, several hundred thousand are leaders in their communities, have strong political influence, and constitute a powerful factor in moulding public opinion.

The commercial group, although comparatively small, can also wield considerable influence, raise lobby funds, and if necessary make an effective fight to protect what they consider their interests. At present, however, the commercial fishermen are not organized, nor have they ever been, except in small groups dealing usually with a single species of commercial fish, such as salmon and sardines.

The Bureau of Fisheries needs the benefit of the combined influence of both groups of fishermen. It is essential, if we are to have true conservation, that the facts of any given fishery be known and properly interpreted. Fishermen should not jump to conclusions. It is an easy course for the angler, when his catch decreases, to place the blame on the commercial fishermen, and with their organizations, their great numbers, their valuable contacts, entirely eliminate the commercial fishermen. In some past instances this has been done without a full knowledge of the conditions prevailing, resulting in unemployment, bitter feelings, and in some instances to the detriment of the supply of game fish.

I quote, for example, an experience in Louisiana as related in the book of Mr. Percy Viosca, on *Pondfish Culture:*

"Little seems to be known of the competitive relationships of game and commercial species of fish. Several years ago, a number of lakes abounding in game fish had been closed by local police power against all forms of commercial fishing, supposedly to protect the game fish from the depredations of these fishermen. There was little poaching, as the anglers saw to that themselves, but there was a noticeable decline in the game fish catch each year, until soon angling was hardly worth while. Upon investigation, it was found that the shallow waters in these particular lakes were largely devoid of all but microscopic vegetation. Turtles were abundant, and the lakes were over-run with buffalo fishes, gars, carp, and carp suckers. The anglers had removed only game fish, leaving their competitors and enemies to breed and grow unmolested.

"Soon a plan was initiated whereby commercial fishing rights were leased to responsible fishermen, and the funds thus provided were used to pay special wardens and to improve both game and commercial fishing. From Lake St. John, one of these lakes, as much as 200 pounds of commercial fish per acre per year were removed without injury to the game fish, and thousands of pounds of gars were destroyed. A balance is now maintained in the waters between the game and commercial species. Thus the war between the anglers and the commercial fishermen was settled in a way immensely profitable to both.

"The above experience emphasizes the need for devoting more thought and study to the ecological relationships of game and coarse species, particularly such forms as gars, carp, suckers, and bullheads, which may dominate waters otherwise admirably suited to the development of an abundant game fish fauna. Prohibiting the seining of the coarse species upsets nature's balance, which certainly cannot be restored in favor of the game fish by the planting of innumerable fry and fingerlings. A well-regulated commercial fishery, working hand in hand with the anglers and their game fish restoration program, is the only answer."

Since 1871, the Bureau has been collecting annual detailed statistics on the commercial fisheries, and these accumulated data supply one of the most important working tools of the fishery biologists in determining the trend of a fishery. Some of the states, too, have developed important statistical data. Practically nothing has been done to obtain statistics of the sport fishery, and no appropriations are available to our Bureau for this purpose. Recent information compiled by several states with the aid of sport clubs and angler groups on a limited number of species has, however, given us some conception of sport fishery statistics. Many of the results are amazing, showing conclusively that some way must be found to obtain these data if fishery biologists of the present and future are to have an index on the trend of the fisheries. Often the available commercial statistics give only half the story.

Recently a report was published by the New York State Conservation Department of "A Biological Survey of the Salt Waters of Long Island, 1938." This survey was a cooperative project of New York State and the Federal Bureau of Fisheries. It was found that the commercial catch of winter flounders for that year was approximately 645,000 pounds, or about one million fish. During the same period the recreational catch amounted to approximately one million fish. This figure was compiled from information supplied from the charter-, open-, and rowboat fisheries, which cater to the general public through the hire of, or passage on these boats, and does not include any record of catch by anglers on private craft nor individuals who reach the beach by private transportation. The recreational catch of winter flounder, therefore, equalled the commercial catch, although only a portion of the recreational fishery statistics are available.

Tagging experiments of 1937 in Great South Bay, Long Island, on the same species, showed that of the total number of returns within a two-year period after tagging, 14 per cent were recaught by the commercial fishery, and 24 per cent by the sports fishery. A 1938 experiment in the same area revealed, after one year, that returns of the commercial fishery were 23 per cent, and of the sport fishery 27 per cent.

Thus there appears little doubt that if we had complete statistics of the catch of winter flounders by the entire recreational activity for

Long Island, it would exceed the catch of the commercial fishery of 1938.

From the State of Washington comes a report that the sportsmen are rapidly increasing their take of chinook salmon in the inside waters of Puget Sound. In 1938 the commercial fishermen took 51.2 per cent of the chinooks, while the sport fishermen took 48.8 per cent. In 1939 the sport fishery for chinooks increased to 58.1 per cent while the commercial fishery fell off to 41.9 per cent. And here again, while complete statistics are available on the commercial catch, only a portion of the sport fishery catch is available.

From the Great Lakes, Dr. John Van Oosten, a noted authority on the Lake Fisheries, writes:

"Although we have no statistics to support our statement, yet it may safely be said that in some areas the angler takes out of the Great Lakes more poundage of certain varieties of fish than does the commercial fisherman. For example, it is believed that the sportsmen take more pike, rock bass, saugers, smelt, white bass, yellow perch, and wall-eyed pike out of Lake Michigan than are taken by commercial fishermen. With the rapid development during the last two years of deep sea trolling for lake trout it was learned that in at least one important locality the anglers' catch of this species exceeded that of the entire commercial fishing fleet operating at this port."

The following summarizes a report entitled, "Our Water Resources and Their Conservation," by R. V. Truitt, Director of the Chesapeake Biological Laboratory.

Approximately 200,000 sportsmen, says Truitt, fished with hook-and-line on the Bay during 1936. Statewide records for 1937 and 1938 indicate that between 290,000 and 300,000 persons go to Maryland's marine fishing grounds annually to try their cunning and luck against game types.

Some 630 boats are employed in the operation either full-time or part-time, on a commercial basis, while hundreds of others carry private parties for which no records are available. Employment is given to more than one thousand persons on the water directly engaged as guides or boatsmen.

From these illustrations it may be seen that the sport fishermen, at least in some cases, are not justified in placing the blame for depletion entirely on the commercial fisherman.

Fresh-water trout from the mountain streams, black bass and other fresh-water species are not subject to commercial use and are reserved solely for the game fishermen. This discourse does not pertain to these species, for commercial fishermen are not seeking to share this catch. Other species may fall in the same category.

This paper deals with species that are now shared by both commercial and sport fisheries, where the interests of the two groups in reality are identical in so far as the conservation of the supply is concerned. If management practices are adopted that will maintain the supply at a high enough level of abundance to afford profitable commercial fishing, there will be enough fish for the angler also. Only in cases where faulty management is practiced, and the supply allowed to diminish, is there controversy between the two groups.

Proper management does not usually mean the elimination of either type of fishing, but means the adoption of regulations which will permit the supply to recover and to be maintained at a stable level. There are situations, however, in which controversy may arise between the commercial fishermen and the anglers which have no relation to the conservation of the fish themselves. Wise utilization of the supply frequently involves a decision as to the best means of utilization; that is, the use of the catch to yield the greatest benefit either in terms of economic income or the satisfaction of all other legitimate demands.

There are local cases where the protection of the supply solely for the use of anglers is the wisest course, yielding the greatest revenue and the greatest benefit. But too often the demands of anglers for the limitation or prohibition of commercial fishing are hidden behind a smoke screen of conservation. In such cases the Bureau of Fisheries cannot support restrictive measures where no conservation interests are involved, but recognizes that such matters must be decided by the individual state legislatures on the basis of economics and social justice.

Public opinion is essential if adequate progress is to be made in solving the many problems of the American fisheries, but it is vitally important that public opinion be directed for the benefit of the public at large, and not merely for a privileged class of citizens. It is for this reason that I appeal to this representative group of anglers and wildlife conservationists, that you may carry back to your local groups an understanding of this important problem—this urgent need to stop now a growing tendency on the part of some ill-advised anglers to encourage dispute between the two groups.

The Bureau recognizes that there are abuses in the commercial fishery. Along our Atlantic Coast the pound nets, the trawl nets, and other forms of commercial gear are taking too great a toll of undersized fish. The Bureau is trying to solve this economic problem by experimentation, by education, and finally with the aid of the states by regulation. In the haddock fishery, material progress has already been made in the design of saving gear, or larger meshed nets, that permit the escapement of immature fish. In this case the commercial fisherman has long erred; but he shows a desire to put into use the new gear, realizing that a small fish that demoralizes the market and constitutes a waste today, will one year hence bring him a substantial profit.

Not until the sport fishermen and the commercial fishermen understand that fish conservation is one and the same problem for both groups will those of us charged with the responsibility of protecting the American fisheries have the full benefit of increased personnel and adequate appropriations to bring about the fullest use of a valuable natural resource that under our form of government belongs to *all* the people.

Every citizen has an equal right to the use of fish, whether it be taken in a net or on a hook. Mrs. Kelly, who lives in the tenement district of one of our large cities with her five children, has no patience with the angler, a full-grown man who wades a trout stream all day engaging in pleasant recreation, or the surf angler who casts his line into the sea; nor is she much concerned with the commercial fisherman who may be struggling with the elements in his ice-coated fishing schooner. But she *is* vitally interested in buying inexpensive fish to feed to her family, for the clinic doctor has told her that little Pat and little Maureen need protein fish food rich in vitamins to avoid rickets, to strengthen their bones, and harden their teeth. And Mrs. Kelly and all the little Kellys are as much entitled to the use and enjoyment of fish as you and I, though none of them may ever experience the thrill of taking a fish from the water.

In conclusion, let me repeat, the Bureau of Fisheries is not *commercial fish minded,* it is not *game fish minded,* but it is *fish conservation minded,* and is exercising to the utmost its authority, its personnel, and its funds for the wise conservation and utilization of all fish for all Americans.

DISCUSSION

CHAIRMAN PITTMAN: Personally I am very glad that Mr. Jackson did justice to the commercial fisherman.

It is my experience as a legislator that you cannot attain the highest success unless you have the cooperation of the states and of the various industries affected by conservation. That is one reason why I assume you are having your round table talk here: Is the Farmer-Sportsman Council the Answer?

I do not believe that any progressive reform movement succeeds unless it is reasonable and fair. The greatest difficulty that I have experienced as a legislator has been by reason of the support of the extremists in the conservation movement. I think that has been covered very well by Mr. Jackson. Congress, of course, is elected by different constituencies throughout the United States and is primarily interested in aiding the various industries. We have got to realize that the fish industry has existed from time immemorial. The fishermen of the world have taken their part in the advancement of civilization. They are entitled to go on with their living. We who enjoy the sport are entitled to that sport also. But commercial fishing and the recreation and sport of the private fisherman are not inconsistent at all. In fact, they should work hand in hand, as Mr. Jackson has said.

We find exactly the same situation with regard to the farmer. I think the farmer is being convinced that conservation of wildlife is of benefit to him and he will go along with that thought and will become a great aid to it unless the extremists in our conservation movement expect too much of him. You cannot take the entire range from cattle grazers; they have to live, that is their only living. In the state from which I come we have found out that the cattlemen and the Biological Survey and the Forest Service can work hand in hand for the conservation of game to the benefit of both. I only call attention to that because in the long run this movement cannot succeed except by the aid of the Congress of the United States. Money is essential to everything, appropriations are essential to the existence of all of these conservation agencies, and that is the reason I am now urging you to recognize that principle, that you must have cooperation.

I am saying this at this time because I realize that I shall not be able to take part in this round table talk. In the United States Senate the Chairman is entitled to half the time. I don't know what your rule is here.

Let me say this, please: that the Special Committee on Wildlife in the United States Senate has made its final report of its services for ten years. That report consists of 600 pages, 60 pages of which are illustrations of the result of the conservation of the various agencies of the United States Government. It is the most comprehensive report ever gotten out. Mr. Shoemaker as Secretary of the Committee went to all the conservation agencies in our government and got brief reports of their activities, and so this report includes brief reports from every conservation agency in the United States.

At the present time, while we are allowed under the rules of the Senate only a thousand copies, by approval of the Joint Committee on Printing we can have more copies printed. I think that you will find that this volume contains more information in one report with regard to these various subjects than you have ever received before.

The next speaker is Mr. William L. Finley of Oregon. From what I know of Oregon and the State of Washington I think possibly you may hear something on commercial fishing. I think it was very wise for Mr. Jackson to be as tolerant as he was before Mr. Finley spoke.

MR. WILLIAM L. FINLEY (Oregon): I really did not know I was to be called upon. I was not on the program. But I do have one or two things I should like to say. I am more interested in the Pacific Coast than in the Atlantic, especially in the chinook salmon, which we feel is the most valuable fish we have in this nation. We feel that the Columbia River is the greatest chinook salmon stream in the world, and therefore we are very anxious to conserve that run for the present and the future.

We have difficulties, of course, with commercial fishing. We do not believe that we have adopted the proper laws. But we have another, greater problem at the present time with respect to using our rivers for different purposes. There are a great many more people, perhaps, in this nation interested in using the rivers for inland waterway transportation, for the irrigation of more lands, for the development of power, than for the general good of the public. We are interested in trying to correct the pollution of our rivers, as was stated yesterday, and in using them for recreational purposes and to increase our supply of food fishes.

The one question I should like to bring up is whether we are putting up so many dams on the Columbia River and the Willamette River that we are not going to be able to conserve our chinook salmon runs. There are two dams under construction, and those cannot be stopped. The other problem of putting up seven additional dams on the Upper Willamette River, which today is the greatest spawning area that we have for the chinook salmon, is something else. We feel that those dams will destroy the chinook runs.

The problem of flood control in the Willamette Valley has been put through to this extent. The dams have been started on the west side of the Willamette River. Those streams are not salmon streams. But on the east side and on up into the Cascade Mountains are the best salmon streams we have at the present time. That is the Upper Willamette, the North and South Forks of the Santiam and the McKenzie Rivers. The Bureau of Army Engineers have said that flood control can be governed in two ways exactly as well: by the revetments or levees down the river which will cost $33,000,000, or by the building of those dams on the headwaters 200 feet high that will cost $62,075,000. The question comes: Are we going to build the dams for flood control or are we going to use those levees and revetments for flood control? If we use those at the lower price the government does not have to pay so much and we will conserve the salmon runs, and I hope you will bear that in mind. If there are any questions to be brought up or any discussion, I hope it will be discussed either here or at the meeting we have this afternoon.

IS THE FARMER-SPORTSMAN COUNCIL THE ANSWER?

JOHN D. CHALK

International Association of Game, Fish and Conservation Commissioners

MR. CHALK:

When the Secretary asked me to open this discussion I was glad when he requested that I be brief. I think he took that precaution because he knows I have always been a farmer and I have also always looked upon myself as a sportsman. Not so many years ago I became a Game Commissioner. Now I think you will agree that the combination of the three is enough to confuse most anyone and to lead the Secretary to hope that I would not get to speaking from all three angles. So I will be brief as requested and say to you frankly that I am unable to answer the question set up in the program for discussion, namely:

"Is the Farmer-Sportsman Council the Answer?"

As a farmer, I have for years attempted to improve game conditions on my own lands and the lands of my neighboring farmers, and as a sportsman and Game Commissioner I have endeavored to harmonize the interests of sportsmen and farmers, and the further I go with these efforts the more I realize the need of closer working relationship between the two factors.

The question is, how shall we bring it about? I know that the other forty-seven game and fish administrators in the United States would like to have the answer, as likewise would the farmers and the sportsmen and all organizations engaged in conservation and agricultural activities.

Following me on this panel are some well known men who are giving time and thought to this problem, and from them I am sure we will get some valuable suggestions, but they probably will not have the ultimate answer but their findings will be stepping stones toward the goal we are seeking, and I want to take this occasion to urge that something be done to continue the study of this subject after the Conference. Those of you who have been attending these conferences and those of the International Association for the past five or six years, will recall that this problem has been up for consideration many, many times. We have discussed it from Canada to Mexico, but without a proper follow-up.

Now, I don't want you to get the impression that I do not appreciate the value of the efforts which have in the past been put forth by organizations and individuals towards solving this problem—a lot of good work has been done—but much more must be done, in my opinion, before the answer can be given to you. So I want to suggest that this conference, before adjourning, appoint a definite planning committee, or something of that nature, of farmers and sportsmen, representing a national organization in each field, to sit down, study the problem from every angle, and try to arrive at some definite plan of action which will cover at least the basis for farmer-sportsmen relationships over most of the country.

D. I. RASMUSSEN
Utah Cooperative Wildlife Research Unit[1]

DR. RASMUSSEN:

In this panel discussion, Is the Farmer-Sportsman Council the Answer? I have been asked to discuss the organization and operation of the committee made up of representatives of livestock owners, sportsmen, and administrators of public lands who have been cooperating in a program of big-game management in Utah for more than a decade. I am not optimistic enough to believe that an exact duplication of the Utah set-up is the final answer to the farmer-sportsman question. Perhaps that question will continue in some degree just as long as these two groups are, or consider themselves, distinct. But the State Game Refuge Committee and Board of Big-Game Control of Utah does furnish an example of an organized body of representatives of various groups and interests meeting together. tackling game-management problems of mutual and vital concern, and arriving at a concerted program. Each of the members is definitely influenced by the interests of the group he represents, and that is as it should be. The committee meetings, however, provide an opportunity for each individual to gain an understanding of the viewpoints and problems of the others, a thing that is absolutely essential, inasmuch as the group can function successfully only by correlating the

[1]The United States Biological Survey, Utah Fish and Game Department, American Wildlife Institute, and Utah State Agricultural College cooperating.

various viewpoints into a single program of action. The results have clearly proved the value of this type of cooperation.

The present-day organization of the Utah committee is slightly different from that at the time of its establishment in 1927, but its major objectives remain the same.

Historically, the committee was first appointed to take action on the problem resulting from the reintroduction of a big-game species into the State, namely, the elk, or wapiti.

During the early period of settlement in Utah a few elk were present in the northern part of the State. These were, however, with the exception of a small band in the extreme northeastern corner, all extirpated by the early 1900's. Between the years 1912 and 1915 much interest was shown in this animal, and 139 elk, obtained from the Jackson Hole and northern Yellowstone herds, were released at six localities in the State, the costs of their handling and transporting being paid by sportsmen and other interested persons through public subscription.

Most of the imported elk found conditions favorable and they increased rapidly. Not all the localities in which they had been released, however, were wisely chosen, and soon conflicts with private property owners arose. Anyone who has had first-hand acquaintance with these big, rugged, truly wilderness animals can appreciate the damage they can cause to the usual livestock fences and to cultivated lands. By 1921 the situation had become so serious that the Utah Legislature passed a law authorizing the game commissioner to kill such elk as were damaging farms or other property and to sell the carcasses, heads, and hides and place the money in the State fish and game fund. Between 1921 and 1925, eighty-four elk were thus taken, but if this satisfied the property owners who were suffering damage, it did not satisfy many of the sportsmen and sponsors of the transplantings, who regarded this monopolistic hunt as a sort of junket for wardens and their temporary assistants. In 1925 a special hunt was organized, and approximately 200 bull elk were killed from two of the herds, but this was still not satisfactory.

The elk problem had then ceased to be simply a question of a special hunt or of damage to cultivated lands and ranch property. Privately owned range lands were being grazed and serious competition with domestic livestock on public lands was reported.

To appreciate fully the importance of this conflict between game and livestock, a review of the land status in certain Western States is essential. Utah is one of eleven far western states that are often designated as the public-land states because within their boundaries are large areas of publicly owned land. These states contain a comparatively small amount of cultivated land but have large areas of range land that is grazed seasonally or year-long by privately owned livestock. Some of these areas are privately owned, but the great majority is administrated by federal and state agencies.

Utah has a land area of 52,598,000 acres, of which only 1,542,000 acres, or approximately 3 per cent, are cultivated. Almost all the remaining area has economic value as either summer or winter grazing lands for domestic livestock. In truth, the only lands not grazed by livestock are certain barren or inaccessible sections, a comparatively small area of national parks (277,000 acres), and certain small tracts valuable as watersheds for supplying water to the larger cities. Of the grazing lands, 5,000,000 acres are in private ownership; 8,982,000 are set aside as national forests; 25,011,000 are administrated by the Grazing Service, 1,740,000 are Indian reservations; and 3,652,000 are state, county, and municipally owned.

In most cases, the imported elk were released on national forests on game refuges established to insure their protection. As they increased in numbers, they began not only to compete for forage with domestic livestock on the national forest lands, but also to utilize private grazing lands and to visit cultivated fields. To complicate the situation further, all persons who had aided or were interested in the reintroduction of the elk rightfully regarded themselves as part owners of the animals.

Thus, a number of agencies were vitally concerned in the elk problem, and a solution was sought in appointing a committee composed of persons representing the various interests and viewpoints. This organization was to meet and formulate a management program for the elk.

In March, 1927, the Utah State Legislature passed a bill authorizing the State Fish and Game Commission "by and with the consent of the Governor, to appoint a supervisory committee, to serve without pay," as the State Game Refuge Committee and Board of Elk Control. This committee should consist of the State Fish and Game Commissioner, who would act as chairman, and a representative of each of the following groups: (1) the Utah sportsmen, (2) the U. S. Forest Service, (3) the Utah wool growers, (4) the Utah cattle growers, (5) Utah Public Park Commission, and (6) County Commissioners of county or counties in which a particular game refuge is situated.

The State Game Refuge Committee and Board of Elk Control met regularly, established, adjusted, opened, and closed elk refuges; set the seasons for hunting elk; and designated the locality or localities in which hunting could be done, and the sex and the number of animals that could be killed. Nontransferable permits to hunt elk were sold to sportsmen chosen by a public drawing. The Committee functioned effectively for five years, until March, 1933, when the law was amended. The Committee's power was extended and a number of minor changes were made in procedure, as a result of criticism during the period of operation. The new Committee was reduced to five members, and was composed of the State Fish and Game Commissioner, chairman, and one representative each of the Utah State Cattle and Horse Growers' Association, the Utah Wool Growers' Association, and the Utah State Sportsmen's Association, and a regional officer in Utah of the United States Forest Service. These were to serve without pay but to receive reimbursement for necessary hotel, travel, and personal expenses incurred while attending official meetings of the Committee. The acts of the Committee were to have the full force and effect of law.

The most important change was giving the Committee jurisdiction over all the big-game animals. (The law defines these as elk, deer, antelope, mountain sheep, mountain goat, and moose.) This was particularly important because it authorized the Committee to handle newly developing problems concerning mule deer in the State.

The Committee's functions were defined as twofold: (1) to define the boundaries of state game preserves more scientifically; to have full power and authority to regulate hunting, trapping, and travel on the preserves by stockmen and other persons; and to designate refuges for big game; and (2) to constitute a board of big-game control when, after due investigation, it finds that big-game animals have increased in numbers in any locality to such an extent that they are damaging public or private property or are overgrazing their range. The Committee is authorized and directed to determine special hunting seasons, the number of licenses to be issued, the areas in which hunting may be permitted, and the number and sex of the animals that may be killed.

The Committee has functioned harmoniously, efficiently, and fairly, even though members have not always voted unanimously on the various questions. It has not only conducted its own field investigations, but has cooperation of big-game and range specialists of the State Fish and Game Commission and of the United States Forest Service. It holds annual public hearing at which all interested persons may voice their opinions, grievances, and wants, and has executive sessions at which it discusses the individual problems, and by a process of give and take, to the best of its ability, formulates Utah's big-game hunting program.

As a striking example of the results that may be obtained from an elastic program of this kind, the Nebo Elk Herd in central Utah may be cited. There a single plant of fifty elk was released in the spring of 1913 (Table 1). The success of this planting was a major influence in the formation of the original Committee. From 1931 to the present time, this herd has been maintained at 500 to 600 animals, it being believed that 600 is the maximum number for a balanced program of game and livestock management on that range. During that period, the Committee varied the areas on which hunting was permitted and the number and sex of the animals removed. Some elk were killed because they were damaging crops. The most outstanding result is that there are now approximately 600 animals on that area, even though 1,411 animals have been removed by hunting and 27 by transplanting to other areas. This means that under a constructive management program, 50 elk increased twelvefold in 26 years, while during the same period 1,438 animals were furnished for hunting and transplanting. Truly, this is an enviable accomplishment in big-game management.

Table 1 contains data on elk transplantings in Utah, showing the locality where the transplantings were made, the date, and the number of animals released, as well as the number removed from the herds and the population in 1939.

TABLE 1. UTAH ELK TRANSPLANTINGS, REMOVALS, AND NUMBERS IN 1939

Area	Date of planting	Numbers planted	Total removed[1]	Numbers in 1939
Cache	February, 1915	24	831	800
Fishlake	February, 1912	10	320	1,000
Fishlake	Winter of 1913-14	37		
Heaston	Winter of 1913-14	10	160	150
Manti	February, 1915	10	696	1,500
Nebo	Spring, 1913	50	1,436	600
Dixie	1925	22	27	75
Timpanogos	1925	8	87	25

[1]The total removed comprises all animals killed by wardens and hunters, including the elk killed in the 1939 hunt, and those transplanted to other areas.

Committee action on Utah deer problems has been confined to the period since its 1933 reorganization. The seriousness of certain local deer problems was evident in the late 1920's. The total number of deer in the State was not excessive, and although hunting of bucks was heavy during the regular 11-day October open season, problems continued to develop. Deer were damaging cultivated crops and conflicts between deer and livestock were occurring on private and publicly owned grazing lands. Most serious, from the wildlife-management standpoint, was the fact that, as a result of overpopulations of deer, the winter game ranges were being seriously overbrowsed, and excessive winter losses of deer were occurring.

All this called for some definite action—not necessarily a general open season, but a program allowing adjustments and providing treatment according to needs of the locality. In 1934, the Board took the first definite action on the deer problem. After a careful investigation, the Committee authorized special permits for a late November hunt of 1,800 deer on the so-called "hot-spot" areas. This was recognized by those who were thoroughly acquainted with the problem as a sound management approach. Only half of the permits were sold, however, owing in part to the lateness of the hunt, but in no small part to adverse public sentiment. The action of the Committee was too much of a departure from old methods to be fully accepted by the sportsmen.

Since 1934 special permits have been authorized for hunting antlerless deer—in 1935, 3,150; 1938, 4,000; and 1939, 10,700. Only in 1939 were all the permits sold, and during that year more than 9,000 antlerless deer were killed in addition to the 20,000 buck deer killed in the regular hunt.

Thus, the Board has, to the best of its ability and knowledge, taken definite and regulated action on the most serious game problem concerned with Utah's most valuable big-game animal. What the 1940 program will be depends upon surveys, investigations, and all information that can be obtained before the time of executive meetings to be held late during the summer. The deer-managemnt program is still very much in the experimental stage, and the effects of the large hunt authorized last year will be watched carefully to determine future procedures. The success achieved in managing the elk herd is instilling confidence in the action of the committee on the deer question.

In conclusion, may I say again that the Utah State Game Refuge Committee and Board of Big-Game Control, an organization of elective representatives of livestock owners, sportsmen, and land administrators, has been functioning successfully in formulating and administering management plans for the big-game herds of that State. This group representing the several interests has operated in fairness and cooperation with a desire to make decisions that are equitable to all interests and that will result in a constructive game-managament plan.

FRANK C. EDMINSTER
U. S. Soil Conservation Service

MR. EDMINSTER:

It is estimated that at the present time over 80 per cent—four-fifths—of all the game shot annually by hunters in the United States comes from privately owned farms. It naturally follows that a large part of the hunting itself is done on these farm lands. For many of the more popular game species, private farms furnish practically all of the suitable habitat. It is clear then that the future of free public hunting depends largely upon the owners of our farm lands.

Emphasizing the dominant part that farm lands play in our modern system of hunting does not detract one bit from the vital part that forests and other non-farm land, both publicly and privately owned, play in furnishing hunting for deer, bear, waterfowl, and other game native to these habitats. A public land policy with regard to these lands is essential to a sound game management program. However, many of our greatest problems in assuring hunting opportunities are arising in connection with farm game and on farm lands. To get a proper understanding of this problem, let us examine a few historical facts.

The period following the World War was a time of rapid transition in regard to hunting problems. So we should begin by noting the conditions prior to that time that were later to make so marked a change. Hunting pressure is probably the most notable. The number of hunters has multiplied five times, and this has taken place since 1920. Whereas we now have around 7,000,000 hunters in the United States, we formerly had between one and two million.

Whereas before the war, the hunters pursued waterfowl, grouse, and deer on wilderness and water areas, and quail and rabbits on farm land, great emphasis now is placed on the pheasant, hungarian partridge, and other exotics—entirely new to our countryside. Most of these introduced species are found almost exclusively on farms.

Formerly the means of travel from home to hunting grounds was by horse and buggy, or railroad for some, or by shank's mare for most. Today it is almost universally by automobile.

The increased public interest in hunting as a mode of recreation, the ease of transportation in the automobile, and the entrance of the ringneck and others as much desired trophies resulted in the greatly magnified hunting pressure, mainly exerted on the farm lands. Thus today we have millions of our citizens, a large part of them urban dwellers, swarming over the countryside during the open hunting seasons, creating a sociological problem in landowner-sportsman relationships that did not even exist before the 1920's.

These changes have resulted in vast restrictions of the opportunity for free public hunting through increased posting of land against trespass. They have also resulted in a strained attitude toward hunting and even toward wildlife management on the part of many landowners, owing to the recurring nuisances committed unwittingly by a few hunters. For their part, thinking sportsmen have attempted to work out some equitable solution to the problem through various forms of farmer-sportsmen-state cooperatives. In the past decade, there have been hundreds of these projects, beginning with the famed Williamston project in Michigan.

The details of their plans undoubtedly cover almost every conceivably workable combination of benefits that has been brought forth for the solution of the problem. Yet, I think it may be said that, with few exceptions, these plans have not succeeded very well. A large number of them survive, at least on paper, but by and large they have so far gained little recognition as a sound and widely applicable answer to the problem. Certainly they are not receiving the widespread application that is so urgently needed.

Why have these past attempts failed to accomplish the set objectives? I think that a dispassionate analysis of the failures, partial failures, and successes of the past will disclose at least some of the reasons. Most of these cooperatives are operated by the states. This is as it should be, but of necessity the states have in most cases been forced to shoulder too much of the burden. The state has sponsored the project, lined up the cooperators, furnished the required materials, and usually supplied such services as posting, fencing, and patrolling. For the most part, the organized sportsmen have done little but pay through their hunting licenses. For the most part, the farmers have done little but acquiesce in the hope that conditions will be improved.

This system as it has generally operated in the past has been too costly. In some states it costs around $0.50 per acre to set up the cooperatives and $0.30 or more per acre annually to maintain—and these are mainly administrative costs—with hardly a nickel going to the landowner or into the land itself to make better hunting. The result is that the money runs out and only a few thousand acres are encompassed. A successful cooperative requires that both the farmers and the sportsmen must derive enough from it to stimulate them to put much into it.

One project that has apparently succeeded very well is the Plain Church Cooperative in Ohio. In the first place, the area involved here is highly productive of pheasants, an excellent condition to assure sportsmen's interest, and one not prevailing generally. Secondly, the farmer derives income from hunting privileges. Another equally important factor is that the cooperative was farmer-initiated and attached to an existing and functioning farm organization, in this case a church group.

This may seem inconsequential at first thought, but it may be a fundamental necessity to a successful cooperative. Without an active, aggressive farmer organization to tie in with, a game management cooperative is badly handicapped from the start. There are many other factors involved in this problem, but I think we have covered those that point to the two fundamental principles: (1) the cooperative must tie in with a functioning farmer organization, and (2) it must function at a low cost per acre for administrative expenses. I would add a third point which in reality only modifies the first: the farmer organization must be actively interested in the conservation of the farm resources in order to engage successfully in the management of wildlife. I think this point is most important.

From this point—with sound farmer participation—a cooperative can build rapidly. It should be apparent that the sportsmen, as well as the farmers, must be well organized if they are to be in a position to cooperate adequately. There must result a tangible and valuable return from the cooperative to both sportsmen and farmers. The sportsman, of course, wants a place to hunt and some game to pursue. What the farmer wants will vary, but whether it be mere protection of property or more material returns, the cooperative arrangements must supply it. I am not concerned now with the details of the plan. It will be easy enough for the farmers, cooperating with public agencies, to establish refuges, plant food patches, protect woodlands from grazing, arrange lease fees, or whatever is needed, once the required organization is functioning.

I believe that there is now a workable answer to this problem. But first, let me again restate the basic requirements: A medium of organization for both farmers and sportsmen, with a firm interest in conservation as a whole, through which the two groups and the state and other interested agencies can cooperate in carrying out a program of wildlife management in conjunction with other conservation work. This organization should provide a means for economically facilitating game cooperatives.

For the sportsman's organization, local sportsmen's clubs and their county and state federations should serve admirably. However, I believe that they must be strengthened far beyond their present level of activity if they are actively and permanently to undertake this cooperative work. The very opportunity for this work should help to stimulate this increased strength. Farmer organizations, with a few local exceptions, have not been in a position to handle the needed cooperative efforts in conservation work. The United States Department of Agriculture, in its work with the conservation of the soil and its resources, recognized the need for some type of farmer organization that would function democratically to solve the common conservation problems of a locality. Legislation enacted by a majority of states within the last three years may go a long way to meet this need. It is the soil conservation district that may well prove to be the missing link in the landowner-sportsman relationship problem.

What is a soil conservation district, how is it organized, how will it help in this wildlife management problem? Well, I think you may gain a better understanding of it if we call it simply a conservation district; for while the soil is the basic resource to be conserved, the resources derived from the soil—farm crops, forests, water, and wildlife—are equally important in the conservation objectives. They are the beneficiaries of the conservation of the soil. So it is not only natural but essential that these districts definitely plan for the care of all of these resources.

The philosophy behind the soil conservation district movement is to place the responsibility for soil conservation and good land use squarely on the shoulders of local people—the people who operate the land. The district is an agency through which farmers may cooperate with each other and with public agencies in the conservation of their natural resources. Through it they may exercise their initiative and take their full share of responsibility for the solution of their common conservation problems. The districts are organized and operated by the farmers themselves and district policies are established by them. This is only possible when the landowners are fully aware of their own problems and are informed as to the methods and techniques of the best solution. That is where public agencies come in—any local, state, or Federal agencies that are in a position to furnish the district with professional guidance and help. When the district faces wildlife conservation problems, it is obvious that it should turn to the state wildlife agency for help; and, it is equally apparent that the state can operate more efficiently on farm game work through the cooperation of a conservation organization such as the district.

Districts are generally political subdivisions of the state and as such require state enabling legislation. Experience by the states has indicated that the logical unit for a district is a watershed or group of watersheds, but they have usually found it expedient to define the boundaries by roads, streams, and existing political lines to approximate the watershed owing to the legal difficulties in defining a watershed boundary. Districts formed so far include from something less than one hundred thousand acres to more than a million acres each.

Let's take a typical district law and see how districts may be organized under it. The act probably provides for the establishment of a state soil conservation committee which may receive petitions for district organization. The petition should contain at least 25 names of landowners or occupiers. Then the state committee holds open hearings in the proposed district area to sound out public sentiment and to answer questions that arise. If there appears to be need for a district and adequate interest in its formation, the committee then defines the boundaries and calls a referendum. If the vote is favorable, the committee may then appoint two directors or supervisors for the district. These appointed supervisors file an application for a certificate of organization with the Secretary of State. When this certificate is issued the district comes into being. Three more supervisors are then chosen at an election.

The board of five supervisors is the governing body of the district. The supervisors' first job is to study the conservation problems of the district and to formulate a program of action. Based largely on soil conservation and the control of erosion and water run-off, this program may include many conservation objectives. Flood control, improved pastures, woodland management, and wildlife management are some of the more commonly expressed objectives in addition to basic soil conservation. On the basis of this program the district may request assistance from any public agencies that are in a position to help them with technical guidance, loan of equipment, or the furnishing of labor and materials. They may ask the state extension service to assist with the education needs; the state college may be asked for guidance on fertilizer and seeding requirements and similar problems. The Soil Conservation Service is usually requested to furnish technicians to make farm plans embodying conservation needs. The state and county highway commissioners, the state forestry agency, and the state wildlife agency are others that may be called upon for assistance. The district may seek cooperation from other organized groups in the vicinity, such as fertilizer associations, chambers of commerce, cooperative marketing agencies, and sportsmen's clubs. In working out the landowner-sportsman relationships problems, the district would logically turn to the state conservation department and the local county federation of sportsmen's clubs.

In most cases a written document of cooperation is drafted to cover the relations of the district with each cooperating agency. Such a document is required by some organizations, such as the United States Department of Agriculture, in order that public funds may be utilized.

With the objectives of the district set forth in its program and with cooperative arrangements completed with various agencies, the district supervisors draw up their work plan. This sets forth in detail what is to be done, who will cooperate in doing it, and when it will be done. As a practical matter, the work plan is usually drafted at the same time cooperation with the various agencies is arranged, and representatives of the interested agencies work with the supervisors in drafting it.

This work plan covers in detail all recommended actions, techniques, and plans. For example, it may be specified that a certain type of soil on slopes of over 3 per cent should be cropped not more intensively than in a four-year rotation of tilled crop, small grain, and two years of hay, in a layout of contour-strip-cropping with the strips not exceeding 100 feet in width. Another example might be—in fact, almost always is—that woodlands shall be protected from fire and grazing. There is no limit to the extent to which practical wildlife management may be included in the work plan. Woodland plantations, shrub plantings, swamp and pond development, herbaceous wildlife field border plantings, hedge plantings, food patches, winter feeding—all may find their proper place in this plan for conservation action. Arrangements for landowner-sportsman-state cooperation are thus made simple and logical. Game management no longer has to stand alone on its own legs, but becomes a logical part of a broader conservation job, an action which is so fundamental to the farmers' future well being that the permanency of the whole is firmly established. By coordinating all phases of land conservation, each is assured its place—another example of the old adage, "United we stand, divided we fall."

I may add that sportsman groups are playing an important part in the organization of districts. I have said that districts are organized and run by the farmers. That is true, but the leadership in guiding the formation of a district may come from any source interested in conservation. I know of one case where a chamber of commerce is the guiding influence. There are a number of cases where wildlife interests have furnished this leadership. In one of these, an Izaak Walton League chapter in Maryland has helped with the organization of two districts, both now operating. The opportunity is there for pioneering service in advancing the cause of practical conservation on the land.

With a district formed, the opportunity for cooperative wildlife work, both in the management of the land itself and in landowner-sportsmen relationships, is unlimited. It is the first time that the various interests in the conservation field have had a concrete opportunity to function together in a unified program. The folks interested in highway roadside beautification, those interested in cooperative woodland management, cities concerned with flood control, sportsmen interested in game, and nature lovers interested in wild animals and plants, these and others as well as the farmer may coordinate their interests in effecting conservation of the resources of the land.

Thirty-seven states have enacted soil conservation district laws in the last three years. There are more than 125 million acres now included in districts, and the total is growing rapidly.

The sportsmen, through their national, state, and local federations, should be fully informed on these new developments in order that they may play their proper part in furthering conservation of our farmlands. While I recognize the difficulty of adequately presenting such a big subject to you in so short a time, I hope that you have at least received enough information to whet your appetite for more.

COLIN McF. REED
Pennsylvania Federation of Sportsmen's Clubs

MR. REED:

I understand that this was to be largely a round table discussion and I have no prepared talk. However, I have some ideas which we have worked out in our own State which may be of some assistance to you in other states.

In the first place, I would like to make it clear that looking at this from a sportsman's angle entirelv there can be, in my opinion, no national system for farmer-sportsmen cooperation. The conditions in various parts of the country are so different that it is absolutely impossible, I believe, to work out any plan that will work perfectly in Texas and in New Jersey or Pennsylvania.

If we cannot have a national policy, the natural result is that we must in our own sections, under our own conditions, work out for ourselves the best proposition.

One reason that I say a national policy is, in my opinion, impossible, is that we have had, as you know, in past years considerable agitation for paying the farmer for the privilege of hunting. I am perfectly willing to admit that in Texas where a ranch is 3,000 acres, it would be perfectly logical and possible to pay the farmer for the privilege of hunting, and the farmer, on his end, would raise game and make of his game a profit. If he did that and we could get better hunting on his ranch, we would be perfectly willing to pay a reasonable fee for the privilege of hunting there.

But in my State of Pennsylvania, or in similar states where our farms are 250, 300 or 400 acres, any such system is, I believe, impossible. No farmer could get enough money out of the game on his farm to make it worth while for him to raise game or at least to go into all the details of the propagation of game. Even if he had a 450 or 500-acre farm and raised game and released it and charged for the privilege of hunting, I would still be willing to go there and pay for the privilege of hunting on his farm, but the result, unfortunately, would be that fifty other farmers within a radius of 25 miles wouldn't do anything to improve the hunting, wouldn't raise any game, wouldn't do a thing to help us, but would say, "Jim Smith is getting paid a dollar a day for the privilege of hunting, and by gosh you can't hunt on my farm without paying!" The result, we believe, would be that a great area of hunting land would be closed to hunting.

In my opinion our farmers do not want to be paid for hunting. They want two things: they want protection and they want courtesy and appreciation. We are trying to work out schemes that will give the farmer what he wants.

We talk about free hunting. We are getting further and further from the possibility or even from the advisability of what we have always termed free hunting, because today we know that to get good hunting we have to have some cooperation from the landowner. The average farm today with present hunting conditions will not furnish good hunting unless the landowner cooperates with us, and how can we expect the landowner to cooperate with us unless we cooperate with the landowner?

We start with that premise. In Pennsylvania we have, shall I say, three different general systems of arranging our hunting areas. We have, first, our own land that we buy with a goodly proportion of our hunting license money. The hunters today in Pennsylvania have bought over 700,000 acres. In that, of course, there is no question of cooperation with the landowner; we own the land. But that reaches a limit beyond which we cannot go, because the care and supervision of that land becomes expensive and you reach a place where you cannot enlarge that even though you may have the money to do it.

Then we have what we call our farmer cooperative plan under the supervision and direction of our State Game Commission. That is simply a scheme whereby the Game Commission gets a group of farmers to go into an agreement to allow hunting on their farms, and the Game Commission agrees to post areas immediately around the buildings to prohibit hunters from those areas and to leave little spots of game refuges over the areas where the game can go and where there is no hunting. We keep a deputy game warden on those areas during the entire hunting season so that there shall be no violation of the farmers' property.

Those have worked very satisfactorily. Of course they are comparatively new, but we have now about 150,000 acres of that type of farm cooperatives.

The third system that we are trying to work out in Pennsylvania is through our sportsmen's clubs. When I say sportsmen's clubs, I do not mean they are all sportsmen, even in the clubs. We have deliberately tried, in Pennsylvania, to get the fellows in our clubs who are not sportsmen. That may sound a little peculiar, but we want them in; we want to try to make sportsmen out of them. We believe that by getting the type of hunter who leaves the farmer's fences down and shoots his chickens into a sportsmen's organization and trying to inculcate in him the principles of good sportsmanship and proper respect for the farmer, we will definitely improve our farm relations, and we have done so. That is our first aim in our sportsmen's organizations—education. We have in our organization in Pennsylvania approximately 145,000 sportsmen. You know, as well as I do, that with 145,000 sportsmen, they are not all naturally endowed with the ideas of good sportsmanship. We have to teach a lot of them.

But the sportsmen's organizations go farther than that. Aside from our Game Commission handling of the problem, we try to handle it in our clubs, and we have had, in some districts, a marked success. We admit that it is largely still on trial, but it does work and it has been very successful.

I will show you one of the signs which we have in a great many districts of our State. We put up last year, I think, 4,000 of those signs in my county, and 90 per cent of them were put up to replace, gentlemen, No Trespass signs. They were put up in the majority of cases where the land was posted. We went to the farmers and discussed the problem with them and we arrived at an amicable agreement and the farmer took down his No Trespass signs and put up these signs. I am going to read this to you to give you an idea of the way we have handled it.

SPORTSMEN

Ask for Permission to Hunt or Fish

You are a guest on this property through the courtesy of the owner or tenant, so respect his wishes and rights.

IT IS UNLAWFUL TO

1. Leave Gates Open, Break Down or Destroy Fences (Climb a wire fence at a post, not between posts).
2. Injure Poultry or other Live Stock, or Shoot within 150 Yards of Buildings.

PENALTY FOR VIOLATION OF THE ABOVE IS $25 FINE OR IMPRISONMENT

(Act of June 29, 1923, P. L. 972.)

The Washington County Sportsmen's and Conservation League will pay a reward of $10 for information leading to the arrest and conviction of any person violating one of the above acts while hunting on this property.

DO NOT

1. Walk over newly Plowed Fields.
2. Hunt in a Field where Stock is Pastured or Shoot near where any Work is in Progress.
3. Pick Fruit, Nuts or Berries without Proper Consent of the Owner. If you want Farm Products, ask to Buy them; the Farmer may have them for Sale.

Issued By

Washington County Sportsmen's and Conservation League

In the Interest of Better Cooperation between the Sportsmen and the Farmer

BE A SPORTSMAN FIRST—LAST—ALWAYS

JOIN YOUR LOCAL SPORTSMEN'S CLUB

We started with that type of sign alone, and last year some of our clubs extended it and issued a little booklet. Of course we say on that sign: Ask for permission to hunt or fish. That is the first premise. The farmer has said, "I would like to know who is hunting on my farm. I'll let anybody hunt who comes here and asks, but I want to know who is hunting any particular day, and I also would like to know how many." One farmer said, "I don't want more than four or five hunters on my farm in any one day." So the sportsmen's organization give him this little book which has a permit and a duplicate. It says: "Hunter's Permit. So-and-So, License No. So-and-So, is permitted to hunt on the Property of the Undersigned. Good only on (date). (Signed)."

That gives the farmer a little more protection. He has a record of who is hunting on his farm each day. If he has some trouble he at least knows to whom he can look. Some of them ask: "If you see anybody else hunting without a permit I wish you would write down their license number, because if I have anything shot or any trouble I am going to blame you fellows and if there is somebody else on there I want to know it and you ought to tell me about it," which I think may be a good idea.

Those are merely suggestions that we have worked out in our State, all of them different in a way, and yet all of them workable.

The principal thing we have to recognize unquestionably is that the organized sportsmen of any community are responsible for the vandal. It is their duty either to educate him, protect the farmer from him, or in some way see that vandalism on the farm is stopped, because neither you nor I can blame any landowner for being very radical, very anti-hunter, who has had his chickens shot. I have had them tell me they had a horse shot. Such a farmer is mad and you cannot blame him. The better type of sportsmen have to take the responsibility, in my opinion, for working out this problem of cooperation with the farmer. In my state we have accepted that responsibility frankly and freely, and we are trying to work it out to the best of our ability.

ARNOLD NICHOLSON
Country Gentlemen

MR. NICHOLSON:

The problem has been well defined by Mr. Chalk; you have examined plans used in several states. As an editor of one of the national farm magazines—and one that has been active in keeping landowners posted on the developments in farmer-sportsman affairs—I want to emphasize that the farmer can be and is interested in the conservation of wildlife, but he also desires protection and respect for his property and himself, and the right to be recompensed when, and only when, he cares for the game that, by law, is not his, but his ward.

I have no national plan to offer. All that I am going to toss into this program for discussion is the thought that in whatever plans are made you leave a spot for youth. Don't forget the boys, the young men who are still in school, both in the cities and towns and from the farm.

You all have a knowledge of the Department of Agriculture's 4-H clubs, and many of you are familiar with the federal system of vocational training for agriculture which takes in, mainly, boys who are of older age. Those boys—and girls, too—are earning while they learn. If the 4-H leader, the vocational teacher, can be drawn into the farmer-sportsman group, and in turn interest his pupils and show them how they not only can serve but also show them how to develop knowledge and practices that will benefit them later, either when they are on their own or working with their fathers, you have started something that is going to pay big dividends in the future.

The young folks, don't forget, soon are going to face the problem that we are discussing, only it will be intensified. I haven't heard, recently, of any reduction in the number of hunters and would-be hunters. We have done a marvelous job, through 4-H conservation groups, the Boy Scouts, and other youth organizations, in teaching the value of wildlife and ways and means to preserve it. But the emphasis has been on the wildlife—the important human relations involved, the topic of this discussion, have not had a great deal of attention. Youth needs more instruction here; and boys can best learn if we can draw them into the picture, or at least allow them to watch from the sidelines in their own communities. And if, in bringing them into the picture, some method can be devised to get the town and city boys working with the farm boys, the cooperation of farmer-sportsman councils ten years from now—the respect on both sides of the fence—will assure success.

The landowners and the hunters must work out their own solution. I would like to say right now that the solution is not and probably cannot be identical for every locality, though the Council matter is undoubtedly one to be considered, and the airing we are giving it here should be passed on to every county in the land. The elders of each community will have to work out the details, but I have evidence that the young men are not only anxious to participate, but capable of doing a fine job.

An associate of mine has a farm in Woodson County, Kansas, which is well known as fine quail and prairie chicken country, and the place where the Midcontinent Field Trials have been held for ten years or more. In that section of the county where the trials are run, the landowners are on their toes to keep the country stocked with birds. They have pride in their hunting, and appreciate its value to them in bringing an outstanding and remunerative event to the country. The farmers have joined with local sportsmen, in the sort of council we are discussing. The hunting on their properties is regulated fairly, and a reasonable charge for the privilege is made. Much of the work in providing for the game, in policing during the season, on about three-fourths of the farms is performed, and I might add, enjoyed, by the sons of the farmers. Many are allowed to keep the hunting fees in return for their work.

That's the sort of participation by youth that it will pay to encourage. I imagine if the commissioner or others from Kansas are here, they could tell us more about it. I'd like to see the boys brought into the farmer-sportsman program if we can.

J. PAUL MILLER
U. S. Bureau of Biological Survey

MR. MILLER:

Mr. Chalk as the lead-off speaker mentioned the fact that for the last ten or fifteen years we had been discussing the matter of farmer-sportsmen problems.

A number of years ago an action program was presented to the game people of the United States by the American Game Association. That program is as sound and practicable today as it was when it was presented. Certain modifications may be required and certain adjustments made because of changing times, but the underlying philosophy and the underlying principles are in my opinion still correct. Why didn't this program succeed? Why didn't it get ahead? I wish I knew the answer to that question. Perhaps two elements enter into it. Perhaps that was not the psychological time, people were not ready to accept it, but more important than that, I wonder if we did not fail to take into consideration all of the groups who had an interest in it. I wonder if it wasn't our own little gang that had an idea and we tried to sell that idea to somebody else. If this program had been sponsored by some other interested group it might have gone forward much better. I have a feeling that now is perhaps the psychological time to try again. I do not feel that a council will answer all of the problems, but I believe that it will help if we will take into consideration the suggestions that were given by the speakers on this platform this morning.

Representatives of farming interests, game interests, and administrative interests have participated in this panel today and all of them appear to be mutually agreed on the essential points.

Let us take the papers that have been given this morning. Mr. Chalk suggested that we take some sort of forward step beyond the point of just talking about it. Dr. Rasmussen outlined for us an action program which should give us some inkling as to how we might go about accomplishing our purpose. He pointed out definitely to us what we may expect when all interested parties are gathered around a table for a general discussion, and the possibilities of success in such a program. Mr. Edminster pointed out the importance of the problem to us. He demonstrated again how action programs should be coordinated. Mr. Reed pointed out the difficulties involved in carrying forward an action program throughout the United States, but he also suggested the possibilities of how it could be done in regions by making modifications. Mr. Nicholson asked us to take a tolerant, a considerate, and an understanding attitude in our approach to this problem.

As an emergency measure an action program may be quite essential, but in the long run the accomplishment of a purpose desired is based on a general acceptance of the philosophy basic to that program. The action program may point the way to certain accomplishments, or it may present the framework within which desired ends may be reached, but to make the application general requires a broad acceptance of the principles involved. Our job appears to be one of establishing means whereby these principles and the philosophy will be generally accepted.

Our Honorable Chairman pointed out to us the grand job that the Senate Committee has just accomplished. I believe that it is the duty of this organization to pick up the task from there and carry it forward. If we with the consent of the assemblage form a council, that council should not be expected to come back with any cut-and-dried program that could be blanketed over the United States; they should be expected only to formulate the philosophy and then as far as possible determine the means whereby that will be placed before the public for their general acceptance. To me the council is the answer.

DISCUSSION

CHAIRMAN PITTMAN: In turning over the chairmanship to Mr. Shoemaker, I wish to thank the Conference for the honor and pleasure given me by permitting me to be here. I have attended a number of these conferences, and can say very frankly and truthfully that this symposium has been the most interesting I have ever heard. I think we all agree that it is impossible to carry this movement to its complete success without the cooperation of the landowner and those who have the right to use the land. I think also that Mr. Reed has disclosed most clearly the responsibility of the sportsman in this matter.

As a member of the Federal Government for twenty-seven years, watching the progress of this movement, I am absolutely certain that all of our great sportsmen societies, all those who love this work, cannot possibly succeed without cooperation along the various lines that have been suggested today. We know, as a matter of fact, that with the exception of migratory birds, the states have jurisdiction over game; they must be considered. I believe also that without the cooperation and the willing cooperation of those who use the laud, again we will be blocked at every turn. I believe that as far as I remember this symposium today has brought us closer to complete cooperation than ever before.

Thank you. I must now go back to the United States Senate.

CHAIRMAN SHOEMAKER: I assume that the forum here now will be devoted to questions and answers on the part of those who have already spoken. I assume also that if there is anyone in the audience who would like at any point to interpose a question to any one of the speakers, it will be permissible.

I am first going to ask Mr. Nicholson to say a few words more with reference to the farmer's attitude, because Mr. Taber and Mr. O'Neal have not been present to present their viewpoints, and I am sure that we would welcome a few additional words from Mr. Nicholson.

MR. NICHOLSON: I mentioned the farmers desiring the right to be paid for the care of game on their farms. I think Mr. O'Neal and Mr. Taber, if they had been here, would have brought up the subject. I know it is a rather sore one in some localities. There have been instances where the farmer groups would receive pay, hunting fees; there have been abuses; there have been times when the farmer could not obtain a fee although he had excellent hunting, and I think the farmers recognize that themselves. I was talking this morning with a man from one of the middle western states. He told me there is very little hunting for fee in his state, the reason being that their hunting is now so good that any farmer who attempts to obtain a fee has no customers. But I still think that right should be recognized.

CHAIRMAN SHOEMAKER: I am going to ask Mr. Chalk to start the questions to any of the other speakers.

MR. CHALK: I hadn't thought of any particular questions. Since I took very little time in the beginning, and since the discussion has gone along, several things have come to my mind as a state administrator. I firmly believe that out of this meeting we are going to get nearer to this problem, and in doing that and in bringing into action the different organizations, we of course will find some of our organizations ambitious and they are going to have different ideas. We must avoid any one particular organization attempting to dominate a problem that all the organizations must solve.

I wanted to ask Mr. Edminster a question. In the formation of the county district committee, on which I have not much information, it came to my attention that the Soil Conservation Service, which is a very valuable government bureau, was suggesting to these committees the possibility of some parts of the game funds being used to provide fertilizer and seeds for the farmers on stripped lands. I would like to ask that question of Mr. Edminster.

MR. EDMINSTER: No, there is no official policy about soil conservation in relation to those projects. That is a matter entirely between the Biological Survey and the states. We feel that since the Soil Conservation Service is the agency of the Department of Agriculture that has been given the responsibility for sponsoring the district idea, it is our duty to point out the opportunities.

MR. CHALK: That is fine. I just wanted to raise the question for this reason: I was a bit alarmed that, if that were done, our meager game funds and our Pittman-Robertson funds would soon disappear, so I was hoping that that would not be so. I just use that as a means to attempt to point out the necessary precautions in working out the details by all of these organizations that take part.

MR. REED: I want to answer to some extent Mr. Nicholson's statement as to the right of the farmer to be paid for taking care of game. As a sportsman, I recognize that right absolutely, unquestionably, and I do not believe the organized sportsmen in any community would object to paying the farmer for something that he does for our game. Our objection to the system of paying the farmer is, as I stated before, where one farmer in these districts would do something for and be of some service to the game, twenty other farmers would simply close their land to hunting or charge for the privilege of hunting and do nothing. It is a most natural human trait. His nextdoor neighbor is being paid a dollar a day for hunting; when I go to his farm and ask him if I may hunt, he says, "No, you cannot," and that farmer will do nothing for the game, he will do absolutely nothing to feed or raise or in any way support it, and there will be twenty of those, in our opinion, to every one who does something for the game in our small farm area.

CHAIRMAN SHOEMAKER: There are two men in the audience I want to call upon. Aldo Leopold many years ago worked up a sportsmen-farmer relationship program (the American Game Policy). I think it was published in 1930.

There is another gentleman, Dr. Joseph Cox of the Department of Agriculture, who has been assigned by the Department to the farmer-sportsmen relationship. Dr. Cox, will you be kind enough to say a few words?

DR. JOSEPH COX: I will briefly present some phases of the relationship of the agricultural conservation program of the A.A.A. and its cooperative program in extension throughout this nation that bears on wildlife.

Last summer while my friend DeWitt Herrick was President of the National Capital Izaak Walton League, we arranged a program that brought Mr. Miller and Mr. Bennett of Soil Conservation and Mr. Evans, the Administrator of A.A.A., together to consider the interrelationships of their programs with wildlife. Mr. Evans gave these astonishing figures. The Agricultural Adjustment Administration has actually paid awards for over 50,000,000 acres of land transferred from soil depleting crops to soil conserving crops. These soil conserving crops are the cover crops and the feed crops, the greater part of them not disturbed by the mower and the plow, permanent woodlots and pastures, 50,000,000 acres scattered throughout the United States.

He told us that over 6,000,000 of the 7,250,000 farmers of America were in the A.A.A. program. By authority of Congress the program was administered in the counties by an A.A.A. Committee elected by the people; a non-partisan election is held and they choose their own committeemen. Everything is being done to throw the administration of A.A.A. close to the land-use problems of the greatly varied areas of this country directed by the farmers and localizing the state administration of the program under the structure of the laws that come from Congress.

This vast amount of cover has been added to our resources—186,000 acres. They planted trees under the program last year, and 26,000 ponds, fresh-water ponds that reach from the Canadian Border to the Mexican Border in the range area—26,000 of these fresh-water ponds. Our friends of the Biological Survey observe that they are being used by ducks and other forms of wildlife, a fresh-water flyway from Canada to the South, which is highly important in maintaining the population of wildlife that during the drouth was forced to use the outland ponds and great losses occurred.

The A.A.A. program works through more than 3,000 county committees in the agricultural counties of America, and the county agricultural agents, the county planning committees, a program very close to Extension Director M. L. Wilson's heart, to set up in each county planning committees of representative farmers and A.A.A. committeemen intermingled to plan a land-use program.

Wildlife is not forgotten in this. This year at the call of the Secretary of Agriculture the great program to coordinate all interests that serve conservation of our national resources and of our human resources was launched. There has been a great response to that program. The Land Grant College presidents of all the states were appealed to to take leadership in coordinating the state agencies, the Soil Conservation Service, the A.A.A., Farm Security, along with the existing wildlife programs where they are involved in all of the states.

More than that, through the insistence of some of our friends, Mr. Miller here, and others in the Biological Survey, and with representatives from the seven states coming in last year, farmers as well as game conservationists, the states, as I remember them, were Ohio, West Virginia, Michigan, Illinois, Pennsylvania and a couple of others, but typical states, and they asked A.A.A. to put a wildlife feed and cover practice in that great program that uses around $500,000,000 a year.

The 1940 program carries distinct wildlife planting projects associated with the farm woodlot, the windbreaks, where they are planted under the direction of the state conservationists, and include border plantings of shrubs, nuts and berries that will furnish more feed and cover. The main thing is increasing the cover throughout the middle part of this country, a tremendous increase in alfalfa and sweet clover, and then shifting over into diversified crops that include soy-beans, cow-peas, increased permanent pastures, all of which, with the farm woodlots, make a very much better breeding and living place for wild game, for song-birds, and for our smaller game animals of all kinds. Whatever is done by legislation, by the programs of breeding and release of wildlife in the farmer-sportsmen's associations, I believe has a much better chance due to what has been done through conserving the soil, increasing our woodlots, and putting programs into effect in each county directed toward that end.

Administrator Evans is very much interested in wildlife. He is a close friend of Dr. Gabrielson's. They came from the same state. He wrote letters to the directors in all the regions of A.A.A., suggesting that at all the meetings held in the counties a member of the A.A.A. committee present contributions being made of interest to wildlife in that county, and get a farmer and a sportsman on the program. The A.A.A. goes no farther than to have the program understood locally and to make those local contacts. That has been done.

I have in my hand the A.A.A. Notebook with a full page on wildlife conservation. This notebook goes to 150,000 committees throughout this country. This is what it says:

"The conservation of soil, water, and trees is stressed in the national A.A.A. farm program. In wildlife conservation, these same practices are of primary importance. Crops that provide feed and cover and protect the soil from erosion are essential practices in conserving and increasing birds and game. By retarding water run-off and lessening soil erosion, these crops are also of importance in improving stream conditions for fish and other forms of water life.

"More Land Under Cover. Under the A.A.A. program, more than forty million acres have been shifted from soil-depleting crops into legumes and grasses. All together, more than fifty million acres, or nearly one-sixth of our farm land, are devoted each year to soil-conserving crops and practices. Of this, about thirty million acres consist of new and additional seedings of legumes and grass primarily for pasture, meadow, and soil conserving purposes. The remaining twenty million acres are devoted to such practices as terracing, strip-cropping, planting trees, shrubs and grass in gullies, planting farm woodlots and windbreaks, and where needed, the construction of ponds and reservoirs and the maintenance of ground water levels.

"Food and Cover for Wildlife. All of these practices contribute directly to wildlife conservation by increasing the crops and trees which wildlife needs for food and cover throughout the year.

"Under the A.A.A. range program, the restoration and protection of range forage is encouraged, and more than 20,000 ponds and reservoirs have been created in the dry areas of the range country. These ponds extend from Canada to Mexico and provide fresh-water feeding and resting ponds for wild ducks and other birds in their migratory flights, as well as waterholes for native wildlife.

"The present basic program of soil, water, and tree conservation is contributing toward the conservation and increase of wildlife in America."

The A.A.A. in one sense is a great cooperative group of farmers. They look to the expert advice of the Soil Conservation Service, the Biological Survey and our Forest Service, both in their states and in the nation, to give practices that can be administered. Basically such things as liming, which has increased 300 per cent, and phosphating doubled, are of primary importance to our upland gallinaceous game. Unless our soil is rich, our crop production diversified, and the lime and phosphorus and basic elements produced in the soil, we cannot go very far with a program for that type of game.

This is all part of the conservation of soil, trees and water, definitely included in the A.A.A. program, and which we believe are of basic importance to the wildlife conservation.

CHAIRMAN SHOEMAKER: Aldo Leopold, will you say a few words with reference to this farmer-sportsmen relationship?

MR. ALDO LEOPOLD: Abauot ten years ago the predecessor of this organization, namely, the American Game Conference, started an effort to put down on paper some guiding principles which might be useful in the evolution of a practical farmer-sportsmen relationship. That thing was called the American Game Policy. One of the fundamental things laid down in the American Game Policy was the recommendation that no sound scheme in the farmer-sportsmen relationship was at all likely to be evolved in the brain of a planner, that these were human institutions that had to evolve in history and not in somebody's mind. The American Game Policy ended up with a recommendation which I may briefly state in this way: Try as many schemes as possible and see how they work.

During the last six years that is what I have been doing, trying as many schemes as possible in my own neighborhood. I am proud to say that this year one of my areas will celebrate its tenth birthday, and within the year I hope to have in print the complete history of that area, including not only the story of what I consider its present success, but more particularly the story of its many false starts, its mistakes, its false assumptions. I am making a particular effort to detail all of that, and to my mind those long-time attempts to learn from actual experience—not particularly my attempt, but many others'—are the most valuable contributions that can be made to date in this question.

We all know, of course, that hundreds and hundreds of farmer-sportsmen enterprises of one sort or another were launched in the early 1930's. I once tried to make a tally of the mortality in those enterprises. I think it was about 1935 I figured that of about 300 I knew of, about 6 were alive at that time. Since that time many new ones have sprung up. In my own opinion the most vital big-scale experiments of that sort that are on the map today are those in Ohio and in Texas. I think that Ohio has told us what it is doing. You can get a written account of the experience of Ohio. I want publicly to urge Texas to do the same thing, because they have things down there which the whole country should be able to draw upon in formulating its own plans.

Going back to the American Game Policy and looking back from a calm perspective, almost ten years having elapsed, I think there was almost only one error written into the American Game Policy. I think we somewhat over-estimated the importance of compensation. At that time we regarded compensation as the only way to express the recognition of the farmer's rights. I am now inclined to believe that it is not the only way. It is one way and a perfectly good way and a way that will naturally find its place in many farmer-sportsmen set-ups, but it is not the only way. There are other ways in which the sportsman can acknowledge and recognize the farmer's rights, and ways that do not involve the exchange of cash remuneration. I find on my own areas that in my particular groups of farmers the privilege of hospitality cuts a much bigger figure than the revenue that they might get. There is no charging on any of my areas, although I readily recognize that maybe another group of farmers, even Wisconsin farmers in the next county, might absolutely insist on a charge and should have the liberty to do so if they desire.

I can see emerging from the decade of experience, one line of demarkation which is perhaps worth mentioning. If the area needs to have its cover rebuilt, then I think that there is little chance of success of any undertaking that follows the general public shooting ground idea. In other words, in order to interest a farmer in a long-time and rather difficult enterprise such as rebuilding cover, it is essential, I think, to recognize that he must have the exclusive right to say how many people hunt, who hunt, how much they kill, and be in complete control of the situation. On the other hand, if an area happens to still have cover and merely needs relatively easy measures like feeding, restocking, furnishing of eggs and that sort of thing, it is perfectly feasible to organize farmer-sportsmen enterprises on a basis where the farmer has only partial control, let us say where he cannot regulate how many men are on his farm, but merely have some tenable relationship with the sportsmen as to whether they do damage, and that sort of thing. So the physical situation on the ground, I think, must govern the degree to which the sportsman must give ground to the farmer in having the fundamental voice in the conduct of affairs.

CHAIRMAN SHOEMAKER: Thank you, Aldo, for that very fine contribution to the discussion. Are there any other questions that any of the speakers want to ask of each other?

One of the very good suggestions that came out of this meeting this morning was the establishment of a permanent council on farmer-sportsmen relationship. Now I assume in order to get that settled we ought to take a vote on it. All those in favor of such a council please signify by saying "aye"; all opposed by saying "no." It is unanimous.

Is there anyone in the audience who would like to ask the speakers questions?

MR. KARL E. MOLLENBERG (Ohio): I have no question, but I believe I have something to offer. I come from the county where the Plain Church Game Association that one of the speakers mentioned exists. We have been hearing a great deal about farmer-sportsmen councils, and as one of the speakers said, there is probably no policy here that would serve as a national policy or a uniform policy, but we have been very successful in Wood County, Ohio, with our Plain Church Game Association. We have perhaps the best ringneck pheasant hunting in the United States. It is not my purpose to advertise it because it is already too well advertised, but nearly every township has a game association made up of the farmers. The farmer is solicited and he signs his acreage in the association and they in turn sell permits. We try to limit the number to about 300 in a township. Non-resident permits we sell for about $3.00 apiece; local resident permits $0.25 or $0.50, but we try to limit the number of permits. The average association will take in a thousand dollars or more from the sale of the permits.

What becomes of that money? We have heard here about the farmer's right to sell his hunting privileges. That is a thing that we have always discouraged and rather resented. We have tried to keep commercialism out of hunting, in other words not to sell the hunting right. There have been a few isolated instances where the farmer will do it. You may have the sportsmen clubs of the city that will go out and offer the farmer a fabulous price. I have heard them offer as high as $5.00 an acre; money is no object with them. We have tried to discourage that and keep hunting the common man's sport.

The farmer can check off where he wants this money to go, either to his church, the township centralized school, or somewhere else. It amounts to about $0.02 per acre sometimes. There are some few farmers who do take the cash, but that is a thing we have always tried to discourage.

These associations are made up of farmers and not of sportsmen. It has been our experience that when a group of city sportsmen are organized and come out there they are sometimes interested in conservation, sometimes their motives are not as broadminded as they ought to be, they are out there after something for themselves.

We have had inquiries from all over the United States. I happen to be chairman of one conservation group there and secretary of another, and we have had many inquiries as to our plan, which has been very successful. I, for one, hope the time will not develop when the farmer will have his hunting right for sale. That is one thing that should not be commercialized.

CHAIRMAN SHOEMAKER: Is there anyone else in the audience who would like to ask a question?

MR. O. V. BURRO (Maryland): I am a farmer in Maryland. The gentleman just spoke of his organization being a farmers' organization, not a sportsmen's organization. The farmer is a sportsman, and I think that expression "farmer-sportsmen" ought to be dropped. We don't want money for hunting on our land. Another matter I want to comment on has to do with the remarks of Mr. Nicholson on a matter which is the crux of the whole problem, the boy. He said they receive a hunting fee. That youngster might be given something for raising game, but I don't think he should receive fees from hunting.

MR. NICHOLSON: That particular area that I mentioned happens to be the Midcontinent Trial Grounds. The hunting there is protected more, perhaps, than in any other part of Kansas and it is done through a farmer-sportsmen group.

MR. BURRO: There's that expression again.

MR. NICHOLSON: I think you are quite right on that. However, we have to differentiate between those who live in town and those who live on the land. We might say landowner-sportsmen.

I was very happy to hear Mr. Leopold, in summing up ten years' experience, state that he felt this matter of recompense to the farmer had perhaps been exaggerated in the minds of those who formed that Game Policy. I don't think it is necessary or desirable in many localities, but I do think that the landowner should not be denied that right if he wants to exercise it. Does that answer you?

MR. BURRO: I had more reference to the child. I think that we are going to get the farmers interested through their sons to a very large extent, more so than in any other way, and if we make it worth the child's time I think we will go forward in the movement.

MR. SETH GORDON: I tried to keep out of this discussion because I have appeared in it so frequently before and I believe we need new faces in programs like this. I happened to be a member of that Game Policy Committee which labored two years before the program was agreed upon. It was adopted in 1930. At that particular time the principal reason for giving some emphasis to the possibility of compensating farmers for the privilege of hunting was inserted in the Game Policy only as recognition of a possibility, because there were certain people in this country who for two or three years previous to the adoption of the Policy were saying, "Start paying the farmer for the privilege of hunting on his land and everything will be settled from there on."

Now the American Game Policy Committee knew that that was not true and that there were other fundamental items that should be given consideration, but we did include that clause in a much modified form over what it had been recommended by certain other groups who, as you well know, were spreading the gospel all over the land: "Pay the farmer and everything will be jake from that time forward."

MR. COLIN REED: As a representative of the sportsmen, I would just like to say to the gentleman from Maryland that when we refer to farmer-sportsmen we do not imply or intend to imply that the farmers are not sportsmen. In fact, I would say from my quite a few years' experience that a larger percentage of the farmers are sportsmen than of the hunters.

MR. ALDO LEOPOLD: Mr. Blackie of Winnipeg has had years of experience, and he has a little something that he would like to contribute.

MR. ARCHIBALD BLACKIE (Canada): I will detain you for only a few minutes. I have been very much interested in hearing this discussion. Our condition in Canada, of course, is very different from yours. We have a great deal of land. This farmer-city hunter problem is arising with us, however, and they conceive that it is going to become more acute every year. We have started to develop a policy that I think is going to get us somewhere, and that is playing up to the school children. We have had 4-H campaigns and we are offering prizes for the best essays on wildlife, and we are offering prizes at the various country shows for children's work. We are trying to insist on all our members wearing the badge of their association. We are also making an effort to have a fair number of our members appointed honorary game guards, so that there will be a means of combating the hunter who is not a sportsman, reporting his misdoings to the proper authorities, or our own members taking action against him themselves. We think that this policy is going to get us some results.

I was very much interested in hearing what Mr. Reed had to say about the type of notices that their association is putting out, and I intend to try to get a copy of that. I think that will be a very good thing to develop friendly relations between country and city.

MR. R. G. TURNER (Tennessee): I have listened with a great deal of interest to the discussion, and I believe there is one phase of cooperation which has not been brought out in the relationship. Law enforcement is the thing that I have in mind. We think of the things that we may do here to fill up the tank, but we don't say anything about the places where it is going to run out of the tank. My experience down in our area, which may be different from others, is that that is the greatest loss we have in our conservation program, whether it be in cooperation between sportsmen and farmers, or what it may be. Law enforcement is the thing it is going to take to work on these people who are sportsmen.

Down our way we worked out a plan whereby three states, Mississippi, Tennessee and Arkansas, together with the government and a local group in Memphis, participated and set out to purchase more than 2,000 quail, more than 500 ducks, and more than 250 squirrels. Using under-cover men to make the purchases, we have made more than 150 cases and by the time it is through perhaps it will run in excess of 200. We believe that in doing that we are laying a foundation so there will be something for the sportsman and the farmer to cooperate on, because when these fellows tell you that they have killed from five to seven hundred quail in one year and sold them, you have something to think about.

MR. "HY" DAHLKA (Monroe, Michigan): I would like to ask Mr. Reed a question. I heard him in Detroit last year speak in regard to the Grange. Our organization operates in Monroe County and has five outposts throughout the country, back in the rural sections. I would like to know from Mr. Reed what would be the possibilities of cooperating to a greater extent with the Granges of that country. We have had no opportunity to get together with them at any time, and I wondered if we couldn't work out some plan whereby we could work more together and not fight so much as in the past. We released around 2,400 pheasants in the county last year, and the year previous to that 2,600 or 2,700, and as yet we have had no cooperation from them, although we do work on a controlled hunting plan with the individual farmers themselves, but we would rather work more directly with the Grange.

MR. REED: I cannot answer the gentleman. In my own county we unfortunately have had a condition where the leadership of the Grange was rather reluctant in any active cooperation with the hunters. Unfortunately, a great many farmers' organizations like the Grange have in their officers, quite frequently, men who are very anti-hunting and are much opposed to cooperation with the hunters. We have had much more success in cooperating with individual farmers and with groups of farmers than we have with the organized Grange in our locality. However, in a great many localities I see no reason why it should not work. One of the leaders of the Grange in my county is a man who damns the hunters and even damns the Boy Scouts because they sometimes leave the road; he takes the attitude that no one has any right to walk across a field anywhere at any time under any circumstances. It has been difficult for us to cooperate under those conditions.

Answering the gentleman who referred to law enforcement, one of the big successes we have had in our sportsmen's organization work has been helping law enforcement. I will tell you a little story that happened in a county near me that was rather amusing, and I think indicates what happens. It was a mountain county, and we had a great deal of law breaking. Those mountaineers had always shot game whenever they pleased and as they pleased. After a great deal of work on some of them we finally sold the idea that if they joined a sportsmen's organization and cooperated we would all have better hunting. We finally sold it to a big raw-boned mountaineer who came in and joined the organization. Bill paid his $0.50, got his membership button and stuck it on his coat, and said, "Now, boys, I ain't gonna break the law no more, and I'm gonna tell you sumpin' else, there ain't no other blankety-blank that's going to break the law from my county either." I think from then on that fellow was one of the best game law enforcers that we have.

MR. E. LEE LECOMPTE (Maryland): I am very glad that we have a Southern Marylander in the audience who is a farmer, Mr. Burro. He has undoubtedly expressed the attitude of the farmers in Maryland. They do not want pay for the right to hunt on their property. We have two groups, one in Montgomery County and one on the Eastern Shore in Queen Anne County, a farm group, one with fifty-six members and the other with forty-two. I attended the organization meeting of each. They are all farmers, they all live on their own property. When that question came up they positively stated, "We do not want any pay for hunting rights. All we want is to know who is on the property." They post their property with their own signs. The request on the sign is: "Call at the house if you desire to come on this area," so they will leave their machines there while they hunt.

Maryland has taken quite a step forward in this movement. The Maryland State Game and Fish Commission was divorced from the Conservation Department June 1, 1939. This new non-salaried advisory board of game commissioners recommended the appointment of farm cooperative councils throughout the state known as the county advisory council. In that recommendation it required five of those members to be farmers living on the farm, or landowners, five to represent Soil Conservation, the Forester, and the sportsmen's groups, and that group of ten to name two at large. We put that in operation. All were appointed through the recommendation of the county agricultural agents, through the Extension Service at the University of Maryland.

I have attended ten of the organizations of those counties. In Caroline County we requested them to elect their president and vice-president and their secretary and to name subcommittees in each election district to cooperate with this county. Of course it is a contact body between the commission and the landowner and the fellow who likes to hunt.

They organized and elected their officers. When they called for subcommittees a hardware merchant of Fredericksburg handed in five names. The county agricultural agent looked at the list. He said, "Mr. Williams, your recommendation includes all farmers living on their own property."

He said, "Yes, but every one of those farmers is also a hunter. We know we will get more cooperation through the hunter living on his own land than through those in town." I thought that was a very good suggestion.

Our proposition to them is the restoration of their soil and wildlife cover. We know, of course, in sections the cover is gone. We are going to try to get those farmers to restore it. We are offering to furnish the seed for the first planting of the farms.

I haven't found a man in the ten counties I have visited that said he wanted compensation for the privilege of hunting on his property. I don't believe it is desired in Maryland.

DEAN WATTS (Pennsylvania): We are talking about creating better farmer-sportsmen relationships, and that may be accomplished by pursuing different methods. I am going to tell you about a very simple method that was tried by a farmer in Pennsylvania. A fellow who was not a very good sportsman came out to his place with his family. He saw a cherry tree which had a very fine crop of delicious red fruit. He and his family, four or five children, got out of the car and walked over to the cherry tree and helped themselves to their hearts' content. The farmer recognized the man. The next time he went to town he entered the man's store, which was a grocery store. He also kept candy, so he walked over behind the counter to the show-case and took out a box of fancy chocolates and started out of the store. The clerk said, "Why, you can't do that, you can't take that box of candy."

"Why sure, I can take that candy all right, and I'm going to do it."

"You can't do that at all; you'll have to see the manager of the store."

"Well, all right, I'll be very glad to see the manager."

So the young lady escorted the farmer to the manager of the store. The manager recognized him. He still held the box of candy in his hand. I think they looked at each other for a few minutes but there wasn't very much said. After that the manager said, "You may take that candy home with you." That was a very effective way of making a better sportsman of that merchant.

MR. WILLIAM J. TUCKER (Texas): I regret the necessity of challenging my friend Lee LeCompte on the proposition that he has enunciated that the farmers of America do not desire to charge for the privilege of hunting game on their property.

MR. LECOMPTE: I beg your pardon, I said Maryland.

MR. TUCKER: That may be very true for Maryland.

MR. MOLLENBERG: Ohio too.

MR. REED: Pennsylvania too.

MR. TUCKER: We have experimented in Texas for fifteen years; this is not a theory with us. We know that thousands of farmers and ranchmen are charging for the privilege of hunting game on their properties in Texas, and as a result of that system more hunters are given the privilege of hunting on those lands for more game than would otherwise be the case. I certainly agree with the gentleman from Pennsylvania that a farmer or a ranchman or a landowner has as much right to charge for the privilege of hunting game on his property as a merchant has to charge for the goods in his store. While it is true that the title to the game is vested in the state, the property owner is the direct custodian of it.

In Texas, more than fifteen years ago a law was enacted by the legislature of that state which provided that anyone who desired to charge for the privilege of hunting on his property would be required to purchase from the Game Department of the State a shooting preserve license, which costs $5.00 annually. The law was later amended to provide that no charge greater than $0.25 per acre nor more than $4.00 per day per person might be made. Lands to which the sportsmen had not theretofore been welcomed went into game management; game was created on those properties by fairly good management principles, and as a result the sportsman was welcomed as a customer.

I think that as far as we are concerned that is a good system. It may not fit conditions in Ohio or Maryland or some other states. Unfortunately, virtually all of the lands in Texas are privately owned. The little public land left is worth little for hunting. We have a law in the State which says that you shall not enter upon the enclosed lands of another person and therein hunt with firearms without first obtaining permission of the owner or agent in charge of such property.'' The law is actually working. Sportsmen of the state, and we have many of them, are beginning to realize that it is necessary to obtain permission before hunting on another's property. We have some lands in the state which have operated as shooting preserves for more than twenty years, even before the law was in existence. The records of the kill on those properties indicate that the game population has been going constantly upward, in fact so high upward in some cases that we are wondering what we are going to do about it. Therefore, we believe that it is not only to the landowner's benefit but to the sportsman's benefit that the landowner is given an incentive to create larger supplies of game on his property. It is unthinkable, unless the landowner happens to be a wealthy sportsman himself who is primarily interested in providing hunting privileges, that he will do any considerable amount for game unless he has some substantial incentive to do it. We have those who do not charge for hunting privileges because they happen to be like the landowners in your states, perhaps, so wealthy that they are not required to do so, but when they give a man a shooting privilege on their property they know the value of that which they are giving away, just as you know the value of a suit of clothes that you might give to a friend of yours.

MR. EARL SANDERS (Iowa): I should like to ask the gentleman from the Church District in Ohio two questions. Do any of the farmers permit strangers to hunt on their lands? Where do the hunters live, on farms, in villages, in towns, or cities?

MR. KARL E. MOLLENBERG (Ohio): Strangers are seldom permitted to hunt without a game association permit, although perhaps some very few are. Some few farmers do not join the association and consent to strangers. The hunters come from all over the United States. Perhaps half are from large cities, a quarter from villages, and a quarter are native rural hunters. That is an estimate.

THIRD GENERAL SESSION

Wednesday Morning—March 20

Chairman: HONORABLE A. WILLIS ROBERTSON

SELLING WILDLIFE TO THE PUBLIC

The Hon. A. Willis Robertson, chairman of this session, will make a few remarks on the subject to be considered by this panel.

HON. A. WILLIS ROBERTSON
U. S. House of Representatives

MR. ROBERTSON:

This splendid assembly of conservation officials and nature lovers have met here today to discuss how we can better sell wildlife to the people. The only effective sales campaign is education. Our manufacturers and our merchants learned that fundamental principle many years ago, and annually spend millions of dollars in advertising their goods, wares and services.

But conservationists have been slow to grasp that principle. When public-spirited men like Jay Darling, Tom Beck, Harry Hawes, Fred Walcott, Senator Pittman and a few others began telling the American public what was actually happening to a once glorious natural resource, the program of education started.

The first essential step in that educational program was the organization of the National Wildlife Federation. I do not minimize the educational work done by many other conservation organizations and by the various state game and fish departments, but it remained for the National Wildlife Federation to tackle the problem of reaching on a national scale the "grass roots," so to speak.

Each spring some thirteen million fishermen would pack up their troubles in the old kit bag along with their fishing tackle and go to some mountain area where sparkling streams concealed in limpid pools the elusive trout, but that was not putting any fish into a depleted stream. Each fall seven and a half million hunters would pay thirteen and a half million dollars for hunting licenses, as well as a million dollars for duck stamp licenses, to pursue their favorite type of game, but that was not bringing into the conservation picture the owners of one billion acres of farm land, except as silent sufferers of careless hunters or willful tresspassers. Neither was it bringing back the flight of ducks, which in 1935 had reached the all time low of thirty million, the deer, and turkeys that had completely disappeared from many of their favorite haunts; nor the call of the bobwhite to the fence posts from which they had disappeared.

To reach the grass roots as a foundation upon which to build a constructive national program, this splendid organization set out to enlist in its active membership the farmers and landowners of the country as the first step in an educational program. Hand in hand with that private undertaking went a greatly quickened interest in conservation by the Federal Government. So much so that recently the Secretary of the Interior announced that during the past seven years the Federal Government had made greater progress in conservation than during the entire previous history of the country.

The first undertaking of these private and public agencies, working hand in hand, was to let the people know the present balance to their credit (since the title to all wildlife is held by the states in trust for the people, with the exception of migratory birds, which are held in trust for the people by the Federal Government under its treaty making powers). That inventory on the debit side showed thousands of miles of polluted streams, millions of acres of burned-over forest lands, millions of acres of farm lands so badly eroded as to produce neither food nor cover for wildlife, the total disappearance of some valuable species, and great reductions in the supply of others. On the credit side it showed that the people of this country owned 26 national parks, with a total of 25,000,000 acres; 158 national forests with a total of 175,000,000 acres and 173,000,000 acres of public domain, all now being administered with a view to wildlife conservation, not only to preserve what we now have but to increase the supply for the future use and enjoyment of the people.

The Congress passed a bill to impose a federal license on migratory bird hunters to produce a fund for the acquisition and maintenance of migratory bird refuges; it passed a bill to earmark the 10 per cent excise tax on arms and ammunition as grants-in-aid to the states for the development of upland game. It created a select committee of the House to study conservation problems from a national standpoint, to coordinate federal conservation activities and to recommend necessary or desirable legislation.

The Congress created the Civilian Conservation Corps, that has built over 4,000 fish-rearing ponds, planted food and cover on 54,251 acres and reforested 1,300,000 acres, and improved fishing conditions in streams to the extent of 6,135 miles. It created the Resettlement Administration that purchased 9,200,000 acres of submarginal land, much of which is now being devoted to wildlife conservation.

The Congress created the Soil Conservation Service, which has 526 projects in forty-five states, with 57,003 farm owners cooperating in the retirement of 683,497 acres of land from soil-depleting crops, strip-cropping an additional 1,084,812 acres and doing hillside terracing to prevent erosion to the extent of 74,249 miles. The Soil Conservation Service has built 3,707 storage dams impounding 80,000 acres of water. Think what such a program has meant to the Dust Bowl area.

The Congress has appropriated vast sums to the WPA, of which $227,000,000 have been expended on conservation projects including the expenditure of $500,050 on fish hatcheries for the Bureau of Fisheries, supplemented by an allotment of $808,500 from the PWA. And that type of WPA activity will be continued through the current year, improving existing federal hatcheries and the fish cultural facilities in the Yellowstone and Glacier National Parks, and a new pond fish hatchery in Alabama.

The Congress during the past seven years has made relatively liberal appropriations for the operations of the Bureau of Fisheries, which has been making splendid progress not only in the improvement of scientific management plans but in the actual improvement of fishing conditions through the annual distribution of some eight billion game fish, many of which were reared to legal size before being planted in the streams and ponds. The Bureau of Fisheries saved the salmon industry on the West Coast by designing practical and successful fishways to move the salmon to their spawning beds in the Columbia River past the Bonneville, Rock Island and Grand Coulee Dams. Approximately a million salmon have ascended these fishways during the two seasons of their operation. The successful administration of the fisheries of Alaska have maintained an average yield of 6,500,000 cases of salmon during the past decade.

The fur-seal herd of the Pribilof Islands has been increased from 130,000 animals in 1910 to about 2,000,000 animals at the present time and during the 30-year period in which the Bureau has managed this valuable resource 900,500 skins have been obtained. After three generations of careful selection, the Bureau, at its Pittsford, Vermont, hatchery produced a type of brook trout that grew so rapidly they spawned a year earlier than wild stock, yielded double the number of eggs and were more resistant to disease. The restocking activities of the Bureau have been centered on the national park and national forest areas, which are under federal control and open to the public, the prince and the pauper on equal terms.

The Congress has likewise supplemented the duck stamp and Pittman-Robertson Act funds to the Bureau of Biological Survey with the appropriation of sufficient funds to acquire approximately twelve million acres of areas suitable for migratory birds, principally ducks and geese. As a result of that program, coupled with a wise restrictive shooting program, our supply of ducks has been increased 100 per cent since 1935, to my mind the most remarkable recovery of a threatened specie in history. But let no one assume that recovery is a signal for letting the bars down to a million hunters since the present supply of ducks in this country is only a fraction of what it once was and far below the population of 120,000,000 birds which we should have before we can say we have brought back the ducks. The Biological Survey has made a valuable contribution to the preservation of domestic fur-bearing animals, from which our trappers derive an annual revenue of about $65,000,000. They have educated the people to the value of insectivorous birds on the protected list, more than fifty of which make war on that enemy of the cotton farmer, the boll-weevil. And they have told us that the bobwhite of the Southern States include in their normal diet fifty kinds of insects that are agricultural pests. The Biological Survey has also shown great zeal and a commendable understanding of local problems in the administration of the Pittman-Robertson Act, under which 167 restoration projects have been started in forty-two states at a cost of $1,350,000. And that program will be stimulated by the federal appropriation this year of $1,000,000 more than was appropriated last year for the same purpose. The engineer of that outfit, Ira N. Gabrielson, has had his hand on the throttle and his eye on the rail.

Time will not permit me to elaborate upon the splendid accomplishments of the National Park Service under the leadership of Arno B. Cammerer, or the U. S. Forest Service, under the leadership of that outstanding forester and beloved man, the late F. A. Silcox. It is more important for me, as a legislator, to hear the views of the delegates to this Conference than it is for me to recount at length what has been done by the Federal Government. Yet reference to what the Federal Government has done is necessary in any program of education to better sell wildlife to the people. Knowledge of what needs to be done and knowledge of what is being done, coupled with a vision of what can be done should quicken and stimulate public interest and public cooperation.

In conclusion, my friends, I wish to touch briefly on another phase of this educational program to sell wildlife to the people, and that is the opportunities it offers to the people to find peace and contentment, now a stranger in many hearts. While the foreign situation is a subject of absorbing interest and, of course, vital concern, we must not let it obstruct the seriousness of our domestic problems. We have many unemployed men and women, we have class antagonisms, we have some un-American and subversive activities; we have many who think that the principles of a democracy should mean equality of property instead of equality of opportunity. We have many who do not realize that contentment is a frame of mind, an attitude of heart and does not come from the possession of material things. We must teach the people how to find peace and contentment in the simple pleasures of the out-of-doors; we must teach them how the principles of equality of opportunity is being exemplified in the administration of our national parks and national forests. We must strengthen the character of the people through the strengthening of their bodies in outdoor recreation, and develop their patriotism and love of constitutional freedom in a representative democracy through the fullest and freest use of the wonderful natural resources that God created for the benefit of man, made in His own image.

One-half of all the people of the world today are engaged in war, engaged in the business of destroying each other and each other's homes, while we can still give thanks that under the wise leadership of an able and conscientious Secretary of State we have not been involved, and the white wings of Peace are still spread over our fair land. But our land isn't any fairer or richer in natural resources than the vast area we once called Russia. It, too, could have been a land of peace and plenty if its rulers had been wise enough and just enough to permit those resources to be enjoyed by all of the people instead of by the favored few. As the result of that policy and that lack of educating the people, there was a bloody uprising in Russia in 1918 in which the masses destroyed the nobility and drove the intelligentsia into exile in the frozen wastes of Siberia. Kerensky promised to establish a democracy. But the ignorance of the masses of Russia was so great they did not know how to preserve a democracy after it had been won, and in a brief period of eight months, the people of Russia found they had swapped a Czar for a dictator, who was even more cruel and more heartless.

Yet the fact remains that the present unhappy plight of millions of people in Russia today can be directly traced to the short-sighted policy of the class that was exiled, and of whom it has been said: "Only in after years when their sins have taught them charity, and their despair has taught them hope, and their loneliness has led them to faith, they shall listen again to the sound of bells coming across the field and comprehend and reverence the symbolism of the Cross."

The Chairman will ask the members of the panel to come forward, please to discuss the subject: How Can We Better Sell Wildlife to the Public? Dr. Frank Thone, Science Service; Mr. C. A. Paquin, Michigan Conservation Department; Mr. John Mock, Outdoor Writers' Association of America; Mr. Bob Edge, Columbia Broadcasting System; Mr. H. W. Hochbaum, United States Extension Service; Mr. John H. Baker, National Association of Audubon Societies; Mr. William T. Spanton, United States Office of Education; and Mrs. Gideon N. Stieff, President of the Federated Garden Clubs of Maryland, representing Mrs. Fae Huttenlocher, National Council of State Garden Clubs, Inc.

DR. FRANK THONE
Science Service

DR. THONE:

When one stops to look at the matter of selling wildlife, it breaks itself down into a number of natural divisions. The problem becomes somewhat the same as the problem of selling anything else. The first thing that anybody endeavoring to make a sale undertakes to find out is the type of prospect. Interest in wildlife, willingness to cooperate in its propagation and restoration must be aroused on the part of at least three roughly divisible groups of our population, the urban group, the small town group, the rural group. The latter group is already fairly well sold over a large part of the country, as we have been given to understand in the numerous preceding talks that we have heard during this present meeting. The farmers have begun to find out that it is not only nice to have quail and pheasant, even deer about, but it is even profitable in terms of dollars and cents. The farmer is fairly well sold. It is not difficult to sell the small town man because he is in fairly close contact with the country, and with his farmer neighbors. Our big problem remains with the vast masses of urban population, all of which have votes and to that extent influence, and many of them have influence far exceeding their single votes.

The problem of reaching the urban population which has little direct contact with wildlife is the big problem, as I see it, that confronts those who would sell interest in and willingness to support wildlife programs in this country. It appeals to me personally because my daily work is the preparation of news material on biological subjects, including wildlife, for newspapers, the majority of which are large newspapers in the centers of urban population. So perhaps my myopic and narrowed angle of vision focuses more properly on that as the big problem.

When you undertake to offer your wares to a prospect, you next have to size up what wares you are offering. A thing that might be worth while discussing during our talks this morning would be just what are we trying to sell. Just what *are* we trying to sell? Are we just trying to get mention of wildlife into the papers, just the mere fact that there is such a thing? Well, that is possible. It is always considered something of an achievement to get your name in the paper or to get your face in the paper. It is always noted if you are mentioned pleasantly and it is always equally noted if your name is misspelled, a sin that forever haunts the poor struggling reporter.

However, something more might be and usually is called for. What we are trying to do is not merely to get a nice animal yarn into the paper, or something about a plant we have seen somewhere. As a matter of fact, that usually has so little color unless there is some trick angle to it, that the editors don't even want that kind of story.

Perhaps the next cut above that in desirability would be stories intending to arouse interest in the wildlife program. Those, of course, have to be written somewhat skillfully lest they be suspected of being propaganda and hence go into the wastebasket.

Since the bitter disillusionment of 1919, people in this country have been victims not of propaganda any more, but of counter-propaganda. We have become so suspicious of anything that can be labeled propaganda, anything that even has the remotest possible tinge of the odor of propaganda, that if we suspect it of having that poison about it we throw it out at once, regardless of its merits, so that if we are trying deliberately to interest people in the wildlife program, the thing has to be done with considerable skill. Usually it has to be concealed unless the situation is something so flagrant that the people are already somewhat aroused and ready to stand up and throw the gang out the window, as happened, as the preceding speaker mentioned, in one of our most prominent states in the Union.

I think, though, when we really settle down to try to find out what we are trying to sell, again by the medium largely of the printed word, but perhaps also through the other media that will be discussed later, what we are really trying to sell is not merely interest on the part of the public, but a willingness, a desire, even an eagerness, to cooperate in the program.

MRS. GIDEON N. STIEFF
Federated Garden Clubs of Maryland

MRS. STIEFF:

Representing the women's organizations of America, particularly the garden clubs, Women's Clubs, P.T.A.'s, Business and Professional Women, and D.A.R.'s, we believe that the correlation of conservation throughout the entire school curriculum to be the quickest, surest, and most lasting way of publicizing wildlife conservation in America today. We know from experience that there is no better way to get mass interest in any subject than through the children. We know that the children from the third grade up to junior high are quick to grasp the significance and importance of conservation in its fourfold phase of soil, water, vegetation and wildlife.

Educators are agreed that the teachers themselves would like something to make the old, narrow road of academic knowledge practical for present-day needs. If conservation material could be made immediately available in the form of visual aids such as motion and still pictures, charts, and relief maps, this, with the pressure of organized groups demanding the teaching of conservation, would bring about a nation-wide acceptance of the subject in public and parochial schools.

The National Council of State Garden Clubs, Inc., at their meeting at Colorado Springs in 1939 adopted the national conservation project of helping to raise funds for the National Wildlife Education Fund. Dr. Henry B. Ward, Dr. Paul Sears, and Mr. Cy Ballum, who compose the Conservation Education Committee, are preparing three teachers aids: One entitled *What is Conservation?* the other *How to Teach Conservation,* and the third *A Bibliography of Conservation Materials.* These books will be made available to every public and parochial school in America, and will be sufficiently simple so that teachers may be able to correlate conservation with the standard subjects of their curriculum.

The word "conservation" is in the constitution of practically every women's civic group in America. Even so there were few who understood its real meaning until the advent of the National Wildlife Federation. By means of the Wildlife Federation's dramatic illustrated lecture by J. N. "Ding" Darling entitled The Progress of Civilization, and the animated movie cartoon entitled Where to Now? women's organizations have been able to spread the message of the basic importance of conservation and wildlife to the lives and industries of every individual and our country as a whole. Through these popular channels of slides and movies we've been able to furnish entertaining and educational programs to thousands of civic clubs and school assemblies. We are begging for more of such visual aids. The women's organizations will see to it that all such educational programs are publicized and used in their respective communities.

Last year when the women's organizations started to sell conservation stamps, we began to realize that most people were as blind as the three men of Hindustan when it came to understanding the words "conservation" and "wildlife." Some of them would say, "Oh, yes, that's the hunters' howl now that they've killed all the ducks, they want us to put them back. I'm not interested!" Others would say, "Oh, yes, that's the farmer's worry. He used up the soil. Well let him put it back!" Some of the men would say, "Conservation, oh yes, that's right. You women want more birds to sing and more wild flowers to pick. Well, here's a dollar for your conservation stamps." Few of the intelligent adults approached, realized that the sale of our wildlife stamps was for the natural resources upon which their homes, industries, and their lives are basically dependent. Our garden clubs therefore have made it a point to make opportunities to speak before men's and women's civic organizations for the simple purpose of clarifying to them the words "conservation" and "wildlife" as basic essentials to the existence of man and industry.

We have called their attention to the fact that in China life is so cheap and natural resources so scarce, there is a law forbidding you to save a life without forever after becoming financially responsible for that life. In Europe when the population becomes too dense for the resources to sustain it, war is generated to kill off the inhabitants and take what belongs to others. In America the rapidly depleting resources are placing us in the stupid ranks of other countries who've misused their natural resources.

Does it not, therefore, seem that we're putting the cart before the horse when we sell Red Cross and tuberculosis stamps to save humanity and do nothing in behalf of the natural resources which are necessary to humanity's very existence? We are also finding that very few men and women understand that wildlife is one of the basic essentials to nature's balance of natural resources. One person was heard to say, "I'm not interested in the sale of stamps that go for the benefit of sick fish. We would rather have our money go to sick humanity." When that person was told that sick fish were always an evidence of impure, sick water and that to correct the sick fish the first step was to purify the water—and that since water is the lifeblood of our country, upon which our health, our crops, our atmosphere, and every industry is dependent, she could readily see why sick fish, though seemingly of minor importance, are nature's first warning that something is wrong in the balance of natural resources that sustain us, our country, and our homes.

I would, therefore, like to leave you with the urgent request from the women of our country that the American Wildlife Institute cooperates to fullest extent with the National Wildlife Federation which represents organized interest of the masses in conservation, and help us to bring about as quickly as possible the teachers' aids upon which our committee is working with pitifully low funds, to help us make available to our schools, our teachers, and civic organizations, dramatic, visual presentations of the importance of wildlife, soil, water, and vegetation to the existence of every human being in our country.

C. A. PAQUIN
Michigan Department of Conservation

MR. PAQUIN:

Michigan is an automobile state. Automotive manufacturing is our dominant industry, and perhaps, for that reason, we in Michigan think in terms of automobiles and their manufacture. The average Michigan resident has at some time or other worked in one of these huge plants or has been closely associated with them. And so, I think it is only natural that in discussing wildlife I should turn to the car industry for a comparison.

There are three distinct and separate functions in the automobile industry; engineering, manufacturing and sales. It is not hard to find a parallel in the operation of state conservation departments—or even in federal bureaus.

Automobile engineering, research, testing laboratories and proving grounds can be compared with our own wildlife technical staffs, research projects, demonstration areas and experimental stations. Automobile production, and assembly lines are identical in design and function with our conservation action-programs of reforestation, fire control, law enforcement, fish and game propagation and land and water acquisition.

The automotive sales and service departments with their local and national advertising programs, local agents with show windows, garages and salesmen, their parts replacement service, their training and coaching of personnel, can be easily balanced with the so-called publicity, educational and public relations functions of our conservation departments.

The entire function of the automobile sales and service department is to keep the new models moving through a steady demand; to keep the customers satisfied that they get their money's worth and to utilize the trade-in system to take old models off the road and out of circulation to make room for the new models.

That type of machinery is exactly what we in conservation work have been lumping under "publicity" or "educational" sections or divisions. Or at least, that is what we have to assume if the comparison with modern industrial organization is sound, valid and significant. So, for the rest of this paper, I am going to consider industrial sales and service functions as being equivalent to conservation department education and public relations.

The essence of both private business and conservation public business is to get adjusted and functioning so that the new models will keep coming off the lines steadily, with the customers expecting them to be better and not just something built for show or for a talking point—something like we had free wheeling a few years back, or like we have chromium radiator grills today—or like many models I might cite in our own conservation affairs.

New automobiles must come along steadily, replacing the out-moded models with a minimum of lag between what is available and what is in use on the road. The degree of such lags is a measure of efficiency in a conservation department just as it is in private industry. We can measure the efficiency of the conservation agencies in any state by the frequency or the infrequency with which such lags develop or are observed. When the lags are great and advances are jerky, the conservation agency isn't clicking—it isn't safe to let alone, and, too frequently, is junked with an entire new plant and personnel through a political shakeup.

I wonder if we can't find an illustration of what I mean. For many years Michigan had an increasing number of fire towers going up and being manned. But we had only a man up there, looking around for fires. He saw smoke and 'phoned in that it "looks like this side of Bear Creek ridge but might be on the other side of the river"—he couldn't tell for sure. In the meantime some other states and on the national forests, special tower maps and sighting instruments had been installed in the towers and cross shots were giving accurate locations. Michigan was ignoring urgings to modernize.

Other phases of Michigan's conservation affairs had developed similar lags so that along came a political shakeup, a reorganization, and a modernization, if you please, and soon the towers were not only equipped with maps and alidades but fire fighting technic got into high gear. The first forest fire experiment station was set up and integrated with field crews, towers began to be equipped with short wave radio, systems for sinking jet wells in the field were developed, booster units were built and on and on. New and better models were on the road and the customers were getting more and better service and it looked like newer models were in the laboratories being tested out. It was being discovered that we could have too many deer for the safety of the herd. Game refuge units were working so well that they began working too well and were being shrunk or opened up to hunting. It was being found that occasionally there was over-stocking of natural hatched fish, in certain waters, so that restocking with hatchery fish was not only futile but extravagant. The planting of fingerlings and adult fish presented problems that resulted in the establishment of a trout stream experiment station. Second growth was coming in so fast that it was radically changing wildlife habitat and a radical adjustment in the reforestation program was necessary and at the same time the theory that "all fires are not bad fires" began to be advanced.

Until only recently we found in conservation affairs only action programs, and such as were all too frequently doped out in the barber shops and the club rooms. It was the old "let's try it out and maybe it will work" idea. Michigan, like every other state, did its share of wasting money—planting trout in sucker waters—planting pine where it never had a chance to grow—spending thousands of dollars on personnel whose influence in a community was a detriment rather than a help to the cause of conservation. We spent thousands importing German carp and are now spending more trying to get rid of them. We spent thousands of dollars importing a half million eels only to discover later they did not spawn in our waters. We even imported forty reindeer and a couple of laplanders. The reindeer died and the laps migrated back to their own habitat in Lapland.

About fifteen years ago Michigan, some other states, and the federal bureaus, began to modernize by bringing in technicians and giving them a chance to show what they could do. Since that time, through the Pittman-Robertson funds, the reorganization of the Biological Survey, the expansion of waterfowl projects, the availability of the CCC to make creel counts, deer drives and other source data, the establishment of experiment stations—we are beginning to get dependable data on which to test the efficiency of the 1910 and the 1920 models and to bring to the show room floor the glistening 1940 samples. I think we can agree that today our engineering, research and technical phases are probably on a par with our production or action programs. If we admit or concede this, what about our sales department? How does it compare in relation to the other two and in comparison with the equivalent phase of the automobile or other modern business organizations? There seems to be little doubt but that it is weak. It was the last to get under way with most departments and in most cases is still young and weak with little if any precedents to follow. With the technical phase there was much to follow as in agriculture, medicine, and engineering.

With the sales department the best single precedent was offered through agricultural extension. The essence of that is to speed up the rate of flow of the results of research between the experiment stations and the farms—to cut down the lags that might otherwise occur between the availability of the information, and its incorporation into action programs; to get the old model cars off the roads and the new models sold fast enough to keep the plant continuously running.

The agricultural people came to this method of sales only after they had found that all other ways to get their techniques into use were not good enough to prevent increasingly serious lags with sales bogged down and production slowing up. The old model ways of trying to "educate" through printed bulletins might have worked in theory, but it didn't work fast or sure enough. And so the county agents, the 4-H, the Future Farmers, and so on, in which cooperation of local groups and local political sub-divisions was sought, was developed and is now enormously potent.

If we are to get our sales phase of conservation affairs up to a level with the technical and the action program phases, we must work out our own versions and applications of some parallel machinery through which to keep the new models selling well, the whole plant operating at capacity and the customers satisfied that they can't get more or better for their money by buying dream books, looking through crystal balls or having their palms read. The main job of the sales departments seems to be to keep the customers well sold on the fact that we are properly and safely to be trusted to know our stuff, or to admit that if we don't know, nobody else does either.

Of course there is an inherent danger in any such ways of considering it as shown over and over again, especially when some state or federal bureau gets too much money, and authority too fast, and the sales run away from production and orders for new models can't be filled. Little or no over-selling will be deliberate or vicious, to be sure, but much of it may be so just the same, as in the case of the long and badly over-sold sanctity of the one buck law in Pennsylvania and Michigan and elsewhere; or the bounty laws of the past, or the proposition that every fire is a bad fire.

Looked at in retrospect from, say, twenty-five years hence, most of the action programs we now consider as sound will appear as sour, futile and defective as the conservation practices of 1900 or 1920 now look to us today. So it will be well if we try to keep ourselves properly debunked as we go along, and that we beware of selling operations which really are peddling more or less bunk or selfish propaganda. In that manner of usage, proper selling operations will be sound teaching, perhaps, rather than mere "selling." But even so it will be teaching in the agricultural extension sense and not in the class-room sense, and maybe, really coaching rather than teaching. It will involve a phase of education in the usual sense and a phase of selling in the usual sense. The two must be combined if the desired results are to be had.

So far we have been talking in a rather theoretical sense. The question now is how to proceed in getting, and then in maintaining, such a combination of selling, coaching and teaching.

Given time enough and enough bulletins and circulars and textbooks and feature stories in the Sunday editions and movies and lantern slides, this line would seep and soak into general public acceptance, but it would go too slowly and with the lags likely to be very numerous and maybe serious.

In medicine the salesman has an easy and sure fire approach in that he could offer attractive prizes. "Take this medicine and you stand a better chance of escaping sickness" and "your baby won't cry so much," and "your hair will curl." In agriculture the prizes offered have been equally tangible and appealing. They say "use our Bulletin No. 7777 on that field and you will get more and better alfalfa," or "prune and spray your orchard thus and so and you will pick and sell more fruit." Health appeal and economic appeal are of universal potency—as witness the advertising pages of any popular magazine, but neither are very potent when it comes to selling wildlife. What equivalent universal and potent appeal is available?

How many of you were brought up on nursery rhymes having to do with wildlife affairs, incidents and complications: The Three Little Bears; Baby Bunting's rabbit skin sleeping robe; The Fox and the Hen; Little Red Riding Hood? Did you graduate from such literature to Aesop's fables and his talking animals? Shortly after did the circus menagerie have almost as great an appeal as did the show in the Big Tent? In one form or another—both sexes, and all ages—that interest and appeal is evidently almost universal. It is at least highly dependable. It is so universal in fact, that it may often become a nuisance to orthodox wildlife technologists chiefly concerned with the biological balances and their reduction to precise formulae.

Wildlife, per se, doesn't need selling. It is self selling as it were, or anyway it sells on sight, dependably and rapidly, even though of poor quality—such as in the city zoos or showing bears at the garbage cans. But it is self selling only in that it is universally interesting; just as the public is interested in new model automobiles and the improvements and gadgets not in last year's cars.

Again let us draw a comparison. When a new automobile model is ready for the market, newspapers and magazines are filled with attractive photographs and descriptions. We hear glowing accounts over the radio. We are handed beautifully colored folders with the various designs photographed from advantageous angles. The public is interested? Certainly. It is curious. But these advertisements don't actually sell automobiles. The prospective customer is not actually sold until he is in the salesroom where all the advantages of the new model are shown him and he finally signs the order only when the salesman takes him for a demonstration ride and lets him drive the car himself.

If we have agreed to the comparisons we have previously drawn between the automobile industry and conservation affairs we must agree that printed and oral advertising must hope only to retain or instill interest but that the actual selling of new conservation models can only be done through demonstration of their qualities, and their advantages over the older models and methods.

As with the automobile salesman and the county agricultural agent, new models of wildlife conservation can be given reasonably rapid public acceptance only through personal contact and through demonstration.

We have tried to follow this theory and this formula in Michigan in selling our wildlife to the public. True enough, it is necessary that we first advertise what we have, what we are doing and what we want, by way of motion pictures, lectures, exhibits, newspaper articles and pictures, magazines, the radio and the other normal channels of publicity and advertising but it has been our experience that such advertising can do little more than create a receptive public mind and attitude. We believe that by following the clinching methods of the agricultural extension organizations and the car salesmen, in demonstrating our wares we have succeeded in selling our new models to the point where they are not going to come back because of a defective carburetor or a sticky valve. Like the extension services we have attempted to obtain the active cooperation of public groups.

Eight thousand 4-H boys working summer and winter on conservation projects have found their sales resistance to new models broken. Likewise agricultural teachers and biology teachers and county school superintendents and other groups who have spent three days in inspecting and watching demonstrations of jet wells, and stream improvement devices and game cover management projects. Likewise students in summer schools who have spent a week listening to lectures and participating in field trips through a score of new model projects. Likewise representatives of women's clubs who have attended one of the annual women's conservation conferences in a state park where new models of recreational facilities are being developed and used. Likewise sportsmen who have just returned from a conducted field trip in a cedar swamp where the bodies of hundreds of starved deer have been piled for a pyre. Likewise the passing motorist who has climbed a fire tower and has viewed the reporting of a fire location through a short wave radio set. Likewise—and assuredly not the least important—the conservation officer, the game refuge keeper, the forest superintendent, the fish hatchery foreman, who has spent a week, year after year, in conference with his fellows studying the tools, the machinery and the assembly lines fundamental to the production of models that are superior to those he has been using during long years of public service.

Just as propaganda was outmoded and discredited by more legitimate and factual forms of publicity and advertising in conservation and wildlife affairs, we feel that this more recent type of selling is soon to be outmoded by adopting industry's methods of, first, obtaining a receptive ear and mind and then by enlisting active public interest and effective and intelligent cooperation.

With this formula in mind and with the research, the engineering and the sales departments forgetting their all too common feudal status and working as a coordinated machine, I have no fears for the future of an accelerated pace in the progress of our wildlife program.

JOHN G. MOCK
Outdoor Writers' Association of America

MR. MOCK:

How can we better sell wildlife to the people?

The question is a pertinent and timely one, for we cannot hope to ever accomplish our goals, our aims and ambitions in the conservation field unless we have the eye and the ear of the public—its interest and active understanding and its sympathy and support.

However, before the task can be accomplished to any degree, we must first sell wildlife and conservation to those who are in possession of the avenues by which the public may be reached. Only then can we hope to begin to better sell wildlife to the people.

There are two means which can readily be created by a popular demand, namely, the radio and the newspaper. The first I leave to those much more familiar with the mechanics of that agency, and shall confine my remarks to the second, with which I am directly connected —the newspaper.

Despite the fact that the daily newspaper is still the means of greatest education to the greatest number, regardless of the subject, the methods of obtaining publicity in these newspapers are still a mystery to those who would and should take advantage of them.

None question the fact that radio has become a great factor in the dissemination of information in recent years. Yet, the radio is a "hear by ear'' proposition, which for the moment is of vital interest but recedes quickly as one's mind becomes filled with other things in this fast-moving world of ours.

We in the newspaper business—and to this particular group that business means an avenue of publicity to become bigger and better—concede that the old expression, ''There is nothing so stale as yesterday's newspaper,'' is substantially true. Yet, newspapers are the most common file or record to which one may refer after a subject, once brought up, and then, perhaps forgotten or delayed, again becomes an issue.

Newspapers are also more valuable to those of us who are interested in the problems of conservation, because they offer a much greater opportunity to the authorities on the various subjects to place their views before thousands for days, weeks and years after any discussion on the radio has faded into thin air.

So, I have been asked to answer the question, vital to us all, ''How Can We Better Sell Wildlife to the People?'' The answer will be in the form of various suggestions toward a greater cooperation between this group and the newspapers.

Like any other business, where one solicits or expects a favor, the easier one makes it upon those of whom the favor is sought, the more certain they are to receive it.

From personal experience, I know that newspapers in action, that is at edition times, are among the fastest moving machines in the world. The paper must be out on time and even seconds count in this regard.

Of course, stories concerning wildlife and conservation, while not what is termed ''spot news,'' nevertheless, must get into the paper and that requires more effort than the person never inside a newspaper office can imagine. Copy must be read, and when I say read, I mean carefully, concisely, with regard to construction, facts, interesting sidelights and all other things which go to make the article beyond libel, criticism or distortion of facts. This job requires the work of one acquainted with newspaper technique and procedure.

One would be surprised, perhaps amused, at the size of the wastebaskets in newspaper offices. More copy reaches these receptacles than ever appears in the paper. The reason for such action on the part of editors is that the material is not properly prepared and because those on the news or sports desks lack the time, and quite frequently the space, to treat the article in the manner in which the contributor had hoped.

So, what is the result: In the rush and hustle to make up editions and getting them out to the readers, many things happen. If your conservation or wildlife articles are gotten up in such a way as to require a minimum of time, the chances are that more of them will appear in type, thereby enabling you to better sell wildlife to the people.

Even newspaper men, when given the opportunity, are likely to "run off at the mouth" and make long-winded speeches. The same thing holds true when a person sits down to write a contributing article, they just write and write. Most articles, though they be interesting to many persons, are so wordy and verbose that even sportsmen do not have the time nor the inclination to read them throughout. That being the case, what about the newspapers which must handle the copy? The printer who sets the type? The man who makes up the "sheet"?

"Cutting" stories is a tedious job for any newspaperman, especially when the article is written by one not conversant with newspaper procedure. Clear, cleancut, concise stories, written with the thought of putting the maximum of ideas into the minimum of space, are the delight of those with whom you must cooperate to get your story before the public.

You may realize by now that I am hinting that the job should be done by a trained newspaperman, who has a thorough knowledge of the subjects at hand. Many times, this combination is not obtainable. In such instances, it is of advantage, if you wish to see your expression in type for the benefit of the thousands you wish to reach, to strike up an acquaintance with the man upon whom you must rely to get your material into the paper. Let this acquaintanceship ripen into friendship by letting the newspaperman know you appreciate what he is trying to do for you. As in anything else, ingratitude is as big a sin in the newspaper game as it is in any other line of endeavor. If you become friendly with your outdoors or rod and gun editor, speak his language and know what he wants, and what he will use, you will soon find your material getting into his columns in better form and construction than had you just casually mailed it to him and depended upon him to do the work for you.

Just prior to my coming here I had a chat with the political writer on my paper. The discussion was in relation to publicity agents. In the course of the conversation he revealed that at the capitol at Harrisburg approximately 175 persons are engaged by the various departments, bureaus, agencies and lobbies to handle the publicity matter by which they hope to sell the public, yet of that number but two are ever given any real consideration by the forty-five reporters maintained by the various newspapers at the capitol press room.

Why? Simply because these two men can be trusted. The newspapermen have confidence in them. The handouts are reliable and always based on facts. One of these publicity men is connected with a department where the mechanics are complicated and strange to the average newspaper writer. Thus they must depend upon the reliability of the information which eventually finds its way to their readers. The same applies to conservation and wildlife and unless the correspondent is a sportsman, familiar with game and fish administration, the subject is foreign to him, therefore your information must be reliable, accurate and authentic.

Newspapermen dare not go off "half-cocked," nor can they waste time with others who do. Neither can nor will they concern themselves with anyone who has a personal axe to grind, or who is motivated by some personal ambition.

Publicity emanating from conservation departments should at all times be confined to news. Too frequently it is merely propaganda under the guise of news. The average outdoors or rod and gun editor is usually a good sportsman; he is fair enough to give a break to anyone deserving it. His policy is not to suppress facts, but he does and will resent being used to spread propaganda.

Frequently, too, the material lacks interest because it is dry and technical. At times, especially when dealing with legislative matters, it is difficult to present it in an interesting manner, but even in such instances, the purpose or the result written briefly would put the story across.

Without going into personalities, I might mention that a certain publicity agent repeatedly breaks into the "All Outdoors" columns of the *Pittsburgh Press,* yet the state he represents is hundreds of miles distant. Why? Simply because his material has appeal and human interest, therefore readers will read and enjoy it.

In most of the larger metropolitan dailies, pictures are always welcomed. However, when picturing game or fish kills it should deal with conservation. Large strings of dead fish are no longer looked upon with favor by the average outdoors or rod and gun editor. The same applies to excessive game bags. The day of the fish and game hog is gone and thank heavens, very few present day conservation writers will devote space to eulogizing such individuals.

There are more, far more people in the world than sportsmen, applying the term to the followers of rod and gun, but it is possible to increase our numbers or, at least, to interest more people in our cause and therefore conservation and wildlife needs all the publicity possible. Newspapers, in general, are beginning to cater to the vast army of outdoor devotees—hunters, fishermen and the others in related activities of sports afield and astream. Conservation has made many friends and it can make many more through the medium which I represent.

But now the most important task confronting you is to first sell yourselves to the press of the nation and this can best be done back home in our own communities. You must popularize the things you are doing and when this is accomplished, it will become a simple matter to better sell conservation and wildlife to all of the people.

You should try interesting one person on each paper in your program. You should also realize that "conservation" in itself is not a thrilling word—it sounds much like "soil erosion," "Einstein Theory" and such other subjects which are of little or no concern to the average person. It is only when "conservation" is translated into "better hunting," "more fishing," "pure streams," or "a better and greater out of doors" that conservation material will find a popular appeal. Once the local newspaperman senses the drama back of it all, you will have a friend who will always help, because he will come to realize that your program is of intense interest to a good-sized portion of his readers.

Show him the number of hunters and fishermen in your territory in comparison to the number of baseball, football or other sport fans. The chances are that he has no conception of your number, because while 5,000 baseball fans, crowded into one grandstand, will make an impression upon him, probably twice that number of sportsmen will be spread throughout the surrounding countryside in search of their sport.

Given the means to sell wildlife to the people, we must sell it not only to those already interested, mildly or otherwise, but also to those who have not been interested. Everybody has a love for Mother Nature. It is fundamental with us all. If that interest has not been aroused or developed, probably it is because those who have been trying to bring it about have been stale, or dull, or too technical with the story.

So, once you have sold your local newspaperman on the many phases of conservation, its altruism and that its administration plays a vital part in the economic structure of the country, then you will have the answer to the question—"How Can We Better Sell Wildlife to the People?"

BOB EDGE
Columbia Broadcasting System

MR. EDGE:

In the discussion of how we can better sell wildlife to the people of the United States, I am reminded of a little discussion that I had with one of the fish and game commissioners of a neighboring state which has within its borders some 300,000 sportsmen. We were sitting around chewing the fat as sportsmen will, and the commissioner was grouching a bit about a certain situation which had existed within his state. He was saying, "Oh, these confounded sportsmen!" He was hot under the collar. I didn't say anything and he went on from there to tell how fine his state was doing in the line of fish and game propagation. He had put out some half million trout, some twenty-five thousand pheasants, the public shooting grounds were so-and-so, etc.

I said, "Tom" (I will call him Tom) "that's all very nice, but I want to ask you something. You've just been talking about the attitude of the sportsmen within this state. I know you are a level-headed fellow and you wouldn't squawk without reason, and in this case I can sympathize with you to some extent. You have just been boasting about what you have within your state. Did you ever look at your publicity department?

"Oh, yes, I get around about once a month when the commission meetings take place," he said.

I said, "Did you ever look at the set-up?"

"No, I haven't, come to think of it."

"Well, you've got one old mimeograph machine. You've got a lot of old yellow copy paper. You pay a man $900 a year to educate the sportsmen of your state and you wonder why those sportsmen squawk."

It seems to me, sitting on this side of a radio microphone and talking to a lot of people clear across the country once a week, that I have a pretty good idea of what the sportsmen in these United States want. They don't want a great deal. Some of you will differ with me on that, I know, particularly you men who propagate fish and birds. Sportsmen want a little knowledge, they want a little education, plain, everyday *common sense* words, not a lot of technical folderol. They want to be told a few things that they can understand.

To get back to this idea of education, we have forty-eight states in the United States, and I want you to picture them as the spokes of a wheel. Some forty-two of those states which have publicity departments send me releases in all good faith and they pay good money for that, expecting me to use the material. Out of that whole kaboodle I can put on the fingers of one hand and two fingers of the other hand those with stuff I could consider using. The rest goes in the waste-basket.

You people are trying to sell conservation, you are trying to sell restoration, you are trying to sell a lot of other terms, which is all very splendid. But if the spokes within that wheel fall down, no matter how much the Federal Government may strive to sell a national idea, the idea will never be successful unless it is sold successfully within the boundaries of the states.

To illustrate further, I have a little booklet (and this is not a plug) which is called ''A Thousand and One Places to Fish.'' I offer that booklet to listeners of the Columbia System as merely a service. Would you believe it when I tell you that in recodifying this book and getting it ready for the 1940 edition, I wrote last January to all forty-eight states and that to date I have never even received acknowledgment from twenty-one of those states? I am giving it to you straight. You want to do a selling job and the people are falling down on you plenty. I have a lot of good friends in a lot of fine states. Sometimes the fault isn't there; the men in charge of fish and game departments are tied up or hampered by a lot of political red tape, and I can sympathize with them plenty. On the other hand, do not complain that sportsmen are backward or awkward or lacking, because they don't know, they have never been educated.

It is my suggestion to every state representative here that he go back home, and if his publicity department, his department of education, needs overhauling, let him do it. Please don't be like the western state which puts upon a very underpaid warden service the task of disseminating or passing along the propaganda of wildlife. I have checked the records of this state very thoroughly and I have found that over a period of a month, in the only educational work done in this state, there has been averaged an audience of about 300 within the state, and all the work, all the talks, lectures, and so forth, were done by wardens in their off time.

I am not going to cite examples of states which I think are outstanding; there are some, but I do wish the fish and game commissions had more Dick Reids and more Bill Sharps.

H. W. HOCHBAUM
U. S. Extension Service

MR. HOCHBAUM:

To anyone at all familiar with the development of wildlife conservation, the progress that has been made in the last few years must seem most remarkable. I have nothing but praise for the various wildlife conservation societies and institutes and their leaders, for the Department of Agriculture, the Biological Survey and the National Park Service and the various state conservation services and commissions, and for the many leaders who have worked so hard in bringing about public appreciation of our wildlife resources and the need for protection and conservation. Out of this conference here this week, it is hoped that something may be done to bring these suggestions into a program that will result in a much wider circle of people supporting wildlife conservation work.

My own interest in the further development of public interest in conservation begins with the many thousand boys and girls on our farms and in small rural towns. Here we have a potential group interest that is tremendous. Already an enormous amount of educational work has been done. You may know that through its Cooperative Extension Service with some 9,000 employees in cooperation with the states, there are our 4-H club boys and girls' clubs now totalling some 1,300,000 members, with thousands of rural volunteer leaders assisting in the work of these clubs.

While the work of these club members revolves largely around agriculture and homemaking problems and improving rural life, during the last five or six years there has been great interest in the study of nature, wildlife and wildlife conservation. Some twenty-seven states report wildlife activities or wildlife programs or nature programs carried on as a part of the work of these boys' and girls' clubs. As early as 1934 Minnesota 4-H clubs carried on a dynamic program, some seventy-five out of eighty-seven counties selecting county winners in a state contest which involved awards based on what individuals had accomplished as indicated by their reports, and also on their narrative stories. The work of these clubs revolved around the following:

Conservation of wildlife as a feature of each monthly program.

The campaign of obeying all game laws in the community and cooperation with the game officials.

Making a survey of wildlife in the community, each member of the local club taking some part.

Each member selecting some individual line of work.

Planting trees and shrubs along streams.

Planting and protecting wild flowers, either by making a wild flower garden at home or in the forest.

Getting acquainted with and protecting some kind of seasonal bird or animal.

Winter feeding of game when food is scarce, and the construction of feeding places.

Making a study of and giving correct information on birds and animals considered harmful but which are really helpful.

Developing bird and animal refuges.

Locating and saving pheasant nests and those of grouse and quail when cutting hay and alfalfa.

Fire prevention and the elimination of fire hazards, creating a sentiment in the community against unnecessary fires.

Planting material desirable for cover and food, and saving nesting material.

Protection of game and song birds from stray house cats.

Constructing and erecting bird houses, and planning bird house exhibits.

Protection of fish, and rescue work.

Planting and developing wild shrubs and trees bearing fruit such as chokeberries, pin cherries, etc.

Rearing of game birds.

Time does not permit giving other illustrations from the studies and the work of these 4-H boys' and girls' clubs.

Their work and their interest warrants unlimited support and encouragement for 4-H clubs everywhere. It is hoped that organizations like these meeting here in some way may cooperate more closely with the Extension Services and the leaders of the 4-H club work in the states. Much can be done by stimulating active work through giving simple prize awards and also by making available to the 4-H club members brief circulars and other printed material on wildlife.

In connection with the above, it may be that new life can be put in Arbor Day celebrations the country over, at least in country schools, and encourage rural boys and girls through 4-H club members putting on a wildlife conservation program on this day. Perhaps in some states or counties we may go as far as to have a special wildlife day in the schools. Suggestions for programs for such days may easily be developed and disseminated.

Another means of encouraging a wide interest and a life-long interest in wildlife and its conservation may be sought in the courses that are now being given in high schools and colleges in botany, biology, and kindred subjects. Certainly, it would seem, at least in the elementary courses, much could be done to build on to the nature interest of our boys and girls in wildlife by beginning studies of the natural sciences with the study of the native animals, trees, fish and flora, and the need for protection and conservation. Instead, I fear that many boys and girls lose their interest in nature by the way the teaching of natural history studies is begun. Years ago I raised the question why we must begin with such things as spirogyra and pickled grasshoppers, yet only the other day my young daughter came home from high school sniffing her fingers, saying she could not get the smell of the preservative off, and when I asked her what she was doing, she said they were using some preserved grasshoppers. Undoubtedly, she will survive this experience and retain her nature interest in everything today, as her brother did before her, and I did, but I am quite sure that many, many do not.

May I state the situation which seems to be all too true in many schools as given by one of our educators some years ago—"As a man feels in his heart, so will he teach. Unless in his teaching a college instructor is willing to forget the research bias of his training and of his study, the breadth of his influence will be limited. If his teaching is merely an adjunct to his research, he will impart his subject as an isolated intellectual discipline, he will select his subject matter and choose his procedure with a conscious aim of training individuals to become specialists and investigators within his field. The fact that 99 per cent of his class are certain not to pursue the academic path is disconcerting; but, through the conscientious and continuous repression of this disheartened thought, he can still bring himself to believe that the instruction must be dominated by the academic motive.

"All the leading men in his field, whom he has become accustomed to admire, were trained with this subject matter, with these methods; therefore, it follows without question, that these same means must be employed in his own teaching. Every hour is harnessed and every step taken to produce that acquaintance with a subject which is of national value for further investigatory advance in the same line. Here is the most obvious weakness of college teaching. It is thorough, it is logical, it is accurate, above all, it is academically respectable, but it fails signally to produce that for which it is presented to the student body of the college. Instead of revealing the manner in which the particular field of endeavor integrates with other fields in the attack on the problems of human existence, instead of exhibiting the reasons for the patient study of such problems by showing their human application, it rather tends to confine the mind within a narrow compass full of academic interest, but empty of human interest for all except the specialist. It may serve a narrow vocational purpose, it may acquaint the student with certain specific or even general procedures, but it fails, because its aim is wrongly conceived, in giving their wider vision which is a peculiar obligation of college education."

How to approach the curriculum makers and the teachers of science in our schools and colleges is a problem for us. I think many of these can be approached and can be made more sympathetic to the needs of our youngsters, and needs of the nation with reference to conservation.

Another point of interest which may be still further developed is to encourage wildlife exhibits at local, community, district, state and regional fairs. Such exhibits should really tell the story of wildlife conservation rather than be simply exhibits of animals, etc.

I have wondered whether there was a possibility of financing a writer or writers who might prepare articles for syndication in the great newspapers of the country, as well as the smaller ones, on wildlife conservation. We have in one of our evening papers articles on nature by a writer or two that are very interesting. With little direction such articles could point more to the wildlife needs and real conservation, and serve a great educational need.

There may be a great opportunity also through the Extension Services of the various states to bring about appreciation of conservation with adults, both rural and urban. Recently, I travelled some 2,500 miles in Texas by auto, in rural districts, and was quite surprised to find in so many places permanent small signs on fences which indicated that these places were cooperative game management demonstrations carried on in cooperation with the state conservation people and the Extension Service. How far such developments may be advanced in other areas is an interesting problem for our consideration.

The Department of Agriculture has launched this year a nationwide drive on conservation. This means not only conservation of soil and forests but includes other natural resources, as well as human resources. I think that this endeavor may be something which should receive your very earnest and sincere attention, and in following it, you may see opportunities for increasing here and there a widespread interest in conservation of wildlife interests generally. This great drive is accumulating momentum and will have an enormous effect on the people of the country and consequent greater conservation of all our resources.

There are many other features, of course, that might be brought up here for consideration. All of us are interested in the development of conservation work of the Departments of Interior in the states in building the parks and recreation centers and the use of the national and state parks, and conservation of their wildlife. These efforts deserve, of course, the widest support of all people. Perhaps there are many stories of all features we are developing which could be brought out through the press, through our magazines, or illustrated through motion pictures. Our need, as far as extension work is now concerned, is to have more material in the way of slides, posters, motion pictures, stories, circulars which through our county extension agents and through our 4-H club members may be used in widening and increasing interest of both young and old.

In closing, I wish again to salute you and commend you for what has been done, and to enlist your cooperation and support in the efforts of the Department of Agriculture, the Extension Service, and Extension Services of the states.

JOHN H. BAKER
National Association of Audubon Societies

MR. BAKER:

I am none too enamored of this subject of others' choosing, so that, if I may be permitted to take a little liberty with it, I believe that I can perhaps emphasize the point I wish to make, and at the same time attempt to answer the author's question, by speaking on the subject of "How Can We Best Sell the People to Wildlife?"

The reason for this discussion at this meeting is that a large majority of our population does not give any appreciable thought to wildlife. Those of us here feel, and rightly so, that sympathetic understanding of the multiple values of wildlife, and intelligent application thereof, would redound greatly to the benefit of everyone.

Are we, however, qualified to successfully "sell" wildlife to the people? I wonder! How can we expect to do so if we ourselves are engaged in exploiting it for our own special benefit, and often at public expense? If, for example, our interest be to trap animals, hunt them, photograph them for commercial reasons, fish for them, crop their surpluses or restock them for taking, it seems to me that any effort to sell the American people on wildlife primarily through such agencies or individuals is foredoomed to failure; that we are then licked before we start.

Many of the personnel of federal and state agencies concerned with protection and preservation of wildlife are engaged in controlling wild animals by killing them. That this sort of thing should occur, as a result of public pressure, is dismal enough. The final *reductio ad absurdum* is the federal and state governments' bringing pressure on us to approve their killing at our expense.

Please do not misunderstand me. It does not follow that we should necessarily be opposed to all such activities, but rather that we may not logically look to those sources for our successful sales force.

I take it that a proper definition of "sell" in this case means that we needs must, through our presentation, bring about in the minds of the mass of our people a self-generating and lasting conviction.

I maintain that wildlife itself is its own best salesman, and that the best course to pursue involves activities that bring the people to it.

Get people into the outdoors in groups, with inspired and enthusiastic leaders. Get away from the laboratory and indoor approach in developing public interest. Steer clear of stress on identification, taxonomy and physiology, which are all very well in their place.

People are at first more interested in the "whys" and "wherefores" of the things the animals do; what they eat, whether they sleep, how far they see, how they keep warm; in what sort of places they live; how do they hibernate? Why do they sing? Where and why do they migrate? Are animals and vegetation inter-dependent? And is there apt to be boomerang effect if man deliberately attempts to control? Such matters are of far greater interest to the mass of people than whether or not the animal makes a good target, is good to eat, has marketable fur or suffers from such and such disease. Think of the millions of people who enjoy seeing and photographing the animals in our national parks, where killing is not permitted, and even control is taboo.

I shall show you color motion pictures illustrating the attractions of wildlife from that viewpoint, showing people developing an appreciative interest through outdoor experience under competent leadership. (Pictures were shown.)

These pictures were taken at the Audubon Nature Camp in Maine, where 781 different persons from thirty-four states have in four summer seasons tasted a fine kind of approach to an interest in nature. They have gone back into their home communities bent on doing their bit to further wildlife preservation. They are a growing force as a sector of public opinion.

This winter we have inaugurated Audubon Wildlife Tours in Florida, again under outstanding leadership and with the same kind of approach involved. These have been so successful that we shall enlarge the tour program both as regards number of units and locations, and can envision thousands of persons participating in such tours organized on a country-wide year-round basis adapted seasonally.

In these days great stress is laid upon the strivings of humanity the world over to gain what is termed security—illusory as that may be. Yet, through communion with nature, one may maintain or attain peace of mind, spiritual and physical comfort, good health and sanity. What better form of security?

Politicians, in my opinion, have been asleep at the switch. Steps by them to minimize discontent are sure vote-getters; initiation of public programs to get people outdoors with their minds off their real and imaginary troubles, giving them health and optimism, has alluring possibilities from a political standpoint. One of these days, an inspiring candidate for the presidency will incorporate this idea in his platform. The countrywide volume of support he thereby obtains will, in my opinion, astonish even him.

Wildlife will have nothing to fear from such persons, and thus will of its own accord become sold on people.

W. T. SPANTON
U. S. Office of Education

MR. SPANTON:

Under our democratic system of government, the home, the church, and the school are the most cherished of all human institutions. In far too many instances, however, the school is asked to assume responsibilities which rightly belong to the home and the church. Furthermore, since our schools are in a sense public property and belong to all of us, there is a tendency on the part of local, state, and Federal Governments to increase their responsibilities and broaden their functions and activities. A glance at the elementary and secondary school curricula now being followed in most states will show the extent to which this shifting of responsibilities to the schools has taken place. A typical elementary or secondary school curriculum today includes instruction not only in the three R's and the so-called fundamental subjects, but also courses in health, citizenship, physical education, art, safety education, and the like.

The one and only responsibility of our public schools is an educational responsibility. When I make this statement I am, of course, thinking of education as defined in its broadest sense. At the same time there needs to be in the minds of all of us a clear cut line of demarcation between educational programs based upon sound, factual, informational materials on the one hand and untried, untested, and unproven theories, philosophies, and opinions on the other. While our public schools must be allowed to retain their academic freedom, they also need to be religiously guarded to prevent their becoming promotional agencies for any organization or group of organizations, either public or private.

Whenever any new movement affecting our economic and social well-being has reached state and national proportions, it is now standard practice for us to expect the schools to cooperate in putting the job across through an "Educational Program." While I regard this situation as a distinct compliment to the educational effectiveness of our schools, I also believe it contains an implied warning that there is a dangerous saturation point beyond which we should not expect the schools to go in conducting "Educational Programs," no matter how popular or how worthy the cause. Otherwise "we, the people," may innocently and unintentionally be guilty of destroying and rendering impotent our greatest of all educational agencies — the schools of America.

I am firmly convinced that the soundest, most effective, most enduring, and at the same time the most appreciated type of educational program is that which rigidly adheres to the truth and to fundamental factual materials as far as possible regardless as to whether it is one of systematic instruction in the so-called fundamentals, being conducted in the public schools, or a 100 per cent "selling" or "commercialized" type of educational program conducted separately and apart from the schools. All viewpoints of social and economic problems in which there is controversy and differences of opinion should be impartially presented. The public schools as a neutral, impartial agency have nothing to sell except education. This fact alone adds greater weight, prestige, and conviction to their teachings in the eyes of the public. By the same token they need to be vigilantly guarded to prevent their becoming a fertile field for the dissemination of certain advertising or propagandizing types of information upon which there may be considerable disagreement and controversy as to their factual status.

I fully recognize that the nature of these introductory remarks may seem to be rather far removed from the subject which I am supposed to discuss here today. I also realize that I could very easily spend all of my allotted time in giving you one outstanding instance after another of the many splendid wildlife conservation programs now being conducted by the public schools throughout the country. The files of our national organization of the Future Farmers of America are fairly bulging with interesting news stories and illustrated feature articles on this subject. However, I believe that most individuals in this audience need not be reminded of many specific examples of such activities since you are no doubt already in possession of much of this information.

As you may already know, I am here today in a dual capacity as a representative of both the Agricultural Education Service of the United States Office of Education, as well as the Future Farmers of America, which is the national organization of farm boys studying vocational agriculture in the public schools of the United States. It should therefore be unnecessary for me to tell you of our genuine interest in the problems of wildlife conservation and of our desire to further expand our opportunities for service in this very deserving program. Ever since our nationwide program of vocational education in agriculture was first inaugurated through the passage by Congress of the Smith-Hughes Act in 1917 an earnest effort has always been made in our office to cooperate with all other public and private agencies, institutions, and organizations that are working unselfishly in the interests of American agriculture and country life.

However, in line with my opening remarks, I feel that such private or commercial agencies or organizations and other divisions of government need to better understand some of the limitations, problems, and difficulties which we constantly experience in connection with our national and state programs of vocational education in agriculture. Such a mutual understanding is essential if widespread cooperative activity programs are to be extensively developed. I will say quite frankly, therefore, that in order to centralize our sources of informational materials and avoid controversy, we have always looked to the various research and technical divisions of the United States Government and to the Department of Agriculture in particular, together with the several State Experiment Stations and Land Grant Colleges, as the final authority and ultimate source of all scientific and technical information in all phases of agriculture, including conservation of natural resources.

Very naturally, therefore, our Office looks to the United States Forest Service, the Agricultural Adjustment Administration, the Farm Security Administration, the Farm Credit Administration, and numerous other government agencies for cooperation and assistance in the development of suitable teaching materials for use in our vocational agriculture classes. Similarly we look to the United States Biological Survey for guidance in the development of subject-matter teaching materials on wildlife conservation to be used in our vocational agriculture departments, local chapters of the F.F.A., and the public schools in general.

I am, therefore, going to offer a few suggestions as to how, in my opinion, the various public and private organizations represented here can render maximum service to, and secure the active interest and cooperation of, local departments of vocational agriculture, F.F.A. chapters, and rural schools in the development and conduct of effective educational programs in wildlife conservation:

1. There is in my opinion an urgent need for greater unanimity of agreement among recognized authorities on wildlife as to which species of animals and birds, if any, should be classified as predatory pests, and therefore subject to attempted eradication. In some states it is my understanding that a bounty is paid for the killing of certain so-called predatory pests. Very naturally under such circumstances our Future Farmer boys, under the leadership and guidance of their teachers, occasionally organize and conduct pest eradication campaigns and believe that in so doing they are engaging in a perfectly legitimate and worthy community enterprise. In fact, one of the purposes of the national organization of F.F.A. is to develop strong rural leadership and good citizenship. However, when the activities of these boys in such instances receive extensive publicity they are sometimes criticized by certain organizations interested in wildlife conservation for having participated in such so-called pest eradication campaigns. These farm boys, therefore, automatically become involved in an unfortunate controversy that could have been avoided easily if there was greater agreement on such matters among adult organizations interested in wildlife conservation.

2. If agreement can be reached as to the particular species of wild animals and birds that need protection, printed lists of such species should be made available to all elementary and secondary schools through the proper and legally constituted state officer in charge of such matters, together with suggestions for further propagation and conservation of such species in their natural habitats.

3. In my opinion the greatest educational service that the schools

can render in the matter of wildlife conservation can be brought about through the incorporation of such subject-matter factual materials as bear on the subject, into the already existing courses of study. Such subjects as agriculture, nature study, biology, and general science should by all means include not only class instruction but organized activity programs in wildlife conservation practices in which all students can participate. In my opinion this method of dealing with the subject is far better than to attempt the establishment of special courses in wildlife conservation in our already over-crowded curriculum.

4. A concerted effort should be made in seeing to it that one or two well prepared chapters on wildlife conservation are included in all new elementary and secondary school textbooks on agriculture, nature study, biology, and general science subjects.

5. All educational programs on wildlife conservation in our schools should in my opinion be as positive and constructive as possible rather than negative, dictatorial, and demanding. Our boys and girls should be so taught that they will have an appreciative understanding of the economic and other values of a community program of wildlife conservation. It is human nature for any individual to automatically oppose anything he does not understand. Consequently most farm boys, as well as their dads who lack the proper background for understanding the problem involved, do not like to be told what kinds of wildlife they shall or shall not kill or conserve. Our problem then becomes one of reaching such individuals with the most effective type of educational program. As far as students of vocational agriculture are concerned, I am confident that the right sort of positive leadership could be provided easily. This could be done through the offering of appropriate prizes to local chapters of the Future Farmers of America that excel in the extent and kinds of wildlife conservation activities in which they have engaged during the year. Such information is reported by them in their report of chapter activities that they make to their respective state and federal offices each year. Furthermore such awards would not involve the setting up of an additional "contest" but would fit in nicely with the present F.F.A. Chapter Contest. In addition such an award would tend to divert the attention of F.F.A. members from engaging in questionable pest eradication campaigns, and toward the more positive and constructive activity of conserving wildlife.

While I do not intend to be boastful, I doubt if any other group of public school students has given so much attention to or accomplished more in the development and actual conduct of wildlife conservation campaigns than have the Future Farmers of America. This organization, with its 6,300 chapters and 207,000 members in forty-seven states, Hawaii, and Puerto Rico, for several years has included in its national program of work an item on conservation of natural resources including wildlife. Each year hundreds of chapters report rather outstanding accomplishments in such activities as: reforestation projects; distribution of game laws and information on game conservation measures; hatching, brooding, and releasing of game birds such as quail and pheasants; cooperation in establishment of wildlife feeding stations; cooperation with state game officials in the establishment and maintenance of game and wildlife sanctuaries; prevention of forest fires; the holding of chapter meetings dealing with wildlife conservation activities; and the radio broadcasting of programs dealing with wildlife conservation on state, regional, and national F.F.A. radio programs.

Finally I will close by saying that I do not come to you with any Utopian educational program on wildlife conservation, but I *can* assure you again that we are vitally interested in the problem and stand ready to cooperate in every practical manner. However, we shall continue to look to such organizations as this for leadership and guidance. Our Future Farmer program is primarily an activity program and in its further development along the lines of wildlife conservation we need your help and I believe that you need our cooperation.

DISCUSSION

The Chair was turned over to Arthur L. Clark of Missouri.

DR. THONE: One idea occurred to me while I was listening to those who followed me on the panel, especially those in the newspaper and radio business, one being Mr. Edge. A further question somewhat along the line of my own initial discussion, to raise the question as to how well we are succeeding in selling our material right now as gauged by public acceptance. It is perhaps a little reminiscent because it has occurred to me that the American Wildlife Institute or some other qualified body might quite readily adopt the technic that we have successfully used on several occasions in the past in Science Service to get some sort of gauge of how things are going in the newspapers and possibly on the radio. Mr. Edge could make better suggestions on that than I. Briefly, it is no good subscribing to clipping bureaus to get a lot of clippings. A lot of the value of an item in a newspaper depends not merely on its being in the paper at all, though that is something, but on where it is, whether it is on page one, which is a preferred position, page two, the back page, or lost somewhere in the inside pages among the advertising. So what one does is to subscribe for a certain period, six weeks, two months, to a selected list of representative newspapers, have qualified people go through them. You can get young women to do that sort of work very readily, simply marking up the papers. Make a survey of that sort, tabulate your results, and at the end you may be able to answer at least in part the question: How are we succeeding at present? With that as an initial point, one might be able to proceed toward an improvement of technic. It certainly has been the case with our own work in Science Service. We have been able to improve our technic and increase our subsequent success by means of these surveys.

I should like to leave that as a definite suggestion before the Conference, that something of the kind might be undertaken. It can be done either on a limited basis with modest means or on a large basis with extended means, as one's budget and one's inclination may dictate.

CHAIRMAN CLARK: Bob Edge, have you any comments to make on the question of how we are succeeding in addition to what you have already told us?

MR. EDGE: I think you are making very good strides, but I think you have plenty to learn. Mr. Mock answered for a newspaperman's point of view, and I think I can answer for a radio man's point of view. I made a remark a while ago that I talk across the country and during the course of the year I probably receive 50,000 letters from sportsmen all over the United States. If they don't like you they tell you mighty quick; if they do like you they also tell you. I have found that a successful program which can be listened to is a mixture. I don't think you have got the proper mixture, to be perfectly blunt, in this work—a mixture of a little bit of humor, a little education. In this I think the American Wildlife Institute is doing a very great service. I used to delve into the dictionary and into the museum and gather subjects which I called "Do You Know?"—do you know this, do you know that and do you know the other thing about wildlife. If you get a little twist on those things that is a service that every newspaper wants, and almost every radio station wants—the education, the humor, and the serious side.

I frankly think in selling anything, whether it is milk or cheese or butter or beer, or whatever it happens to be, that it is high time some new slogans were invented. I am not a slogan inventor, but I think conservation needs perhaps a new word; maybe conservation has been worked to a fare-thee-well. I am sincere. I don't believe that conservation isn't a fine thing, but I think you have to get some new slogans for conservation and restoration. I think the tackle manufacturers, to be honest with you, the people who are interested in the game from the commercial standpoint, are those people who are more wide awake because it comes back to the old story that they are the ones who are willing to get out and spend the money to tell the story. You can't do it unless you pay for some high-priced men. You can't go along far with a man who, though he be the finest technician in the world, is certainly a dud when it comes to writing press releases and telling the story.

CHAIRMAN CLARK: A practical and helpful answer. Have you anything to say on that subject, Mr. Mock?

MR. MOCK: Not being familiar with any of the surveys that might have been made in any of the other phases of it, and being familiar only with what has been done on our own paper, we find the outdoor coverage ranks on top with the rest.

CHAIRMAN CLARK: Mrs. Stieff, have you any questions?

MRS. STIEFF: No, I feel that we certainly seem to be covering the subject pretty thoroughly with our radio and press and general information, and in more specific fields where a few people are taught, as at the Nature Camp, and educating for the future through the schools.

In my presentation I spoke of trying to get into the regular curriculum, the study of conservation for the benefit of the young. I feel we are really making a pretty good effort.

CHAIRMAN CLARK: Have any other members of the panel any questions to ask each other? If not, we still have a few minutes for questions from the floor.

MR. WILLIAM MCCORMICK (Washington, D. C.): I would like to ask a question of Mr. Spanton. Could you tell us something about that radio script exchange work which your organization is doing? We have found that particularly effective in amplifying our radio work. I don't think many people know a lot about it.

MR. SPANTON: I am sorry that I cannot tell you very much about it, more than you probably already know. I know that it exists in our office—it is, of course, a large office. We have in the vocational division not only agriculture, but trade, industrial education, home economics, business education, distributive occupations and rehabilitation; and then in what we speak of as the other division we have all these other services. That happens to be in the other division. I know the man in charge of it, Mr. Boutwell, at least he was in charge of it, and I know some of those people. I think they are doing some very fine work, but the details of it I am sorry I am not familiar with.

The following remarks on the part radio is playing in educating the public to the need of conservation were prepared by the Educational Radio Script Exchange, U. S. Office of Education, and are inserted as a matter of record.

Radio is playing an important part in educating the public concerning the great need for conserving our American plant and animal wildlife. In this connection local leaders in wildlife conservation will be interested to know about the services of the Educational Radio Script Exchange.

In 1935 the Federal Communications Commission created the Federal Radio Education Committee to promote more effective cooperation between educators and broadcasters on a national, regional and local basis. The work of the FREC is being sponsored by the broadcasting industry, educational foundations and the U. S. Office of Education. The Script Exchange is one of the services of the FREC.

By serving as a central clearing house for all kinds of information pertaining to the field of educational radio and by acting as an exchange for radio scripts and production aids received from active educational radio groups throughout the country, the Script Exchange helps hundreds of local civic and educational organizations each year to become more adept in using radio.

Practically all of the scripts available in the Exchange have been broadcast at least once in some part of the country. Many hours of time are spent in writing a worthwhile educational script and too often in the past the work and skill of the writers have been lost after the initial broadcast. By getting such scripts out into useful circulation the Script Exchange is in a sense—Conserving Creative Ability.

In November, 1938, Mr. William McCormick, Director of Education of the American Wildlife Institute, Washington, D. C., contributed to the Exchange fourteen scripts selected from the series America's Wildlife, which is being broadcast over the facilities of the Mutual Broadcasting System. Twenty-five sets of the scripts were bound for circulation and approximately 200 organizations have had the use of the scripts through the Exchange. As of April 1, 1940, twenty-one of the twenty-five sets were out in circulation and were being used by such groups as: Bethlehem Central High School, Delmar, New York; National Historical Society, Worcester, Massachusetts; Station WBAA, Purdue University, Lafayette, Indiana; Carnegie Junior College, Carnegie, Oklahoma.

How can you receive the various services of the Script Exchange? That's easy! Send ten cents in coin or stamps to the Educational Radio Script Exchange, U. S. Office of Education, Washington, D. C., and ask for a copy of the Fourth Edition Catalog which includes descriptions of more than 500 radio scripts on various subjects, as well as numerous supplementary aids to production, such as: *Radio Manual, Handbook of Sound Effects, Radio Bibliography*, etc. The materials are available to you without charge.

MR. VERNON BAILEY (Washington, D. C.): I want to ask Mr. Hochbaum why he limited his remarks to the 4-H Club when there are twice as many members in the Future Farmers of America doing the same work.

MR. SPANTON: May I answer that for Mr. Hochbaum? Mr. Hochbaum may be modest, but I, representing the Future Farmers of America, want to say that you are mistaken in those numbers; the 4-H Clubs have probably three or four times as many as we have in the Future Farmers of America.

MR. BAILEY: Those numbers were a year ago.

MR. SPANTON: Even today they have three or four times as many numbers as we have.

MR. HOCHBAUM: The figures are 1,350,000 4-H Club members, now.

MR. H. LEE HOFFMAN (Maryland): I would like to ask a question. In view of the fact that the Garden Clubs have been militant at times, the Audubon Society has been militant at times, and they have been successful in accomplishing to a great degree their objectives, and are continuing them, I would like to ask any one of the members of the panel what part militancy plays in conservation?

CHAIRMAN CLARK: A very good question. Mrs. Stieff?

MRS. STIEFF: I think I would like Mr. Baker to comment on it first.

MR. BAKER: It strikes me Mr. Hoffman has something on his mind he would like to say on this question, otherwise he wouldn't have asked the question.

MR. HOFFMAN: We got eight column heads in Baltimore's fine papers, in all editions. We were quite militant and still are. I would like to have an answer.

CHAIRMAN CLARK: Mr. Baker, you have had a lot of experience with being militant. What about it?

MR. BAKER: I don't know that this is a very good place to get into a lengthy discussion in an attempt to define what militancy is. I don't know that there is any accurate definition that we could all agree on. Certainly fighting for what you stand for with conviction to get results is advisable, is it not? We all agree on that. If that can be done with the least development of antagonism I would say it is most successful militancy.

CHAIRMAN CLARK: A very diplomatic answer, I should say, and I hope it is satisfactory to the audience.

MRS. STIEFF: I might say a word. The Garden Clubs have always been able to get publicity on conservation matters (we are speaking of that now) because everyone realizes we have no personal axe to grind, we are not in the political game, we are just a group of lay people with altruistic objectives: even though people may not always agree with us, when we do come out for or against a certain proposition the papers usually do accord us a good deal of publicity because they feel we are sincere and we are not in it for any ulterior motive. I think that is where we have been very successful.

CHAIRMAN CLARK: A very solid ground to stand on.

MR. BAKER: I wonder if on behalf of the Garden Clubs and the Audubon Societies I may thank Mr. Hoffman for paying us a compliment.

MR. HOWARD ZAHNISER (Washington, D. C.): Mr. Mock spoke about the importance of getting newspaper readers to understand the economic value of wildlife as well as the commonly accepted recreational and esthetic value. I am wondering if he has anything further on that line, or suggestions as to how that could be done, and what kind of facts should be given to them.

CHAIRMAN CLARK: The Chair happens to know that Mr. Mock has some further information and I am sure that it is worth while taking the time for him to present a very brief prepared statement on that subject. Thank you for bringing up the question.

Mr. Mock's paper, Mr. Sportsman Take a Bow, was printed in "American Wildlife" for May-June, 1940, and numerous other publications.

MR. JOHN M. PHILLIPS (Pennsylvania): There is one question that Mr. Mock has not touched on. That is the food value of the game that costs so much to kill in Pennsylvania. I haven't the figures for '39, but I have the figures here for '38. We killed 25,500,000 pounds of wildlife in Pennsylvania in that year. Some of that meat was worth fifty cents an ounce, ruffed grouse. Deer purchased for venison cost sixty cents a pound in Pittsburgh. So placing this 25,000.000 pounds at $0.50 per pound would give us $12,000,000 interest we have taken from the forests and fields of Pennsylvania in one year. At 4 per cent, that would leave us in the old bag of nature $300,000,000, the value of the wildlife in Pennsylvania. In addition to that, we cannot figure the sport in dollars and cents, of taking that game. We train our men in the outdoors to take care of themselves, make them familiar with firearms, and in time of war we have quite an army for our defense.

CHAIRMAN CLARK: Thank you, Mr. Phillips. I hope the audience agrees with the Chair that this discussion of the economic structure has been very interesting and important. We are sorry to draw the meeting to a close as it approaches time to adjourn.

MR. JACK VAN COEVERING (Michigan): I should like to ask a brief question. What does Mr. Edge consider an average return of the fan mail on his radio broadcast when no teaser or free item is offered?

MR. EDGE: That depends entirely on the season of the year and the time of the broadcast, and with how many stations you are hooked up. I would say that at the present time I am on at 9:15 on Sunday mornings, which of course is not the best time in the world, but without any teasers or anything of that nature, with a hook-up of some seventy stations on the average, the response from the sportsmen runs around 150 letters a week, just on general questions or expressions of appreciation or dislike of a particular problem. It also depends a lot on the subject matter which is taken up. For example, I spoke about hawks on one occasion, and I found that I was bombarded. It seemed to be a very popular subject. I didn't say which hawks to kill or which ones not to kill, but the mail jumped from 150 letters, I think, to around 700. So you have a lot of factors to determine. On the other hand, if you are offering something that the sportsman wants at cost or free, I can give you an illustration there. On seventy-seven stations offering the same booklet about which I spoke, tips on fishing everywhere in the United States, on a free basis the number went up to as high as 5,000 requests in one week from forty-four states and ten Canadian provinces, including, of course, the District of Columbia. When the booklet is offered at $0.10 a copy, which covers cost of handling and mailing, it averages around 1,000 to 3,000 copies a week.

QUESTION: How many listeners?

MR. EDGE: That we have no way of determining, but someone has said the basis on which you can figure is one out of 10,000. If we are going to accept that I think you can consider it a fairly large audience.

MR. D. E. WADE (Pennsylvania): The fur industry as a whole has been largely neglected in this Conference, and I would be safe in estimating that about $50,000,000 is invested in fur, starting from the trap to the final product. Trapping is a good industry, a good recreation, and a good sport.

CHAIRMAN CLARK: Thank you, Mr. Wade.

RESOLUTIONS

William L. Finley of Oregon took the Chair.

MR. FINLEY: I would like to have Mr. Pough introduce a resolution.

MR. RICHARD POUGH (New York): *Resolved,* That the Fifth North American Wildlife Conference favors the passage of legislation to give federal protection to the bald eagle, commonly known as the American eagle, the emblem of the United States, and therefore urges Congress to pass at its present session H. R. 4832 introduced by Representative Charles R. Clason of Massachusetts and referred to the Agricultural Committee of the House.

I move the adoption of the resolution.

The motion was regularly seconded, put to a vote and carried.

MR. FINLEY: A resolution with regard to salmon resources of the Pacific Coast.

Whereas, The Columbia River and its tributary, the Willamette, are the natural habitat of the spring Chinook salmon, the most valuable fish run in the United States as well as the world, and

Whereas, The proposed building of more dams on these rivers is seriously affecting the salmon runs, and

Whereas, The proposed project of building seven dams on the Upper Willamette will destroy the largest Chinook runs of the Columbia, and

Whereas, In the published report of the Army Engineers it states flood control in the Willamette can be equally handled by levees and bank revetments at a cost of $33,000,000 or by high dams at a cost of $62,075,000, now therefore be it

Resolved, That if this project is carried out the levee instead of the dam system should be adopted as a protection to the salmon runs as well as reducing federal expense.

I move that that be adopted.

CHAIRMAN CLARK: The Chair would like to ask Mr. Finley to comment regarding the origin of this resolution.

MR. FINLEY: I was called, without my knowledge, to talk at the meeting yesterday, and I gave a short talk in regard to this matter. I can at any time repeat that talk but I do not think you have the time at present. It was suggested by several that the resolution be made up. I made that resolution and presented it to you.

CHAIRMAN CLARK: The only point I wanted to make, Mr. Finley, was whether this emanated as a recommendation to the Assembly from the Directors of the Federation.

MR. FINLEY: No.

CHAIRMAN CLARK: It is presented for consideration.

The motion to adopt the resolution was regularly seconded, put to a vote and carried.

MR. AYLWARD: I have here a letter from our friend Juan Zinser of Mexico which expresses his regret at being unable to be with us this year. He indicates that he is out of the Department of Forestry, Fish and Game, and hints broadly of politics. He sends greetings and best wishes. We are very sorry that he is not with us.

CHAIRMAN CLARK: In declaring the morning session of the Conference ended, I do so with regret and wish to thank again the members of the panel for their intelligent discussion and cooperation, and I offer the audience an opportunity to express their appreciation to the panel members for this helpful and interesting discussion.

PART II

SPECIAL SESSIONS

FIRST TECHNICAL SESSION

MONDAY AFTERNOON—MARCH 18

Chairman: DR. THOMAS H. LANGLOIS

Franz Theodore Stone Laboratory, Ohio State University

FISH STOCKING POLICIES

NEW YORK'S BIOLOGICAL SURVEY AS A BASIS FOR FISH MANAGEMENT RESEARCH

C. W. GREENE
New York State Conservation Department

The Bureau of Biological Survey of New York State was created by legislative enactment in 1926 for the purpose of determining "the most practical methods of increasing fish production." A sum of about $18,000 was spent for the work during that year.

In this same year of 1926, the Conservation Department spent about $253,000 to pay for the culture of eggs and fish for restocking waters open to public fishing. Similar amounts had been appropriated for fish cultural purposes for many years.

The fish cultural work, in general and considering the difficulties, was well done by conscientious workmen. Doing their jobs well, these men had no time to make a serious attempt to find out if all these young fish they worked so hard to produce were really improving the fishing. Was a dollar spent hatching and rearing fish producing a dollar's worth of fishing? Five dollars' worth? A nickel's worth? They were not paid to investigate those questions.

Fishermen and the general public soon became convinced that this work of applied fish culture was necessary to the welfare of fishing. For that reason, although true values were unknown, the demand value was soon great enough to insure production whether fish culturists and fisheries "experts" wished to continue production or not. The cart was securely placed in front of the horse.

In entering upon a program to determine the most practical methods of increasing fish production, the newly created Bureau of Biological Survey would seem to have had a wide choice of procedures. Actually the 12-year program as outlined at that time was dictated to a considerable degree by the situation sketched above. Authorities concerned in outlining the new program were confronted by a hatchery system which annually produced millions of eyed eggs, fry and fingerlings. They knew that this product of the hatcheries was distributed on request of individuals or clubs to waters which were unknown or known at best only in a general way. The decision to catalogue the state's waters biologically, placing particular emphasis upon their suitabilities for stocking, grew naturally from the existing situation. It might be characterized as a "realistic" program.

The plan as developed gave little prospect of solving the problems of where stocking really pays and how much it pays. It was designed rather to prevent some of the obvious abuses of the fish distribution program then in vogue and the procedure assumed that some sort of stocking was beneficial in most waters. Determinations of criteria basic to the need for stocking were neglected for the more immediate criteria necessary for decisions of where to distribute a product in hand. The cart was still leading but an attempt was being made to install a steering wheel.

During the course of the surveys, the broader purpose for which work was initiated was never forgotten. The survey pioneered in the study of fish production in wild waters and although its inventory form was not primarily designed to solve fundamental questions, it has helped to define basic problems and has suggested solutions for many of them.

Considering the limited scope of the program then, I believe results have proven the annual watershed surveys to have been of outstanding value. Their value as a method of conducting fisheries research has been considerably enhanced in this particular case, I believe, by the extent and variety of the waters found in New York State.

The principal, practical accomplishment of the survey has been the formulation of a stocking policy for most of the important waters of the State. Ways in which this contributes to better fishing conditions may be grouped under prevention of mistakes, improved uses of this method of controlling fish populations and education of the fisherman.

Prevention of types of stocking likely to have a permanently harmful effect probably is the most important single result of the stocking policy. This is being effected through general limitation of species stocked to those which are native or which were present when the waters were surveyed, as well as through an educational campaign demonstrating harmful results from introductions of non-native species. The survey has been instrumental, also, in the enactment of legislation calculated to prevent indiscriminate stocking by individuals or clubs through private sources. This law requires permits for all stocking except for private ponds lacking inlet and outlet streams.

Formally, our control of fish planting is practically complete. In practice undesired species of fish occasionally appear here and there because of inadequate supervision or enforcement. But before the survey stocking policy became effective, these occurrences were comparatively common.

Limitation of stocking to waters "suitable" to maintain the species stocked is a further preventive measure of considerable value in avoiding waste. Waters classed as dry, small, polluted or unfavorable because of other habitat conditions include many waters formerly persistently stocked and even more which were occasionally stocked. Ponds and lakes superficially favorable for trout species but actually not favorable constitute an important class of such waters.

Where stocking is effective it functions as a means of controlling fish populations. Early in the survey work it became obvious that, in most situations, stocking with several competing species could not possibly serve a useful purpose. It became a general policy of the survey, therefore, to advise selecting for stocking only the few species for which it seemed control was desirable and possible in a particular situation.

Control, of course, may consist either of increase or decrease of a population. Increase is the common aspiration but generally is advisable only where natural spawning facilities are limited or some of the numerous other possible limiting factors have operated to reduce the population below the potential capacity of a particular body of water to maintain it in sizes desirable to the angler. Stocking may be incapable of improving the situation even then, certainly in many cases will not do so efficiently unless careful analysis of the particular water indicates the correct sizes to stock as well as the best times and places for such stocking.

Stocking for the purpose of reducing populations has not been utilized extensively but seems destined to be more widely favored. Its possibilities as a control method are being investigated in one lake in New York State and isolated examples of its possibilities have been reported from other states.[1,2]

Educational values incidental to the preparation of the survey's stocking policy, I believe, have been considerable. The idea of stocking on a maintenance capacity basis has been consistently adhered to by the survey. The futility and waste of attempting to force a body

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[1]Hoover, Earl E. 1936. Contributions to the Life History of the Chinook Salmon and Landlocked Salmon in New Hampshire. Copeia, No. 4, pp. 193-198.

[2]Eschmeyer, R. W. 1939. General Management Suggestions for Lakes Surveyed in 1937 in the Several National Forests of Michigan. Progressive Fish Culturist, Nov.-Dec., pp. 41-42.

of water to produce more than its capacity are beginning to be recognized by the fisherman. The idea that many waters are self-maintaining in as far as young fish are concerned has been so often repeated that it also is accepted in some quarters. The demand for testing the values of various kinds of stocking and of any kind of stocking is not many steps away. Only when the demand, or at least the tolerance, of the public for such work is present can state departmental agencies engage in it extensively.

The feat of moving the horse around in front of the cart is now being attempted, generally under the leadership of agencies least directly responsible to the public for practical fish management policies. As it becomes possible, New York's biological survey hopes to bear its full share in this undertaking.

Inventory data of the New York survey are available as bases for alterations of policy when desirable changes are determined and meanwhile are available in planning research for the selection of these desirable new methods. Since the units requiring management are comprised by the total number of bodies of water in the given management area, each unit being distinct in characteristics from every other, the value of an inventory survey for these purposes is obvious.

The inventory gives us, to begin with, a record of important habitat conditions for all streams and for the more important lakes and ponds in the state. This record includes, in most cases, a list of the fish species present and includes in many instances estimates of their relative abundance and growth rates of the more important species. It is true these records are dated at the time of the survey and we have no accurate record of variability of the various elements of the environment over a period of time. They may be likened to single exposure photographs as compared with motion picture film. Nevertheless, these records comprise a base line invaluable in planning fish management research and for purposes of future comparison.

Present ambitions of the survey with regard to stocking are:

1. To carry on research designed to place stocking in its proper position as one of many possible methods of fish management.
2. To test various methods of stocking for the purpose of determining efficiencies and values received.
3. To maintain the effectiveness of the present policy and to alter it as available information makes it possible.

As Eschmeyer[3] has stated, "freshwater fisheries investigation has reached the point where it suggests that current practices in fish management are frequently of questionable value but has not yet gone far enough to indicate what changes and substitutions are desirable." The

[3]Loc. cit., p. 38.

acquisition of basic information leading to new methods of fish management is slow work. While it is being done, application of present knowledge must be continued; the fisherman shows no intention to hang up his rod while fish managers get the horse hitched up right and get a little head start.

From the angler's point of view no stocking or other management method is of any value until it is applied. To point research toward practical applications, knowledge of the waters to be managed is desirable; for actual application of methods, knowledge of the waters to be managed is essential.

FOREST SERVICE FISHERIES DEVELOPMENTS AND POLICIES IN THE SOUTHEASTERN UNITED STATES

ANCIL D. HOLLOWAY
U. S. Forest Service

Fisheries work is conducted under a cooperative agreement with the U. S. Bureau of Fisheries and, in most areas, with the various states.

The U. S. Bureau of Fisheries is charged with the responsibility of conducting the research necessary to determine the principles upon which fishery management will be based, and acts in an advisory capacity in carrying out technical management recommendations. Five trout rearing stations with a capacity of 200,000 six-inch fingerlings were constructed under the guidance of the Bureau of Fisheries. Except at small isolated holding-pools, all stations are operated by personnel engaged by the Bureau of Fisheries.

The cooperative agreements with the states are simple working agreements by which all construction activities such as game warden dwellings and stream improvements are accomplished by the Forest Service. The states furnish full-time game wardens. Administration of the fishing and hunting activities are the joint responsibilities of both parties, and financial income is divided equally between these organizations to be used only in further development of the areas under agreement.

It is recognized that no sound management of our fishery resources can occur unless they are based on scientific investigations. To this end the U. S. Bureau of Fisheries has two well-qualified investigators assigned to the region.

One, assigned to trout problems, is stationed on the Pisgah National Game Preserve near Asheville, North Carolina. This unit is used as an experimental area for testing wildlife management methods and conducting new investigations. Several miles of typical Southern Appalachian trout waters occur here which make it a particularly fine location for trout investigations.

Another investigator is stationed at the U. S. Bureau of Fisheries Experimental Station at Welaka, Florida, adjacent to the Ocala National Forest. About 17,000 acres of lake waters exist on this forest within the Ocala Cooperative Wildlife Management Area. Through cooperative arrangement with the State it is possible to close, open or regulate any given experimental lake as the investigator desires.

No fish are planted in any stream until temperature readings, bottom food counts and analyses of the amount of the stream made up of pools and riffles have been made, and silting and other factors have been considered. Plans for planting are made by the Fishery Technician of the Forest Service in cooperation with the U. S. Bureau of Fisheries investigators. These plans name the species, size, number of fish to be planted and give some general idea as to how they are to be distributed throughout the stream. Annual catches are regulated by the number of fishermen permitted or streams are closed for the year after a definite number are removed.

Such plans are made to guide the supervisor of each forest in making up the annual work plans by which the state and the Forest Service harvest the crop, replenish the stream with young fish and administer the fishing.

For those waters within National Forests but outside the Wildlife Management Areas, plans are generally available as to number, size and species to be planted. When it is impossible for the state to stock such waters, the Forest Service does it to the extent possible with the availability of funds, personnel, and fish. Cooperation is effected with the state to prevent duplication of stocking. It has been the policy to stock as many waters as possible outside the management areas to furnish sustenance to the local population with low incomes.

For the colder mountain waters, the native brook trout are given first consideration. If the water becomes too warm or is better suited to rainbow trout, this species is planted instead. Brown trout are being tested in a few streams to determine their possibilities. In small isolated mountain streams that do not feed into larger trout waters rock bass are being recommended in the hope that they will prove to be a good "meat species" for the local mountaineer, as well as a species that will give some utilization of these streams, without expensive annual planting, such as is necessary with trout.

In mountain streams too warm for trout, smallmouthed and Kentucky bass, as well as rock bass, are recommended. First consideration is always given to the species already present.

During the past few years several small recreational lakes have been established throughout the forests of the Southern Appalachians. For the most part bluegill bream and crappie are being planted in these. Planting of a very prolific breeder is needed to support the heavy fishing load. Generally, no attempt is made to regulate the catch except to conform with state regulations.

Annually, the Forest Service plants approximately 125,000 trout averaging 6 inches in length in the forest waters of the Southern Appalachians. The trout are distributed three to five at a place throughout the course of each stream planted.

In the Southern Appalachians, we feel that brook and rainbow trout cannot be mixed with successful results for the brook trout. This has been verified repeatedly on a large number of streams. Barriers such as waterfalls are used to divide brook trout areas from those inhabited by rainbow. Where natural barriers are not present, artificial ones 3½ to 4 feet in height are built.

The warm waters of the Southern States with the exception of those in the Piedmont Region were originally blessed with an abundance of bass, bream, catfish and other species.

The laxity of enforcement of game laws in far too many areas and the almost total absence of a reasonable limit on catch in others have reduced the game fish population to almost nothing.

In such forests it has been our policy first to develop cooperative agreements with the respective states in order to obtain warden protection and restricted limits on catches.

Before fish are planted, preliminary surveys are made in order that only those species best adapted to the particular waters will be liberated. Topographic maps of the lakes were made on which the vegetation was plotted. They were thence seined and examined at night to establish the need of stocking and to obtain a picture of the fish population present.

After the exact acreage and the comparative productivity of a lake are known, numbers of bass and bream are recommended accordingly.

In the comparatively small lakes of 75 acres or less which contain little vegetation, only bream and crappie are planted. Largemouthed bass are stocked in larger lakes where an abundance of forage fish occurs.

In the so-called intermittent streams of the Arkansas and Oklahoma forests, stream surveys, analyses of the fish population, and some life history studies have been made. It was established that the spotted bass was reproducing satisfactorily and that past plantings of largemouthed bass were giving unsatisfactory results. It will be our future policy to reserve the largemouthed bass for large streams and lakes.

In many waters it has been found that much money and a great amount of time have been expended in planting species from which no satisfactory results could have been expected. It has been our policy to prevent duplication of such proceedings.

In the last five years, fish management has become a major activity of the Forest Service in Region 8.

During 1934 the U. S. Bureau of Fisheries made preliminary stream surveys on streams in Georgia, North Carolina and South Carolina. Between 1936 and 1940 a continuation of these surveys with the resulting management plans has been a major activity of the Forest Service biologist.

Several hundred stream-improvement devices were installed in the trout streams of the Pisgah National Forest as experiments to see what could be accomplished in this respect. Other such improvement was done in Georgia, Tennessee and Arkansas. Except for a few of the first structures built, they have endured extreme flood waters without damage.

From 1936 to 1940 the trout waters of thirteen cooperative wildlife areas and two federal game preserves were developed and managed for trout fishing. Approximately 435 miles of trout waters over 15 feet in width with an additional thousand miles of feeder streams exist in these managed areas. Approximately 125,000 trout 5 to 8 inches in length are planted in these streams annually.

Many of the streams do not yet have their trout population built up to where they present optimum in fishing. In 1939, 6,410 fishermen removed approximately 38,000 trout. In 1940, approximately 90,000 trout will be available for removal. Fifteen thousand anglers will be permitted.

Records from certain managed areas where the catch is recorded indicate that approximately 25 per cent of the anglers get their daily limit of ten or twelve trout. The average catch per angler for most streams varies between four and nine fish.

In the streams of North Georgia and certain inaccessible streams in western North Carolina we have built up exceptionally fine trout populations, and as yet have insufficient anglers to harvest the crop. On the other hand, in the Tellico Cooperative Wildlife Management Area in Tennessee the fishing has increased from 400 man-day permits the first season (1936) to 2,358 during the 1939 season.

Perhaps the biggest and most important single accomplishment in our trout work has been the successful training of Forest Service personnel to transport and plant properly the products of our rearing stations. It is no small job to haul the small fish from the hatcheries to the rearing pools, to haul 125,000 large fingerling trout from the rearing pools to the streams and to distribute them, three to five in a place, throughout several hundred miles of rough mountain streams. In justice to the Civilian Conservation Corps enrolees it must be said that without their help the job would have been difficult to accomplish. Training schools in fish planting and transportation were given the Forest Service officials and game wardens at the beginning of our trout management program. For new employees, this is a part of their annual training. Although planting is only a small part of our annual program, a large part of our success can be attributed to the excellent condition and wide distribution of fish when planted.

The development of our warm waters parallels that of trout waters. During the past two years 144,000 largemouthed bass fingerlings and 290,000 bream and 12,500 crappie have been planted on the Florida forests. Stocking plans have been made for the four National Forest units in Alabama as well as those in Arkansas and Oklahoma.

WHAT ARE THE PROSPECTS FOR THE CONTINUATION OF SPORT FISHING IN TENNESSEE VALLEY AUTHORITY WATERS?[1]

A. H. WIEBE
Tennessee Valley Authority

There are certain matters pertaining to the TVA's reservoirs that should be made clear to this group. This is necessary because (1) of the interest that fisheries and wildlife workers have manifested in these waters, and (2) because of the size of these bodies of water. With respect to the interest just mentioned, we have heard of biological deserts. With respect to the extent of these flooded areas, it may be stated that in the near future these waters will at normal level cover one-half million acres, and eventually the Authority will have created in the neighborhood of 600,000 acres of water (less the area of the original channel).

One point that fisheries and wildlife workers should have clearly in mind is the fact that the Authority's reservoirs were built for certain primary purposes, and that the conservation and the multiplication of fishes and of wildlife species were not included in these primary objectives — flood control, navigation, hydroelectric power, and national defense. These are the primary purposes for which these reservoirs were built. Who in this audience would expect or hope that reservoirs of such magnitude would ever be built merely to further a fisheries and wildlife program? It would be wonderful if this were done, but such a thing has as yet not happened either in this or any other country.

A second point that fisheries and wildlife workers should keep in mind is the fact that although these reservoirs were not built to fur-

[1]Published by permission of the Tennessee Valley Authority.

ther a fisheries or wildlife program, they, nevertheless, make such a program possible. These waters provide an opportunity to increase the fishery and wildlife resources of the region. It is our duty, our problem, and our opportunity to determine what can be accomplished under these circumstances. Our task will be made much easier if we accept the fact that the primary purposes—flood control, navigation, power, and national defense—must receive first consideration.

Let us now examine very briefly how these primary purposes affect a fisheries program. I believe that most people would have no quarrel over the importance of flood control or national defense. Some people may be critical of the idea of water transportation, but many people seem to have the idea that the production of electric energy is peculiarly inimical to a fisheries program in the Tennessee Valley. For this reason, I would like to say at once that the power interest—I mean those responsible for the Authority's power program—are the best allies that the fisheries program in these reservoirs has.

The production of power is facilitated by high water levels and the constancy of these high levels, if stream flow permits, is no detriment to either the power or fisheries programs. Water transportation is likewise aided by constant high levels. It should be obvious from these statements that neither the production of power nor the use of the reservoirs for transportation are inherently detrimental to fish life. It is true that reservoir levels are lowered by the demand for power and for the purpose of facilitating navigation. These reductions in level as a rule are substantially less than those practiced in the interest of flood control or that would occur in the original river.

What would be the effect upon a fishery program if the Authority's reservoirs were used for flood control alone? There would be no such program. Flood waters would be dammed up temporarily, but would be released at the first opportunity. If the TVA followed this procedure, we would have no reservoirs in the Valley during the greater part of the year. No bodies of water that now afford year-round recreational opportunities of some sort or another to hundreds of thousands of people. The combination, however, of power production and navigation with a flood control program makes a fisheries and recreational program a definite possibility.

Now that these preliminary but most important statements have been made, permit me to revert to the title of my talk. This title refers specially to the continuation of sport fishing in the Authority's reservoirs. To answer this question I want to give you a couple of illustrations of the situation as it actually exists in the Tennessee Valley and I hope that you, in your own minds, will compare this situation with what may exist in a river or in a natural lake. Let us take first what may be considered an extreme situation—Norris Reservoir.

Norris Reservoir has an annual drawdown of 60 feet for flood control purposes. That is quite a wide fluctuation, and certain consequences that affect fish life result from this drawdown, namely, the production of fish in Norris Reservoir is not so great as it would be were there no such fluctuation. Why? Norris Reservoir has a maximum depth in excess of 200 feet. It is situated in a relatively narrow gorge of the Clinch and Powell Rivers. It is subject to thermal stratification. The hypolimnion is subject to oxygen depression. The drawdown makes impossible the existence of a zone of vegetation and the organisms usually associated with this zone of vegetation. As a consequence, what is generally known as the bottom fauna, a permanent bottom fauna, is restricted to those few species of animals that can exist in the stagnant hypolimnion. Of course these organisms may at times become very abundant and furnish considerable food. I am pointing out these things because this situation is a limited factor that has a major influence upon the production of fish food in Norris Reservoir. This situation has, however, existed ever since the reservoir was built.

Norris Reservoir is, in each successive year, virtually a new body of water. The 60 foot annual winter drawdown represents two-thirds of the volume of the reservoir below spillway level (incidentally this indicates that flood control is a reality). If the incoming water, the quality of which does not vary greatly from year to year, produced fish food and a suitable environment for game fish in 1937, why should it not do the same thing in 1945 or 1950?

The gizzard-shad is a dominant species of fish in the reservoir. I believe I am correctly informed that the gizzard-shad feeds on algae and organic debris to a large extent. At any rate this species is very abundant in Norris Reservoir. We have three species of black bass and two species of pike—walleye and sauger—in Norris Reservoir that feed on these gizzard-shad. Now the question in my mind is, why cannot this situation prevail indefinitely? I am not saying that it will, but one problem we within the Authority hope to settle is whether it is inevitably true that reservoirs are productive for some time and then cease to produce.

I have said that Norris Reservoir has a fluctuation of 60 feet and it may at times be more; it was more last year due to emergency conditions caused by drought. But during the growing season Norris Reservoir is for all intents and purposes a constant level pool. The reservoir is filled with the early spring rains, it is not permitted to fill before about the middle of March (flood control), but it is filled just as soon after that as the water flow permits and then it remains practically stable until the fall drawdown begins unless, of course, there may be a slow drawdown for power production during the summer, if that power is needed. But so far this has not been a common occurrence. Again I say, for all intents and purposes, during the growing season for fish, Norris is a constant level pool. And the reduction in level does not become serious until well after the growing season.

Studies by Dr. Eschmeyer (1940) have shown that so far pike and bass in Norris Reservoir grow more rapidly than they do in Michigan or Wisconsin—where they don't play with the level. The crappie (black) also is making excellent growth. Sunfish, on the other hand. grow very slowly because the insect life associated with the plant life is absent.

Now that is one situation, an extreme situation from the standpoint of fluctuation of water level. At the other end we have Guntersville Reservoir. The normal fluctuation of this reservoir is 2 feet, and the maximum drawdown in advance of flood is 4 feet. The reservoir covers 65,000 acres. Even during the first year of its existence it developed a fair crop of aquatic vegetation, even some rather useful aquatics. The fishing, of course, cannot be too good this year because here a relatively narrow river channel has suddenly been transformed into a reservoir of 65,000 acres, but it only has a maximum drawdown of 4 feet and that only in advance of a flood. Thus, Guntersville Reservoir has a fairly constant level except in the event of floods, it has many areas of relatively shallow water that should be very productive, and there is no reason why they should not continue to be so.

In between these two extremes we have a number of other reservoirs where the normal drawdown for power production, navigation, and flood control ranges from 3 feet in Wilson Reservoir to 10 feet in Chickamauga Reservoir. These figures include the drawdown in advance of flood. These fluctuations are greater than those in many natural lakes, but are less than those in the original rivers. (Hiwassee Reservoir is in the same class with Norris Reservoir.)

Another reason why we think that fishing can be good indefinitely is because we believe that the stabilization of water levels during the spawning season is of major importance. We find, for instance, that in Hales Bar, a reservoir which the Authority has recently taken over, fishing is reported to be bad but the bottom fauna is very rich. On checking the records, we find that the fluctuations during the spawning season in past years have been very extreme, and it is therefore easy to see why the fish population decreased. With the cooperation of the Authority's Water Control Board we have been able to control water levels during the spawning season with a marked degree of success. Where a single reservoir is operated this would be virtually impossible, but with a series of connected reservoirs of such sizes as those of the Authority this necessary stabilization can be accomplished without interfering with power production or navigation. The stabilization of water levels during spawning time makes it possible for many fish to be born—a matter of considerable importance to the fish population.

In addition to the chance of being born, the fishes must have an environment wherein they can exist. Conditions of existence in the Authority's reservoirs are rather favorable. Pollution is not an important problem, as the waters are relatively free from pollutants and, except in the deeper strata of Norris and Hiwassee, there is always an abundant supply of oxygen. In Norris and Hiwassee the situation will be complicated, because at times density currents do produce a stratum of stagnant water at from 25 to 50 feet below the surface.

The depths in sections of practically all of the Authority's reservoirs are such that stratification and bottom stagnation might occur. However, the volume of flow prevents these conditions in the main channel and the backwaters are kept mixed by wind actions.

The food supply is another important factor in determining the size of the fish population. With the exception of Norris and Hiwassee Reservoirs, and possibly sections of Wilson Reservoir, the depths of all reservoirs is such that a permanent bottom fauna can exist throughout the entire reservoir outside of the zone of the annual drawdown. (Even here quite an amount of food is produced during the time that these areas are flooded.) The plankton—the basic food supply—is more or less independent of bottom conditions and can thrive despite flunctuations.

Another question that comes up in connection with reservoirs is the exhaustion of the fertility of the bottom. I would venture the suggestion that in the case of such deep reservoirs as Norris and Hiwassee, taking into consideration the low rate of diffusion of ions, the effect of the fertility of the bottom upon the mass of water would be slight. In shallower waters this effect may be more significant. In any event, the loss of fertility of the bottom would to some extent be compensated for by the nutrient matter mixed with the silt content of the incoming water. I believe, moreover, that the character of the run-off from the watershed will, to a large extent, determine the fertility of a reservoir. The character of this run-off will not vary much from year to year. The character of this run-off will be determined by the fertility of the watershed. If soils are improved through the extensive use of fertilizers the character of the run-off may also be changed. This should result in the greater fertility of a reservoir that receives these waters.

In conclusion, I want to say that I have given you but a very crude idea of the conditions in the Tennessee Valley as they relate to sport fishing. For me to say today that sport fishing will always be good would be folly. Even natural lakes have not in all instances furnished good fishing, but I am convinced that there exists the possibility that continued sport fishing may be enjoyed. It is my personal opinion that if sport fishing deteriorates, it will not be because these reservoirs have served their primary purposes of flood control, navigation, power production, and national defense, but because the sport fishing has been abused and the rough fish have not been properly controlled. The cry "biological desert" will accomplish nothing. Sound regulations based on a thorough program of investigation should accomplish much. Let us as fisheries and wildlife workers and as sportsmen always remember that these bodies of water were not built to serve our purposes, but that with the proper intelligence they will serve us well.

A COORDINATED FISH MANAGEMENT PLAN FOR NORTH IDAHO

DAVID J. MACLAY
U. S. Forest Service

In past years considerable investigative work has been done on the inland waters of much of North America but there remains an immense section of the Northwest wherein the fishery is still virtually unexplored.

Northern Idaho, a part of this area, presents a fair cross-section of the mountainous and timbered portion of this region. The north end of the State or "Pan-handle" which adjoins the Canadian national boundary is drained by the Columbia River and the Snake, with their tributaries. Originally these large streams produced a variety of resident and anadromous fishes but with developments of mining and lumbering industries, pollution has eliminated the primitive faunal life of some of the streams and modified it in others, making them less productive. Logging operations have also contributed to rapid spring runoff and resultant stream bed disturbance of much of the mountainous country. The construction of dams has effectively blocked certain salmonoid species. To complete a picture of changes incompatible with trout life, forest fires have burned much of the headwaters of the Clearwater and Selway Rivers, which converge with the Snake River at Lewiston, Idaho. It was a common occurrence in the years of big forest fires to observe thousands of dead trout floating downstream after a drainage had burned. Other developments led to increased human occupancy and resultant increases in uncontrolled uses of fish from all sources.

Since little attention was given to the needs of conserving the trout in the accessible area, they became scarce and attempts were made to regain the losses by increased hatchery operations. The hatcheries of northern Idaho now produce a combined total of about fifteen million trout annually. The usual run of attempts to stock bass, perch, crappies, and other warm water fishes in trout waters and attempts to transplant forage fish into waters unsuited to them have resulted in a conglomerate population that has not promoted the welfare of the fishery. Certain restrictive measures have, however, been invoked—for example, the creel limit on trout for Idaho is twenty-five fish or fifteen pounds and one fish, but it is still legal to use spears to catch salmon in certain rivers. The use of salmon eggs as bait was outlawed last January, 1940.

With the establishment of a new Fish and Game Department last year and the selection of a staff of permanent personnel, great steps have been taken toward adequate fisheries management. Quite recently (1940), a program of inventory of the fish streams and lakes was begun with plans to use this inventory as a base from which to formulate management plans. Each agency having a part in production of fish or management of lands containing the fisheries resource has participated with the State Fish and Game Department in assuming some obligation in the program. Coupled with this is a public awareness that mere production of fish in the hatchery cannot completely solve the problems. The result has been a public demand that the management of trout waters be enlarged to include planning in accord with biologic laws.

Administrative units were set up by drainages and each large drainage was further divided to form logical smaller units which could be easily administered by field and hatchery men. Since the United States Forest Service has established administrative units which roughly coincide with these drainage areas, national forests were taken as those districts. In this manner the northern end of Idaho is divided into six units, namely, the Kaniksu, Coeur d'Alene, St. Joe, Clearwater, Nezperce and Selway-Lochsa. Each of these large units contains a number of districts which form integral parts of major drainages as shown below:

Unit	*No. of Districts*	*Drainages*	*Hatchery*
Kaniksu	6	Kootenay Clarks Fork Pack Moyie Priest	Sandpoint Clarksfork Gold Creek
Coeur d'Alene	4	Coeur d'Alene	Coeur d'Alene Shoshone County
St. Joe	7	St. Joe St. Maries Palouse	Coeur d'Alene Shoshone County
Clearwater	6	Clearwater	Boyd Creek
Nezperce	7	Lower Selway River	Boyd Creek Grangeville
Selway-Lochsa	8	Upper Selway and Lochsa River	Salmon City

It is recognized that at the present time there is insufficient money available to conduct adequate stream and lake surveys. The revenue accruing to the state game authority from all sources is insufficient to fill the needs of administration and with a tendency toward decreasing federal budgets, it is not likely that funds will become available soon to do extensive field work. Fisheries management plans for northern Idaho are, therefore, in the form of stop-gap devices based upon readily accessible facts. Four of the six units listed have been examined and management plans formulated. By May 1, 1940, it is hoped to have the rest completed. The following outline of the method is given to show what is being done.

The initial step in the development of the plan consists of correlation of the efforts of all interested agencies, namely, the State Department of Fisheries, U. S. Bureau of Fisheries, U. S. Forest Service and local conservation groups. Thus we have a common viewpoint in the approach to the problem with the State functioning as the spearhead. The next step consists of bringing together all available facts bearing on fish management in each district. All of the above agencies are, of course, drawn on freely. Thus is built the foundation of the plan without delaying action because of the lack of more detailed and scientific information. The following statement shows the factual material that is assembled:

1. The approximate width, depth, volume of flow and average temperature during the warm season.
2. The character of the stream bed, occurrence of pools, shade, natural cover and the altitude and gradient.
3. The relative abundance and kinds of fish food present, both of the obligatory aquatic and the terrestrial forms.
4. The relative abundance of game and forage fishes, their average size and condition. Observations to be made at this time regarding the efficiency of natural reproduction of the species.
5. The accessibility of the stream and the degree fished.

For lakes the following information should be available:

1. The area, the character of shore line, the altitude of the lake and the kind of bottom, whether rock, gravel or mud.
2. The relative abundance and kinds of food organisms present. incapable of carrying heavy fishing loads or are subject to excessive tions upon their bodily condition. Observations of the efficiency of natural reproduction as an aid in determining the need for stocking.
4. The accessibility of the waters and the actual recreation demand.

Streams have been classified as follows:[1]

1. Class A streams are those which produce an abundance of food,

[1]Fearnow, Theodore C. Five Year Work Plan for Stream Development, Allegheny National Forest, 1937.

have a year-around resident trout population and are capable of carrying a heavy fishing load. Their tributaries are included with the main streams.

2. Class B streams are those which may be similar to those of Class A but for some reason do not carry year around fish populations, are incapable of carrying heavy fishing loads or are subject to excessive high or low water periods. In this group also fall the streams whose beds have been disturbed by the practice of driving logs.

3. Class C streams are those potentially good trout producers, but which have become unfit because of pollution, complete diversion for long periods of time or other causes.

Lakes are grouped as shown below:

Class A lakes are those capable of withstanding heavy fishing loads with naturally produced stocks of fish.

Class B lakes are those which will provide fishing but by reason of their location, character of shores, bottom, or water supplies, are incapable of carrying heavy fishing loads without restocking with hatchery reared fish.

Class C lakes are those which are not adapted to trout production because of insufficient water supplies, preponderance of shallows without adequate oxygen reserves for winter use, and muddy bottoms, preventing successful natural reproduction of trout.

Class D—This fourth grouping of lakes is proposed in which are placed virgin lakes, that is, those without fish life. These lakes are generally remote, inaccessible and little known and, therefore, may be potentially good trout producers when stocked.

When the data is tabulated, each stream or lake is given a priority for restocking which is based upon its accessibility, proximity to large population centers and the resultant intensity of use by the fishing public and restocking programs arranged accordingly.

Other management needs are discovered when an analysis is mad in this way such as the need for restrictive measures to insure continued supplies of fish, the need for channel adjustments or improvement, the logical districting for supervision and hatchery output, etc.

No claim is made that this is an adequate plan. It merely represents an attempt to proceed in a logical manner. Some of the benefits which are being experienced by their use is that,

1. Emphasis is placed upon the need for scientific approach to the problems.

2. Restocking activities are usually curtailed and attention drawn to the need for creel limits and other management activities more in keeping with the ability of the water to produce fish. Duplication of effort is minimized.[2]

[2] Tentative Fish Distribution Plan for the Coeur d'Alene National Forest.

3. Designation of responsibilities in the work of administration and encouragement of research organizations to go ahead.

4. Coordination of all agencies which deal with the fisheries resource by inviting their participation in the formulation of management plans. This is being accomplished and is, we believe, justification in itself for the time expended.

A DISCUSSION OF FISH STOCKING POLICIES IN NATIONAL AND STATE PARKS OF THE SOUTHEASTERN STATES

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The stocking of fish, like any other technique of wildlife management, must be based on a working knowledge of the primary limiting features of the available environment and the basic requirements of the fish species employed if desired results are to be obtained. With this fundamental background it is also important that common sense and a reasonable degree of good judgment be exercised. Too often these simple fundamentals are absent from the thinking of those engaged in fish distribution and planting because of ignorance, emergency of the circumstances, or false optimism. The literature is full of records of unwise fish stocking, and one need not search far to find still others of the present day. In order to avoid serious errors and to insure success of the undertaking, it is necessary that carefully drawn policies of management and a properly executed stocking program be adhered to. In park waters, both national and state, it is also especially important that a natural aquatic fauna be preserved, and this feature must be given major consideration in planning a fish management program.

Fishing is an exceptional privilege in National Parks, inasmuch as game fishes are the only forms of wildlife which can be removed from their natural haunts. The degree to which fishing is to be developed or maintained artificially can be determined only on a basis of whether a sacrifice of the highest park and recreational values is involved. The preservation of natural conditions in wilderness areas is of greater concern than the insurance of a large catch of fish.

In the National Parks, the general policies governing fish stocking are well defined, and have been in force since April, 1936. These bear repetition in a discussion of this subject. "No introductions of exotic species of fish or other aquatic life shall be made in National Park or Monument waters now containing only native species." This fundamental rule aids in preventing unwise introduction of exotic aquatic life, which not only might threaten the welfare of native game fishes but might destroy other stream dwelling forms as well. "In waters where native and exotic species now exist, the native species shall be definitely encouraged." Exception is made "in waters where exotic species are best suited to the environment and have proven of higher value for fishing purposes than native species," in that "planting of exotics may be continued with the approval of the Director and of the Superintendent of the park in which such waters are located."

This policy permits a reasonable utilization of available waters when native species do not adequately fill the bill, and modification of the environment has been such that it is doubtful if native forms can be entirely restored. An excellent example of the workings of this policy is seen at Great Smoky Mountains National Park, where brook trout, smallmouthed bass and rainbow trout are the principal species dealt with. Native brook trout originally ranged from the small headwater streams as low as the upper limits of the smallmouthed bass (1,500 to 2,000 feet elevation), but now are rarely found on most of the larger streams below 3,000 feet elevation. Their present decreased range is traceable to the building of roads and railroads, logging of the forests, removal of bank cover, severe forest fires, dynamiting of the streams, and uncontrolled fishing. Introduction of rainbow into this region in the early 1900's and many times subsequently also contributed to the withdrawal of the brook or speckled trout to headwater streams and to tributaries isolated by waterfalls impassable to rainbow. The rainbow fills a place which otherwise would have been at least temporarily unoccupied by game fishes. It does not conflict in breeding habits nor hybridize with any local species, and fills the fishing needs of the Great Smoky Mountains admirably. No other exotic species of fish has been or should be planted in this part without careful study of the probable effects. Service policies further state, "In waters where the introduction of exotic species threatens extinction of native species in an entire National Park or Monument Area, such planting shall be discontinued and every effort made to restore the native species to its normal status." The rainbow has penetrated farther up some of the virgin streams than is desired, and efforts to discourage its further spread are in force. Carefully planned stocking and management is assisting in bringing the situation under control.

Guided by the above policies, a definite program of fish stocking has been followed at Great Smoky Mountains National Park, where the writer has been stationed. The restoration of brook trout in several streams where the species formerly existed but later was forced out has been accomplished. This has been brought about in certain streams even though a fairly good population of rainbow was present. Closing the stream to fishing for one or two years, accompanied by fairly heavy stocking with brook trout, has benefited the latter species. It must be admitted that in some instances the residual rainbow population also increased while the streams were closed. Neither species seems able to maintain fair numbers on the more heavily fished streams without aid by restocking. A continued drain on the rainbow places them at a disadvantage among the more numerous brook trout, provided the environment is well suited to both. The habitat of the brook trout is expanding with the return of streamside cover, and on several streams I have noticed the margin of brook trout occupancy from one-quarter to one-half mile farther downstream each year for the past three or four years. Some of the streams where brook trout appear to be firmly established are Indian Camp Creek, Eagle Rocks Branch, Little River above Fish Camp Prong in Tennessee; portions of Cataloochee Creek, Straight Fork, Bradley Fork, Indian Creek, and others in North Carolina.

Careful consideration is given to the sizes of trout which are stocked in the various streams at Great Smoky Mountains National Park. In primitive areas, on small streams, and in the least accessible waters it would be a mistake to attempt the planting of other than fingerling trout. The wilderness setting of such waters should not be diluted by offering the angler semi-wild fish. In the Great Smokies a plan of rotation has been evolved, whereby the small streams are opened in alternate years or one year in three. Stocking with 3- to 6-inch fingerlings is done the autumn following the open season, and in case of a three year rotation again the following autumn, giving a full year for acclimatization before the streams are again opened to fishing. In this way the finest in sport is offered those who prefer to do their fishing in more isolated and less artificial surroundings.

On the other hand, the writer is firmly convinced by evidence offered in creel census returns, reports of reliable anglers and personal observations, that in the more accessible and heavily fished streams the only way to maintain reasonably good fishing is to plant at least some of the increment as legal sized trout. This is true when the number of anglers is in excess of 100 per mile on a medium sized stream and during an open season of twelve to fourteen weeks. It is too much to expect that a stream the size of Little River in the Great Smokies will continue to produce more than 400 legal rainbow (8 inches and over) per mile annually, when only 4 to 6 inch fingerlings are stocked. Meanwhile the drain on the stream, expressed by more and more trout-hungry fishermen, is increasing. The only way to meet the situation seems to be to take some of the burden off nature's shoulders. Any planting of legal sized trout, especially in park waters, should be sufficiently in advance of the opening of the fishing season that the trout have at least some of the characteristics of wild fish. For rainbow this may be a matter of a few weeks, for brook trout it is longer. Too, the planting should be well distributed. Anticipated adoption of a staggered open season (May 15 to July 15, September 1 to 30) will facilitate this program.

A full utilization of rearing pool facilities is possible with such a stocking program as outlined above. Pools can be kept fairly near to capacity for almost the entire year. The increase beyond capacity can be planted in closed streams throughout the summer and autumn. The stocking of part of the crop as keeper-sized trout probably reduces the actual cost of the trout in the creel, considering the great loss of fingerlings which every fish manager expects. In this connection, it should be reasonable to expect recovery of at least three-quarters of the larger trout, while the smaller fingerlings which eventually reach the angler's creel certainly are under one-quarter of the number planted. It is considered more economical to save the fish making the most rapid growth until they reach the legal limit, planting first those which make the least favorable response to culture methods. The loss of trout because of floods is avoided to considerable degree by planting the largest fish in the largest streams in the spring or summer after the worst flood period is over. It is unquestionably a loss of fish, time, and money to stock undersized trout just prior to the start of an open season. The chance of catching larger fish is reduced and the stream population is thrown completely off balance at a critical time.

The subject of numbers in trout planting is a difficult one that can be satisfactorily determined only after data on the fish population already present, available food supply, and average desired catch are known. There is no question that overstocking results in a population of undersized fish which hinders progress in the development of good fishing. Experience in the field and familiarity with the water in question is still of paramount value in judging the numbers and sizes of trout to be stocked. An average of 500 to 1,000 fingerlings are stocked per mile in the Great Smokies, depending on the size of the stream, size of the fish available, and the extent of fishing which may be expected. Weights of all plantings have been recorded for the past three years. With species which move but little following planting, as the brook trout seem to do in the Great Smokies, it is possible to overstock small sections of stream, yet leave large distances understocked. Thorough and careful distribution is one of the keys to successful fish stocking.

My duties as wildlife technician in the National Park Service have enabled me to follow the development of many of the small artificial lakes, created for purposes of recreation, on eastern state parks and recreational areas. Fishing is almost always included as one of the justified forms of recreation to be developed. One of the most difficult features to control has been the stocking of the impounded waters with the proper species of fish. Frequently local groups and even representatives of the state conservation departments are eager to pour in the first bucket of fish, often at the moment the water starts to rise behind the dam. In a new lake of slightly under 70 acres on a state park of one of the Southern States, I learned a year ago that about 65,000 warm water fish, including bream, crappie, black bass, and catfish from backwater ponds had been stocked. Not content, park authorities had added several thousand rainbow trout. This is a regrettable situation when there is opportunity to do some constructive planning and stocking with an unspoiled body of water. Good fishing has rarely resulted from haphazard stocking. In fact, the results of poor management are more evident in a lake where the unfortunate creatures cannot escape than in a stream where those ill adjusted can seek a more suitable environment farther upstream or downstream.

Rarely have representative collections of original stream inhabitants such as minnows, crustacea, and aquatic insects been made prior to impounding a stream. Chemical analysis of the solids and gases contained in water entering through principal feeder streams, to be followed by a seasonal analysis of the impounded water, would provide data extremely valuable to the fish manager. Information on the nature of the underlying rocks and soils from many of these new lakes has been conspicuously absent. The National Park Service has not had the personnel, funds, nor equipment to conduct other than the most superficial research on these problems. Inasmuch as most of these areas are either state property or will become so, the task of research falls to the state or to interested educational institutions. The need for this basic information is well described by Senning (1938), who states:

"It should be emphasized that a satisfactory habitat for fish is not merely a body of water. Careful planning is necessary to insure the success of the new lake. If it is planned to stock a lake with one particular species, the ecological requirements of that species should be known. The extent to which the lake meets these requirements should be determined. Of the many factors which determine the success of fish plantings in a new lake, chemical conditions are of extreme importance."

Pickett Forest State Park, Tennessee, includes a small lake of 15 acres impounded about five years ago. It is cited as an example because it illustrates so well the failure of fish in an unknown environment, which is later found to be unsuited to them. Dr. Shoup of Vanderbilt University made a series of studies there in 1938 and '39. His description is well worth repeating here. "Pickett Lake lies at a relatively high altitude (1,800 feet) on the North Cumberland Plateau, imbedded entirely in the Pennsylvanian sandstone, and without access to soluble limestone. It is a winding narrow protected lake, well shaded by cliffs and vegetation, and has a maximum depth of approximately 15 feet. Little mixing occurs in the water of this lake, and a rather broad thermocline can be detected on plotting the vertical temperature distribution curve. Decomposing bottom vegetation markedly reduces the amount of dissolved oxygen in the stagnant water below the 8-foot level in nearly all portions of the lake, and the quantity of free-carbon dioxide becomes very high throughout the main body of water. Only very small quantities of alkaline substances (bicarbonates) are available for buffer action, and the pH range for this lake is from 5.4 in the deeper portions bearing high concentrations of carbonic acid, to near 7.0 for the aerated surface waters. The bottom fauna becomes extremely limited in Pickett Lake a few feet from the shore, with only occasional *Chironomus* larvae and the phantom larvae of *Corethra* remaining below the 8-foot level."

The lake at Pickett Forest Park was stocked with rainbow fingerlings (a reported 10,000) and a small number of adult rainbows by the State of Tennessee in the autumn of 1936. A few of the adults were recovered by poachers but the young rainbows disappeared without leaving their story. Had Dr. Shoup's studies been made soon after impoundment and before any fish were stocked, the loss of the rainbow could have been avoided and a beginning made in the establishment of the proper warm water species. Temperature records were the only bio-chemical data available and the deficiency of oxygen below the epilimnion was not suspected.

Most state conservation departments now pass on all applications for fish to be planted in private and state owned waters, and endeavor to supervise the actual stocking whenever possible. Not until this is 100 per cent effective will many of the present mistakes be prevented. I have in mind a small new lake in the Cumberlands where I was especially anxious to use smallmouth bass as the principal species. Technicians from the State Department of Conservation concerned agreed with me and a nice beginning was made in establishing the species. Imagine our disappointment to find that a group of local fishermen had seen fit to liberate several hundred adult largemouth bass and Kentucky bass, 500 Warmouth, and 2,000 bluegills into the lake without consulting any authority. Frequently the story is much worse. Care should be exercised in stocking new lakes that diseased fish are not liberated and the lake polluted for years to come. Fish from lowlands and backwater ponds, even though they be readily available, are not usually desirable specimens to plant in a new lake hundreds of miles inland.

In addition to selecting species which have at least a fair chance of surviving in a lake, and which promise not to make a nuisance of themselves, it would be well to consider the type of recreational use which is anticipated on and around the particular lake. There are numerous instances where a camp for teen age youngsters would have received immense benefits from their pool or lake, had such species as the lowly bullhead, crappie, and bluegill been stocked for their express use. An opportunity for providing real enjoyment and for teaching the fundamentals of conservation to youth has been overlooked in planning the management of water resources on many parks and recreational areas. Too frequently adults have preempted the use of the fish resources and by dictating the management policies, denied the younger generation the benefits which it also should receive.

There is need for further research on the matter of compatability of fish species. Caution should be a constant watchword in stocking fish, especially in new waters and where more than one species is involved. For instance, when the smallmouth bass is used in stocking new or unpopulated lakes, there is always the question of which species of food or game fish should be used with it as a companion species.

There is real need for careful research on food habits and preferences of fish, for certainly it is as important to know what a fish eats as it is to know what is available. A complete analysis of aquatic fauna in a given area of habitat still may not tell us what a bass or a rainbow would prefer for his evening meal. In studying the food habits and relative value of food plants for upland game, wildlife specialists are not content with a quadrat study of vegetation, even though it be statistically significant. The same should be true for fish.

The possibilities of growing and stocking natural fish foods has intrigued the fish specialist, but only a beginning has been made in this direction. In lakes the solution is not entirely unknown but in trout and bass streams the field is wide open. Stocking with keeper-sized fish has its limitations. We need to know how to feed fish naturally so they will grow bigger and better and so that more of them can live in the space available, if anglers' demands are to be met in the future.

In a word, proper stocking is one of the keystones in the structure of any fisheries management program. Without losing sight of the economic side, the worker who succeeds will adhere to the fundamental rule that an organism to prosper must live in an environment for which it is suited. There is still room for the exercise of common sense in stocking fish.

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FISH STOCKING IN THE NATIONAL FORESTS IN THE NORTH CENTRAL REGION AND THE COORDINATED PROGRAM IN MICHIGAN

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There is an increasing skepticism among biologists as to the value of fish stocking. Under certain conditions it has proved definitely harmful by aggravating over-crowding, by causing stunted fish populations and by disturbing the biological balance in a lake or stream.

Under certain other conditions—such as absence of natural spawning, extremely heavy fishing pressure, in barren artificial lakes, or in seasonal streams—stocking has proved valuable as a means of getting fish into the angler's creel.

Fisheries researchers are investigating the stocking problem and are beginning to provide the answers. As this new information becomes available we hope it may be applied to national forest waters. The purpose of this paper, however, is to describe the procedure being followed under *existing* conditions and in the *present state* of limited knowledge on the subject.

A number of groups are interested in fish planting in national forest lakes and streams, and there are four sources of the fry, fingerlings and yearlings used in stocking:

1. Hatcheries and rearing ponds of the State Conservation Department and the Bureau of Fisheries.
2. Forest Service rearing ponds.
3. Private rearing ponds (usually sportsmen's clubs).

Most of the state fish are planted by the state conservation officers. In recent years, however, the Forest Service has been able to assist, to a greater degree, in transporting and planting these fish with the use of CCC man-power.

Federal fish from the Bureau of Fisheries and from Forest Service rearing ponds are planted by the Forest Service.

Fish planting by private individuals and by sportsmen's clubs presents something of a problem although the number planted in this way is small. There are several disadvantages:

1. Such plantings are hard to correlate with the regular program.
2. The individuals are less experienced in handling fish.
3. They frequently have an axe to grind with the result that most of the fish go into waters where the individuals expect to fish during the season.

An important advantage of private planting is the interest aroused among the sportsmen participating and the feeling that they are helping in a worthwhile conservation undertaking.

There are still examples of over-lapping activities and duplication of effort in fish planting. As a hypothetical example, the case of Spring Creek in any national forest might be cited.

One day the Conservation Department fish truck drove up and the local conservation officer supervised the planting of some brook trout. A week later the Forest Service truck came along and some brown trout were planted. Then, on the following Sunday, the sportsmen's club planted some rainbows there. Later on in the summer, some individual got hold of a few smallmouth bass, so since trout fishing was poor, the bass went into the stream too. Possibly when a study was made of Spring Creek, it was found that only the headwaters were suitable for brook trout and only the lower portion for brown trout. Possibly, too, it might have been discovered that natural spawning was good and the fishing pressure so light that no stocking was necessary.

In general, the important waters in the states are classified as to the fish species suited to them. Stocking in national forest waters is done in accordance with the general classification and thus stocking of the wrong species is being eliminated. Duplication of effort, however, has not been entirely eliminated since two or three agencies might conceivably plant the same species in one stream. In order to provide for more complete coordination, a stocking program was worked out a year ago for the national forests in Michigan and has been in operation during the 1939 season. It was developed by the Conservation Department and the Forest Service with the cooperation of the Bureau of Fisheries. In brief, the plan is as follows:

Lists were prepared by the Forest Supervisors of all forest waters by name and by location—county, town, range, and section. Those waters which had been surveyed and mapped were indicated. The lists were then considered jointly with the State District Hatchery Superintendents and the approved stocking program drawn up. The waters to be stocked by each agency were designated, as well as the species to be used.

The informational basis for the program came from several sources: the lake and stream surveys, creel censuses, the pike lake - bass lake classification of the Conservation Department, information from local people, the personal experience of the field men and the intensive investigations of the Michigan Institute for Fisheries Research on certain waters.

Size and number of fish to be planted are adjusted by the field men according to current needs and the supply available. The record of fish planted is maintained by the agency doing the planting. At the end of each year, a report is made to the Conservation Department of all fish planted by the Forest Service.

Provision was made for keeping the program flexible as new and better information is secured. Already, several changes have been made as a result of new information. Also, some shifts may be expedient due to a transportation problem or some other situation in an unusual season. These adjustments are handled locally by the field men of the Conservation Department and the Forest Service.

This coordinated fish stocking program, as set up in Michigan, has greatly facilitated this work, since definite responsibility for stocking each of the waters has been assigned one agency or the other. It has harmonized policies, forestalled duplication of effort, eliminated stocking in certain questionable lakes, assured the stocking of each water with the species considered to be most suitable based on the best information available and has considerably reduced paper work and correspondence in connection with the job.

NATURAL PRODUCTIVITY OF FISH AND CRAYFISH IN RIFFLES

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Since the organization of the American Fisheries Society seventy years ago, we note a number of papers published in the annual Transactions dealing with the two major topics for discussion at this conference, "stocking policies" and "measurement of fish populations."

In the early days fish culturists were impressed with the importance of artificial propagation. Today biologists realize the value of natural propagation. For ten years Ohio tagged sample lots of fish farm fingerlings and Lake Erie breeder fish. Our best return from any release was 15 per cent from 5,000 adult channel catfish, planted back of two dams in the Scioto River. One dam was 65 feet high and the other 32 feet. These channel cat, irrespective of the barriers, moved downstream and within one year were caught by fishermen in an area 140 miles long. All our records for ten years show the same thing and certainly Ohio can be proud of the good looking and well conditioned fish she raised in fish ponds and wild breeders purchased from Lake Erie.

In the past, fish culturists devoted their time primarily to the propagation of game fish, but in recent years forage fish propagation has received more attention. Conservation departments are releasing these domestic fish in wild waters and the combination of a new fish in an occupied and a strange current environment may be the explanation of some of our poor results in the past.

To determine natural fluctuations and populations of riffle fish and crayfish (to our knowledge not influenced by stocking) we decided to deplete, at intervals, the riffle populations of fish and crayfish in a stream near Columbus. Over two years' work, September, 1937, to February, 1940, on the number and weight of potential forage fish and crayfish per acre of water in the riffles of Blacklick Creek, shows at times wide fluctuations and enormous populations of darters, minnows, crayfish and, at intervals, suckers. These forage animals, under the conditions mentioned below, reach their maximum abundance during the summer and fall, when young fish and young crayfish make up most of the population, although stable gravel riffles during the spring spawning season may show a large concentration of breeder rainbow darters. The smallest numbers were found during the winter months. Four riffles were selected: Station 3 represents headwater conditions, disconnected pools during the summer months, dry riffles and a drainage area of 12 square miles that is largely pasture land. Station 5 is in the center of the basin, with a drainage of 30 square miles, and is subject to serious erosion. Station 7, with a drainage of 55 square miles, is typical of the middle third of the stream and is the most productive of game fish, particularly smallmouth black bass and rock bass. Station 8 is within a mile and a half of the mouth, with a drainage of 61 square miles, and is the best crop land along the stream. The riffle area at each station ranged from 138 to 1,029 square feet. The lengths and widths were measured to the nearest inch and depths to one-eighth of an inch. A complete series of physical, chemical and biological determinations were made in this stream from May, 1936, to May, 1939. This was made possible by a WPA stream research project under the supervision of Lee Roach, Rendell Rhoades and John Pelton, at present Fish Management Agents for the Ohio Division of Conservation and Natural Resources, and the writer.

The present report is general in nature and represents a very small part of the entire project. In most places entire riffles were depleted, but due to numerous stream irregularities this could not always be done. We decided to use the same riffle each month, but Mother Nature, with her floods, droughts, ice action, erosion, etc., modified or changed our riffles from time to time. This stream rises rapidly, falls fast and clears in a short time. However, our records show a modified or new riffle will build up its population of fish and crayfish within one month. In fact, preliminary results indicate a new population may move in within 48 hours of the previous depletion. Each riffle was blocked at the head and the foot with one-eighth inch square mesh nets. These were held in place by stakes and stones. We removed the fish on the inside of the impounded area with two 6 or 8 foot, one-eighth inch square mesh nets fastened together. Four to eight workers were used to deplete each riffle, with one or two men pulling the seine, while the others assisted. All shuffled their feet on the bottom, turning over stones and catching fish in the net as the group worked in unison over the riffle. Preliminary work proved it was not possible to take all the fish and crayfish in two or three seine hauls over the same area, so we repeated our operations from eleven to nineteen times, the number of hauls depending upon when we reduced the catch to zero. Rotenone, electricity, diverting the riffle, or possibly some other method may prove to be easier, but the labor was available and our records show we took practically the entire population of fish and crayfish of the sizes taken in our nets. The lengths of the smallest darters are as follows: rainbow, 17 mm.; fantail, 17 mm.; Johnny, 21 mm.; green-side, 27 mm.; banded darter, 31 mm.

Fifty-two riffles were depleted. All fish were preserved in the field, weighed in the laboratory to one-tenth of a gram, measured to the nearest millimeter and sexed whenever possible. Fifty-three different kinds of fish, or one-third of the number recorded for the State, were found in the 30 miles of creek, and of this number 31 were identified from the riffles. Two species, rainbow and fantail darters, dominated the situation and were associated with each other on all riffles, although six other kinds of darters were found, including the Johnny, green-side, banded, orange-throat, black-side and variegated. The soldier darter made up 46.9 per cent and the fantail 41.5 per cent of the darter population. While the sexes of the two darters varied from month to month, adult male soldier darters made up 67.9 per cent of the adult population of this species and mature female fantails composed 54.5 per cent of the adults for this species. The two species comprised 88.4 per cent of the entire darter population. These interesting little fish rarely exceed 3 inches in length and during a large part of the year most species live on the bottom of the riffle under or between stones. The males of several kinds are brilliantly colored in winter and during the spring breeding season. At times bluntnose minnows, common shiners, stone rollers and hog suckers were important.

The figures given below are the calculated numbers, and weights in pounds, of fish and crayfish per acre of riffle.

Station 3—This rubble riffle could not be worked in the summer due to a lack of water, or such a small supply we could not seine it. However, in May, 1938, the production was at the rate of 19,800 adult rainbows per acre, with a weight of 23.6 pounds. The take of all darters was 32,340, and for all fish and crayfish 67,155, weighing 220.5 pounds.

Station 5—In May, 1938, we removed from this gravel riffle adult rainbow darters at the rate of 27,427 per acre. In May, 1939, it was 54,859 per acre, weighing 105.2 pounds. The fantail darter population was low, probably due to their habit of spawning under stones in pools, along shore in shallow water. The adult crayfish population was 65,335, weighing 651.8 pounds. The total fish and crayfish numbered 127,856 per acre, weighing 789.36 pounds, or at the rate of three fish and craws per square foot.

Station 7—In August, 1938, this rubble riffle produced at the rate of 40,414 fantails and 24,684 rainbows per acre. The total darter population was 67,035 with a weight of only 44.08 pounds. The total fish population was 102,850. Add to this 89,056 craws weighing 272.8 pounds it gives us a grand total production of 191,906 per acre, weighing 346.28 pounds. This is over four fish and craws per square foot of rubble. To show how rapidly fish and crayfish move into a new area, we depleted a riffle in June, 1938, that had previously been dry up to two days before we depleted it. Our records show the presence of darters, minnows and crayfish at the rate of 46,927 per acre. In September, 1937, we depleted a riffle of 26,341 darters per acre. Two days later the same area was again depleted and we took darters at the rate of 11,924 per acre, weighing 14.24 pounds. The first depletion produced 8,417 crayfish per acre and two days later we took 6,070. This indicates that within two days the darter population was 45.3 per cent of the original crop and crayfish 72.1 per cent. In August, 1938, two weeks after one of our highest floods, we were surprised by taking 67,034 darters and 89,056 crayfish per acre. The total number of fish and crayfish was 191,906, weighing 346.28 pounds, or over four per square foot. Station 7, where these collections were made, is modified more by floods than any other part of the stream. Our maps and pictures of this area over a period of four years show this beyond a doubt.

Station 8—This sand and gravel riffle near the mouth of the stream was the least productive of the four stations. The greatest production of rainbows was in August, 1938, when we took 11,491, weighing 13.2 pounds. The production of crayfish was 6,250, weighing 26.9 pounds. The total production of fish and craws was 31,516, weighing 64.63 pounds. Three different riffles at this station all yielded maximum populations of fish and crayfish during this month.

The lowest production of fish and crayfish, at all four stations, was during the winter months. At Station 5 in December, 1937, the fish population consisted entirely of darters and these totaled only 384. This same month at Station 7 the fish numbered only 2,634, weighing 17.9 pounds. At Station 8, December, 1938, there were 1,016 fish weighing 4.34 pounds, and no crayfish. In February, 1940, the total fish population ranged from 722 to 4,064, and crayfish from 310 to 4,284 per acre.

The results indicate wide fluctuations in populations. They seem to show an abundance of native potential fish food on riffles, particularly in the spring, summer and fall, in the form of darters, minnows and crayfish. The populations vary from year to year, season to season and month to month. In fact, the above data shows two days may materially influence these populations. The work indicates if living conditions are suitable riffles tend to build up rather rapidly their native fish and crayfish populations. This build-up seems to take place along with such conditions as high floods, unusually long droughts, heavy ice action and continuous erosion. The results tend to help us to understand why the introduction of more fish farm fingerlings and Lake Erie breeders in our streams may not always produce the desired results.

PREDATOR CONTROL IN RELATION TO FISH MANAGEMENT IN ALASKA

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This contribution to the theory and practice of wildlife management is neither the crusading outburst of an ultra-preservationist nor the demand of an economic royalist that all which stands in the way of his dollar profits shall be wiped from the earth.

Predator control seems always destined to bring conflicting wildlife interests into clash. Administrative decision should therefore rest on a full understanding of all points of view, and on all facts which can be determined by impartial and penetrating research.

The destruction of fish predators in Alaska constitutes a special problem, in that the control is conducted exclusively for the benefit of a commercial fishery, rather than of sportsmen. In fact, the chief conflict has been between those who fish for gold and those who fish for sport.

It should be held prominently in mind that the salmon fisheries have long been of prime importance in the economic exploitation of the Territory, providing the citizens of the United States with an annual profit of about 600 per cent on the original investment of $7,200,000 (the purchase price of Alaska). For years approximately 50 to 85 per cent of the Territorial taxes have been drawn from the commercial fisheries. Unless the food-fish supply is maintained, Alaska will fall at least temporarily in financial and social collapse. If therefore the continuity of a profitable fishery is to any considerable extent dependent on the elimination of the natural enemies of salmon, predator control in Alaska assumes the role of a dominant economic necessity.

If, on the other hand, the control of predators has no large effect on the continuity of the golden runs of fish, waste of effort or worse may be perpetrated. More than lost effort may be involved, because many thousands of dollars are being spent in predator control. To cite the largest item, for some years $25,000 annually has been the approximate amount expended on bounties for trout tails, and at least one man has been employed full time to kill trout. Furthermore, either actual or potential game-fish resources (of unestimated value to the Territory) are being destroyed.

Of other animals on which a bounty is being paid, the hair-seal is assuming some economic importance, particularly to the natives, and the bald eagle is a real economic asset from the standpoint of tourist interest. And these thoughts of dollar values should never be allowed to wholly exclude from our minds the interests and desires of those who would preserve our wildlife for enjoyment or research.

In other respects predator control in Alaska involves distinct problems. The natives (and some who are concerned with native welfare) are coming to regard the right to kill and to collect bounties as a vested right, and are calling for an extension of the bounty to other animals, for instance gulls and bears, which feed on salmon. A real danger is involved, for the natives constitute about one-half of the population, have the franchise and exert a powerful political pressure (along with the special privileges they claim and receive as natives). Fortunately the wildlife regulations in the Territory are much more subject to federal control, by congressional and departmental action, than in the states.

In bringing to light what may well be interpreted as abuses in the bounty system and in hired killing, and the wholesale destruction and waste of valuable food and game fish, and the killing of eagles and seals and terns and other animals (which many thousands wish to have preserved), I am not condemning the individuals, in the fishery industry or in the government service, who have been responsible for predator control in Alaska; nor do I attack any branch of the government service. With few exceptions, the destruction of salmon enemies has been allowed, financed and prosecuted in the honest belief that the prosperity of the great salmon industry and hence of the Territory demanded such action.

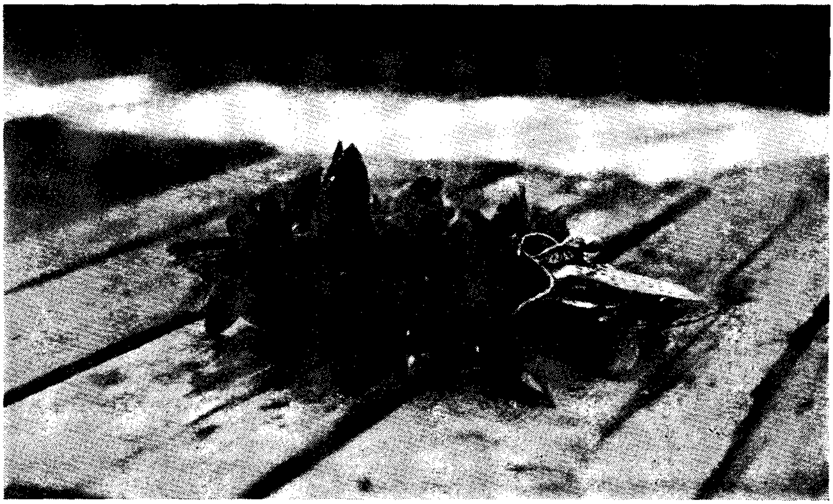

Fig. 1. Trout tails prepared for barter at the trading post on Iliamna Lake, Alaska: 38 large rainbow and 2 Dolly Varden tails, representing $1.00 bounty at 2½ cents per tail. August 2, 1939.

Fig. 2. Native woman on Newhalen River, Alaska, illegally cutting tails from giant rainbow trout for bounty, and discarding the fish. August 2, 1939.

We all appreciate of course that it is human nature to blame others, and that in the wildlife field this tendency often causes us to attribute to predators the depletion of the "favored species" which man destroys for his own use or pleasure. The commercial fishing interests and the government agents charged with the protection of those interests have naturally come to the conclusion that the salmon enemies consume millions of salmon that otherwise might find their way into cans.

No evidence has been secured, however, to indicate that any really adequate investigation has ever been made to determine either the biological or the economic consequences of the control of any predator along the Alaskan coasts. First business principles would seem to have called long ago for such stock-taking of administrative practices. (Occasionally a critical voice has been raised, for instance by Baltzer Peterson, president of the Red Salmon Canning Co., in regard to the appropriations by the canning industry for dolly varden control.)

A common argument for the control of salmon predators is based on the large number of loose eggs which are eaten by certain animals. Knowledge of the normal spawning habit of the salmonoid fishes, however, makes it seem extremely improbable that such loss is in general of any material significance. There is little chance that any eggs not buried in the gravel will hatch. If a dolly varden trout or sculpin does not eat a loose egg, a gull, fish duck, crab, or starfish probably will. Furthermore, most loose eggs would probably become fungoused.

In all investigations of predators, consideration should be given to the desirability of control through employees of the Fish and Wildlife Service rather than through the bounty system or through men appointed by the canning companies. Federal control procedures would make it more probable that only the designated species are destroyed, and only to a reasonable extent, and only in the areas where actual harm is being done. Under such practice, the right to kill for bounties would not come to be regarded by the natives as a vested right.

It would seem that all of the air and land predators upon salmon are of relatively little significance in controlling the numbers of these fish. It is extremely doubtful that any or all of these predators are as harmful as the dolly varden trout.

The bounty on trout was inaugurated by Dennis Winn, when working jointly for the Bureau of Fisheries and the salmon packers. Mr. Winn's hatchery experience, and his field observations in the Bristol Bay region, led him to believe that more salmon could be brought to maturity through the killing of the dolly varden trout than by the operation of fish hatcheries. Dr. Willis H. Rich recounts that he and Mr. Winn caught about 100 dolly varden trout in Lake Alegnagik at the mouth of the inlet from Lake Nerka, and of these, all or almost all

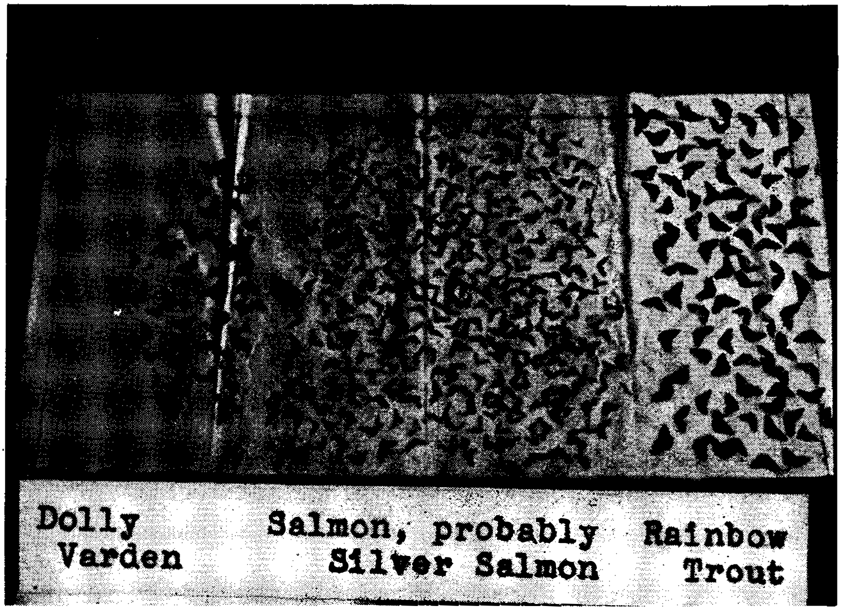

Fig. 3. One of 40 sets of 500 trout tails delivered by one person to the Bureau of Fisheries office in Yakutat, Alaska, for bounty payment at 2½ cents each. There are represented 94 rainbow trout, 51 Dolly Vardens (the only species on which the bounty could legally be paid), and 355 young salmon. August 14, 1939.

Fig. 4. A one-day destruction of 495 Dolly Varden trout, caught with single hook and line by Henry Loof (employed by salmon packers for the destruction of salmon predators), on a stream in the Olga Bay district of Kodiak Island, in July, 1939.

were filled with migrating red salmon fingerlings. Winn induced the cannery companies to raise $10,000 a year for trout bounties, which he administered (as indicated in several privately published annual reports). At first the bounty was 5 cents per fish, but this sum was later reduced to 5 cents for large fish and 3 cents for small ones, and is now fixed at 2½ cents per tail regardless of size.

One of the outstanding dangers of the Dolly Varden control, as already mentioned, is that the sale of the dried tails, or their use in place of money in the trading posts, is coming to be regarded as a vested right essential to the welfare of the natives.

Another very real danger is that rainbow trout tails and even salmon tails have often been offered and accepted for bounty. Striking instances of such unlawful sale of tails, from fish other than Dolly Vardens, were observed in the field investigations of 1939 (see figures). Testimony from various sources provides convincing indication that such abuses were not isolated instances. As the Dolly Vardens have been reduced in numbers in the Bristol Bay region, the natives have turned their attention to the giant rainbows of the Newhalen and Naknek Rivers, which are regarded by experienced anglers as among the largest and finest in all the world. Are they not worth much more to the Territory than 2½ cents each?

At several places in Alaska, evidence was obtained that young salmon have been extensively netted for the Dolly Varden bounty. This abuse seems to have been prevalent about Lake Iliamna and particularly near Yakutat. In the Bureau of Fisheries office at Yakutat samples were examined of 20,000 trout tails, made up in lots of 500 each. Rainbow trout tails, easily identifiable by the dark spots and the shape, outnumbered the Dolly Varden tails, but both species of trout were greatly outnumbered by the widely-forked tails of young salmon, presumably silver salmon. When sorted and identified, one representative set was found to contain 94 rainbow trout, 51 Dolly Vardens, and 355 salmon. By proportion this would indicate that the 20,000 tails, presented by one person in one season for bounty payment of 2½ cents per tail, comprised 3,760 rainbows, only 2,040 Dolly Vardens (alone legal for bounty) and 14,200 salmon.[1]

The potential destruction of Dolly Varden trout by paid employees is illustrated by the work of Henry Loof, a former employee of the Bureau of Fisheries, who for some time has been engaged by the salmon packers to destroy salmon predators and otherwise to improve the salmon run on Kodiak Island. On August 3, 1939, Mr. Loof testified that he alone had destroyed 1,500,000 trout, and that he had caught as many as 45,000 in one month by single hook and salmon

[1]It is understood that following the investigation, no bounty was paid on these 20,000 tails.

eggs. In just two hours on July 28, Mr. Loof and his 8-year-old son had caught an even 1,000 trout by this method, in one hole, which on two previous days had yielded 515 and 495 fish (the latter catch is shown in Fig. 4).

Neither the biological consequences of Dolly Varden trout control nor the economic significance have as yet received any adequate inquiry. It certainly needs to be determined whether the $25,000 a year appropriated alternately by the Territory and the canning interests brings back more than $25,000 worth of salmon a year. It would seem probable that this benefit is obtained, at least locally, but there is yet no positive assurance that this is so. The biological consequences of the depletion of Dolly Vardens are not simple to determine. It is known, for example, that the Dolly Varden trout consumes the fresh-water sculpin (*Cottus*) which in turn feeds on the eggs and young of salmon. In Karluk Lake in Kodiak Island, the sticklebacks swarm and compete with the salmon for food, and the Dolly Varden trout are about the only control on the sticklebacks. Investigations of the present summer by Allan DeLacy in the Karluk River drainage have shown that the control of the Dolly Varden trout there may have had little significance, because only the distinct, sea-run race has been decimated, and the land-locked form which may have been doing the damage has not been controlled at all. In Wood River near the outlet of Lake Alegnagik, the Bureau of Fisheries party this summer found that almost all of the migrating red salmon were seriously parasitized by a round worm (perhaps the same one that has been causing trouble in the salmon pack), and it is entirely possible that the extensive control of Dolly Varden trout here has been a factor in the increase of parasitization of salmon. The probability is that the Dolly Varden control has been beneficial to the salmon run in the Bristol Bay area, and perhaps in some of the localities, but the question can not be regarded as thoroughly established until an extensive investigation has been made at several localities.

Many leading sportsmen disagree with the widespread claim that Dolly Vardens are unfit as game or food. The wholesale destruction of these fish through bounties and paid agents of destruction has therefore been decried, most dramatically perhaps by Corey Ford and Alastair MacBain. The kill of giant rainbow trout is even more bitterly assailed by anglers. And of course no one would condone the payment of bounty on the tails of young salmon.

The one-dollar Territorial bounty on the bald eagle has never been justified by any thorough research. This bounty has been continued because of the claims that the eagles are very destructive to young game mammals, to fox on fox islands, and to salmon. All of these claims need to be investigated. The consensus of opinion in the Territory seems to favor a continuation of the bounty, but this attitude may be in part the result of the feeling that the eagle bounty is now a vested right. Naturalists, as a whole, think that the bounty is nonsense and very undesirable. The only investigation of any consequence is one that was recently made in the Aleutian Islands by Olaus Murie of the Biological Survey. His conclusion, for that region, is that there are no biological justifications whatever for the eagle bounty.

It is commonly held, of course, that the eagle is "no good, anyway," but this point of view totally neglects the interests and rights of bird lovers and naturalists, and also the very high value of the bald eagle as a tourist attraction along the steamer routes. Passengers will be seen to scurry to the rail and show great interest when a cry of "Eagle!" goes up. The fact that the Alaska bald eagle is the largest of its group and that the eagle is on our national emblem are points worthy of consideration in movements for its protection.

It is doubtful that the Alaska legislature will remove the bounty on eagles. Appropriations will continue and about the only saving point is that the appropriations are insufficient and usually run out long before the end of the biennium. Federal legislation to supersede that of the Territory will be very desirable, but should be accompanied, or perhaps preceded, by a thorough investigation of the status of the eagle in Southeastern Alaska.[2]

From the natural history standpoint, one argument against the bounty control is that it might lead to the shooting of the magnificent Steller sea eagle, which is of such extremely rare occurrence in Alaska that the destruction of only a few birds might lead to its elimination from the bird list of the continent.

Despite present protection, there is some killing of gulls on the charge that they are salmon predators, and there is a very general feeling in Alaska that the wholesale slaughter of gulls should be encouraged. About the only contrary view comes from the vicinity of the canneries, where the stench would become even more obnoxious if it were not for the scavenger help of the gulls. Claims are general that the gulls eat salmon eggs. As a whole, these eggs are the loose ones which are doomed to loss in any event; but several men recite observations of the gulls treading on the sand bars to mush up the sand and release eggs which are hidden. One observer even mentioned shooting one such gull and finding eyed salmon eggs in its stomach. The charges are also general and are made by naturalists as well as laymen that the gulls pick out the eyes of salmon while swimming over shallow riffles. However, the salmon so attacked are usually humpbacks or, perhaps even more commonly, dog salmon, and these are the

[2]Since the paper was read, Congress has passed an Act to preserve the eagle—except in Alaska, which was the only place where the protection seems vitally needed.

less desired species. Unless both eyes were picked out, the salmon probably spawn anyway. Naturalists, who have observed and speak of the destruction of salmon by gulls, claim that it amounts to only a drop in the bucket. Clearly, this is a matter that requires careful study and it is reprehensible that the Bureau of Fisheries has never conducted such an inquiry.

In some parts of Alaska, perhaps particularly in the Bristol Bay region, a considerable number of young salmon are consumed by terns. If my own observations are indicative, only very small salmon are taken and these are probably of the least desired species (dog salmon). Years ago, tern control was rather vigorously carried on. Published statements on salmon management recounted cases in which all of the eggs of whole tern rookeries were tramped out of existence. It was once customary for the Bureau of Fisheries to buy ammunition for distribution and for employees' use in the killing of terns and gulls, but this practice is said to have been brought to a close (partly because of the general claim that much of the ammunition, both that distributed and that retained in the Bureau, was largely used in the hunting of ducks and geese, in and out of season).

One of the dangers of controlling the terns, pointed out by Olaus Murie, is that the extremely rare Aleutian tern might be rendered extinct through the wholesale slaughter of terns, because the ordinary layman or official would probably not distinguish the species.

It is claimed that the Audubon Society brought pressure to bear on the matter and that the destruction of terns is now at a minimum.

Some think that the bears destroy more salmon in Alaska than do any of the birds, but most intelligent observers do not regard the kill of salmon by bear as of any material significance. It is a common observation that both the brown bear and the black bear do most of their feeding in the salmon streams during the height of the salmon run, and it is of course known that the older bears are quite adept at catching the live salmon (the younger bears are usually less skilled and more customarily eat the dead salmon). However, there is no reason to suppose that any really significant percentage of the salmon in any locality is destroyed by the bears. Consequently no bear control can seemingly be justified on the basis of the depletion of salmon. The matter should be thoroughly studied by some scientist in the Fisheries Service, working in conjunction with a member of the field staff of the Alaska Game Commission.

The control of salmon predators in Alaska may be of vital significance in the maintenance of the chief industry of the Territory, or may be wasteful and unnecessary. The value of some predators as fur, food, game, territorial economy and recreation may more than balance any harm they may do in destroying salmon. For each species and each region it remains to be determined, by sound research, to what degree the kill of salmon predators is justified. It hardly needs be pointed out that abuses which have grown up with the bounty system need be rigidly avoided.[3]

THE FORAGE RATIO AND ITS USE IN DETERMINING THE FOOD GRADE OF STREAMS

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A large amount of valuable information has been obtained concerning the feeding habits of fishes by examination of stomach contents. The value of such data would be greatly increased if it were accompanied by information concerning the kinds and relative numbers of food organisms present in the environment from which the fish were taken. The kind and amount of food eaten by a fish is a result of interactions between the fish and its environment, and in order to understand this result we should study both units of the interaction.

During October, 1939, the writers carried on an investigation in a small section of Cascadilla Creek in front of the Cornell fish hatchery. During this period ninety black-nose dace (*Rhinichthys atratulus atratulus*) were collected from the stream and a study was made of their stomach contents. These fish averaged 37.3 millimeters in length, with a standard error of 0.8. During the same period, ten random samples were taken of the bottom organisms in the same section of stream. These samples were taken with the circular square-foot sampler.* The data obtained in this study are summarized in the accompanying table.

From this study it is concluded that, for this species at least, the kinds and relative numbers of organisms found in the stomachs of fishes do not necessarily represent the kinds and relative numbers present in the habitats from which the fish were taken. The term "forage ratio" is proposed for the ratio of the percentage which a given kind of organisms makes up of the total stomach contents to the percentage which this same organism makes up of the total population of food organisms in the fish's environment. These percentages may be calculated from numbers, volume, or weight. For convenience, numbers have been used in this paper, but the use of weight or volume is probably preferable. From the data, numerical forage ratios have

[3]It is understood that appropriate administrative action has recently been taken to avoid such abuses.

*This sampler was described by the senior author at the meetings of the Limnological Society of America, at Richmond, Virginia, in December, 1938.

been calculated for the black-nose dace and are included in the table. No correction has been made for differences in rates of digestion (Hess, 1939), since the necessary data are not available.

Where a group of organisms has a forage ratio significantly different from one, it should be the result of either a difference in availability or a difference in preference. Available food organisms are here defined as organisms which are capable of being eaten by the fish if he so desires. This would exclude organisms which are inaccessible, too large for ingestion, too fast to catch, etc. The word preference should only be used to refer to a definite exercising of choice by the fish. A measure of preference for a particular kind of food organism may be obtained by dividing the relative number eaten by the relative number available (Hess, 1939).

A study of the data presented in the accompanying table would seem to indicate that the differences in forage ratios are due to availability rather than to preference. A large percentage of the Trichoptera were of the genus *Helicopsyche* and none of these was eaten, the size of case probably making ingestion impossible. Few *Hydropsyche* were eaten, probably because of their secretive habits. Many of the Plecoptera were large species, such as *Neophasgonophora capitata,* which these small fish could not ingest, and many of the species which were small enough to be eaten hide under the rocks where they are inaccessible. Most of the Coleoptera were *Psephenus herricki,* none of which was found in the fishes' stomachs. This species is probably made unavailable at this time of the year both because of its size and its habit of living closely appressed to the rock surfaces. Most of the Diptera were of the family Chironomidae. The fact that they are small enough to be easily ingested and live in the algae on the rock surfaces where they are quite accessible probably explains their high forage ratio. Where a detailed study is being made of the feeding habits of a species of fish, it would be advisable to determine the forage ratio for each species of food organism, since one or two species in an

TABLE 1. FORAGE RATIO DATA FOR *RHINICHTHYS ATRATULUS ATRATULUS*

	In the Stream			In Stomach			
Organisms	Mean Density Per Sq. Foot	Mean Per Cent of Total	Standard Error of Mean	Mean Per Cent of Total	Standard Error of Mean	Forage Ratios	Food Grade Values
Coleoptera	62.7	16.2	7.86	1.34	0.93	.08	5.0
Diptera	107.6	27.7	12 6	75.0	12.3	2.7	107.6
Ephemeroptera	26.6	6.86	3.11	6.77	0.71	.99	26.3
Plecoptera	43.2	11.1	6.88	1.34	1.28	.12	5.2
Trichoptera	126.9	32.7	14.5	15.5	5.27	.47	59.6
Others	21.0	5.42	2.87	0		0	0
Totals	388.0	99.98	42		Effective Food Grade = 203.7		

Coefficient of Variability of Mean Total = 12.4 per cent

order may be valuable food organisms even though other species are not. It should also be pointed out that a particular species may be of no value as a food organism in one stage in its life history, but will be eaten in large numbers in another stage. An example of this is the eating of emerging caddisfly pupae by trout.

Heretofore the food grades of streams have been determined from the total number of organisms, disregarding their relative values as food organisms. The following method is here proposed for determining the food grade of streams:

> Only those organisms which make up 1 per cent or more of the fish's diet will be considered as food organisms. Sufficient numbers of both bottom samples and fishes' stomachs shall be taken to keep the standard error within 10 per cent of the mean. Those organisms which have a forage ratio of one or more will be given their full sampling value, but those having a forage ratio of less than one will be given a value equal to the forage ratio times the mean number or amount per sample. The total number or amount of organisms resulting from these calculations will constitute a measure of the food grade of the stream in terms of the species of fish for which the forage ratios were determined. It is suggested that food grades determined by this method be termed "effective food grades" since they designate the effective density of food organisms.

The numerical food grade for the section of Cascadilla investigated in terms of *R. atratulus atratulus* would thus be 204, though the mean density of organisms per square foot was 388. Such food grades will, of course, vary with the seasons, with the species and age-group of the fish being studied, and with the composition of the population of food organisms.

For use in developing stocking policies, the food grades might be given group classifications, such as poor, medium, and rich, but it is not proposed to designate the limits of such classes nor their value in determining stocking policies without further research.

Thanks are due to Professor Mottley for advice and criticism during the course of this investigation and Laboratory of Limnology and Fisheries, Cornell University, Ithaca, New York.

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SOME FACTORS OF IMPORTANCE IN A STOCKING POLICY FOR TROUT AND SALMON LAKES

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Less significant progress has been made in formulating stocking policies for trout and salmon lakes than in the case of trout streams. The causes for this difference seem to be that the physical nature of lakes makes it the more difficult to obtain reliable information on densities of fish populations, and that lake habitats are generally the more diversified and subject to more drastic seasonal variations in those environmental factors which affect trout and salmon. Methods of stream census are available to the extent that fairly accurate data on trout populations can be obtained. The methods available for a lake census include: population estimates from netting; counts subsequent to poisoning, winter-kill, etc.; and population estimates based on tagging and recoveries. None of these methods pertaining to lake fishes appears to offer the degree of accuracy plus the ease of prosecution necessary for their general application; this is especially true since a census on a given body of water should be made every few years in order to keep up with the ever changing status of game fish populations. The diversity and seasonal variations in environmental factors among the various lakes are largely the result of the variations in depth and fertility and the consequent variations in vertical stratification of temperature and oxygen and other chemical factors. The vertical and seasonal distributions of food organisms (plankton, bottom organisms, and forage fishes) add to the diversity of lake habitats as a whole.

A general knowledge of the suitability of a given lake for trout can be obtained by the currently popular method of conducting superficial surveys; but it is also true that no great degree of refinement in stocking recommendations can be realized from such studies. During the course of lake surveys in Maine the present writer has found himself in that rather uncomfortable position where it was necessary to recommend a stocking policy for a group of trout lakes on the basis of a rather superficial survey.

The principal factors which determine whether or not a lake will support trout or salmon (or other cold-water fishes) are temperature and chemistry of the water, and food supply. The availability of cold water during the warm summer months is a function of water depth and the amount of oxygen in the deep cold water. The amount of such oxygen is generally inversely proportional to the amount of organic decomposition, and consequently the best trout and salmon lakes, from the standpoint of water supply, are inherently the poorest in biological productivity. Other factors which contribute to the maintenance of a large population of trout or lake salmon are spawning facilities, fishing intensity, and amount of stocking. The above factors are all recognized by Davis (1938) in his stocking policy for trout lakes, and were also used as a basis for a similar stocking policy for trout and salmon lakes in southern Maine by the present writer (Cooper, 1939).

During the lake surveys in southern Maine it has been observed by the writer that these lakes do not support the expected number of stocked trout (*Salvelinus f. fontinalis*) and salmon (*Salmo sebago*) if warm-water game fishes are abundant and even though all other conditions are apparently favorable. Local residents have invariably reported that the decline of trout and salmon populations in these various lakes, in spite of continued stocking, has been coincident with the introduction and increase in abundance of the various warm-water game species. Similar circumstantial evidence that these competitors eliminate trout and salmon is obtained by numerous comparisons of closely adjacent and similar waters where trout do better in lakes with less competition. Another similar general comparison can be made between lakes in the northern and the southern parts of Maine. In the northern and generally more remote portions of the state there are numerous shallow lakes and ponds which are uniformly quite warm (over 75° F.) during late summer, which support very large trout populations often in spite of heavy fishing, but which, because of their inaccessibility, have not been stocked with warm-water fishes. These northern waters are in sharp contrast to many similar ponds of southern Maine which contain competitors and generally produce little or no trout fishing in spite of continued stocking. The elimination of trout from their native habitats by introduced competitors is a general phenomenon which has been noted in various parts of the country (Greeley, 1930; Smith, 1939; Eschmeyer, 1938, et al.). In recent fisheries management the seriousness of competition in trout waters has been recognized to the extent that control methods by poisoning have been used to restore lakes for trout fishing (Smith, 1936; Eschmeyer, 1938).

Competition by warm-water game fishes should, therefore, be considered as an additional factor in the formulation of a stocking policy for trout and salmon lakes. The degree of competition must be, to a certain extent, in proportion to the relative densities of the populations of the different game species, and the chances of survival of a given stocked trout or salmon would be roughly in proportion to the degree of competition. Therefore, the allowance for a graded scale of competition in proportion to the abundance of competing species seems to be a reasonable procedure in formulating a stocking policy for trout and salmon lakes. Such allowances were made by the present writer

(Cooper, 1939) in stocking recommendations for lakes of southern Maine.

The most important of the competing warm-water game fishes in Maine are the white perch (*Morone americana*), chain pickerel (*Esox niger*), smallmouth bass (*Micropterus dolomieu*) and yellow perch (*Perca flavescens*). The following arbitrary numerical values were used to express the intensity of abundance of these and other competing species: abundant = 3, common = 2, and rare = 1. The numerical values for the abundance of the various species which were present in each lake were added to give a total or "competition factor" which is supposedly an expression of the severity of the competition of warm-water game fishes against salmonids. The competition factors were applied to the stocking policies by assuming that a competition of six (equivalent of two abundant or three common species, etc.) would reduce the carrying capacity to half the theoretical amount; a competition of twelve would reduce it to one-fourth; and other values in the same proportionate amount. Thus the stocking values for a given lake might be at the rate of one hundred 6-inch trout per acre if it had no competing species, but only at the rate of fifty per acre if it contained two competing species abundantly, and only twenty-five per acre if it contained four abundant competitors. The application of the competition factor was, therefore, to materially reduce the number of fish to be stocked with increase in competition.

The several logical and important questions which arise at this point, and the writer's comments pertaining thereto, are:

(1) Is the whole idea of modifying a theoretical stocking policy for trout and salmon on the basis of intensity of competition a sound procedure? It does seem to be a sound procedure, in view of the extensive amount of evidence indicating that competing species will drive out or supplant the salmonids.

(2) Is the proposed modification made in the right direction, i.e., would it not be better to increase stocking with increase in competition, with the idea that an extremely dense population of trout would crowd out competing forms like perch and pickerel? There is little, if any, evidence that trout could crowd out these competitors; at least it is a safe conclusion that the cost in terms of stocked trout would be prohibitive.

(3) If then we assume that the basic idea of reducing the rate of stocking from the theoretical carrying capacity according to the abundance of competing species is a logical procedure, how valid is the method as proposed by the present writer (Cooper, 1939)? The writer has no illusions concerning the extreme accuracy of the method, for its obvious weaknesses are many. The use of the numerical ratio of 3-2-1 to express competition intensity for the poorly defined abun-

dance categories of abundant, common and rare for different species is highly theoretical. Some other ratio such as a 5-3-1 or 9-5-1 might represent the true picture of competition more closely. The later ratios, such as the 9-5-1, would place more importance on competition and would tend to greatly reduce or almost eliminate trout stocking wherever one or two species of competitors were abundant; this might be desirable. Observed instances are common where a single competing species such as perch, pickerel, bass, etc., has, by itself, apparently eliminated populations of trout. The elimination of trout by a single species might take place more readily in a small lake than in a large one, and therefore the competition factor would have to be considered with respect to the size of the lake. There is, also, a probable fallacy in the present method of giving equal competition factors to the different species, i.e., of assuming that the different species compete with trout and salmon to the same extent.

The above account might correctly be considered as the proposal of a "competition factor" as a working tool in the formulation of a stocking policy, an acknowledgment of some of its weak points, and a defense of some of its merits. It is my belief that the method is far from being refined but that it is worthy of further study and more general application. Trout and salmon are continually being planted in hundreds of lakes and ponds where they are failing to survive in the presence of competition by other game fishes. Stocking in such waters should be decreased in proportion to the extent of competition and the fish should be planted in more favorable waters.

In the trout stocking table as presented by Davis (1938), stocking is recommended on the basis of a certain number of fish per acre for that portion of the total area of the lake having "water 50 feet or less in depth." Our studies on southern Maine lakes have indicated that trout and salmon occupy both the shallow and moderately deep parts of a lake during spring and fall when the surface water is cool, but that they live mostly in the moderately deep water, commonly down to depths of over 50 feet, during the summer from about the middle of June to the middle of September. While temperature restricts the amount of available trout water in a lake from above, in many lakes oxygen depletion restricts the trout habitat from below. In moderately deep lakes the extent of the trout's habitat changes gradually during the period from spring through late summer. Our studies on food habits have revealed that these same fish feed heavily during the summer as well as in the spring, and the summer food is largely bottom organisms, plankton, and deep water fishes. Because of this restriction in summer habitat and the resultant cutting down of available food supply, it seems to the writer to be the most logical procedure to stock on the basis of the average between the total area and volume of the lake and the bottom area and water volume which, during late summer, is delimited by warm water above and oxygen-deficient water below. In the case of large and very deep oligotrophic lakes like Sebago where a large per cent of the total area is over 100 feet deep, this deep bottom area and deep water is generally inaccessible to trout and salmon, unproductive of fish food, and should be omitted from stocking calculations. In Sebago Lake, however, the chief food chain for the salmon is through the plankton and smelt populations which are distributed generally over the lake; thus the lake's productive capacity is more in proportion to water volume available to trout and salmon than to the extent of bottom area between certain depths.

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SECOND TECHNICAL SESSION

MONDAY AFTERNOON—MARCH 18

Chairman: DR. A. A. ALLEN
Cornell University

VALUES OF NON-GAME SPECIES

ECOLOGICAL CLASSIFICATION OF THE MAMMALS AND BIRDS OF WALKER COUNTY, TEXAS, AND SOME ADJOINING AREAS

WALTER P. TAYLOR
U. S. Bureau of Biological Survey

An attempted functional classification of the forty-nine kinds of mammals and 171 species of birds recorded from Walker County and neighboring areas in Texas, principally in 1936-37 by members of the Bureau of Biological Survey in cooperation with the Texas Cooperative Wildlife Research Unit, is of interest as showing the place in the community occupied by these animals, from the standpoint of their relationships to their associates and to man.

The mammals found in Walker County and adjacent lands may be classified as follows: Seed-eater, one; house followers, two; soil workers, three; flesh-eaters, or regulators, four; insect-eaters, six; domestic, seven; buffer species, serving as food for fur animals, game, and regulators, seven; fur animals, nine; and game animals, ten.

As each species is mentioned but once, it is obvious that the above classification is quite arbitrary. The principal ecological function of each in the biotic community is taken as a guide to reference, however, and seemingly there are excellent reasons for the listings as given.

Notable in this region is the absence of seed-eaters, either as individuals or as species. The numerous kinds of pocket mice, kangaroo rats, and ground squirrels that would be found in almost any locality in western Texas, New Mexico, and Arizona are conspicuously absent. There are plenty of seed-bearing plants, but the moist climate of east-

Seed-eater:
- Hispid pocket mouse

House followers:
- House mouse
- Roof rat

Soil workers:
- Texas mole
- Louisiana pocket gopher
- Brazos pocket gopher

Flesh-eaters, or regulators:
- Texas coyote
- Mississippi Valley wolf
- Northeastern jaguar[1]
- Texas bobcat

Insect-eaters:
- Large short-tailed shrew
- Common brown bat
- Florida red bat
- Rafinesque bat
- Georgian bat
- Texas armadillo

Buffer species, serving as food for fur animals, game, and regulators:
- Texas cotton rat
- Texas rice rat
- Attwater wood rat
- Texas flying squirrel
- Dark baiomys
- Texas white-footed mouse
- Rhoads cotton mouse

Domestic:
- Domestic dog
- House cat
- Cow
- Horse
- Pig
- Sheep
- Goat

Fur animals:
- Virginia opossum
- Eastern raccoon
- Texas ring-tailed cat
- Southeastern mink
- Texas otter[2]
- Louisiana skunk
- Gulf spotted skunk
- Ocelot[2]
- Texas beaver[2]

Game:
- Louisiana black bear[2]
- Florida gray fox
- Eastern red fox
- Southern gray squirrel
- Western fox squirrel
- Merriam jack rabbit
- Alabama swamp rabbit
- Oklahoma cottontail
- Texas white-tailed deer
- Plains bison[1]

[1]Extinct.
[2]Extinct, or nearly so, in area considered.

ern Texas and the prevailingly heavy clay soil are hardly suitable for the extensive burrowing operations of seed-eaters, which in this eastern Texas region are represented by a single species of pocket mouse.

Correspondingly less conspicuous than in more arid climates are the soil workers also. Here are but three, comprising two species of pocket gophers, confined as a rule to the sandier soils, and the Texas mole, which is somewhat more generally distributed. None of these is abundant anywhere in the region, perhaps because of the prevailingly heavy character of the soil and the humid climate, which must render burrows somewhat precarious at times.

The domestic species are of much more importance than is ordinarily considered. Probably the cow is more important than any other, followed by the cat, dog, pig, horse, goat, and sheep in about the order named.

The grazing to which the eastern Texas post oak and pine forest sections are now being subjected is probably far more severe than any similar pressure in all the previous geological and ecological history of the region. Perhaps more serious to wildlife than any other predators, except man himself, are the domestic cat and the dog, although more field work is desirable to determine their exact status. Under certain conditions the rat and the mouse may be troublesome and highly detrimental to man's interest. The pig is harmful to the long-leaf pine, but there is little of that species of pine in the section herein treated, and some of the pig's activities are beneficial to herbaceous vegetation. The other domestic species are as yet relatively unimportant.

At present, the species listed as flesh-eaters have little influence or economic importance. The Texas coyote is of doubtful occurrence in this locality; a few Mississippi Valley wolves still occur; and there are probably more bobcats than any other predator.

Closely related ecologically to the regulators or predators are the fur animals and some of the game species. Nearly all the fur animals are in some degree flesh-eaters. The fur animals are regarded as more valuable for their fur than detrimental as a result of their predation. The ocelot is extinct in Walker County, and there are no very recent records of the otter. The original stock of the beaver has been gone for some years, but a restoration program is under way. More important than all the others put together are the opossum, raccoon, and mink—the opossum for its numbers, the raccoon for its numbers and value, and the mink for the value of its fur.

Deserving of more than passing interest are the so-called buffer species, those mammals that serve an important function in transmitting green vegetation into flesh for their carnivorous associates. Individually none of the species is of any great importance except possibly the cotton rat. Even this species is not very numerous in eastern Texas because of destruction of its habitat by close grazing. Potentially inimical to quail, the cotton rat, kept within bounds, is probably a necessary and valuable animal from the standpoint of food for certain game and fur animals.

Last let us consider the game species. The bison and black bear are gone, the former for certain, the latter as a species of any significance. The white-tailed deer finds suitable habitat in eastern Texas and the only limits to its development as an important and valuable game species are those set by legislation, agriculture, and the attitude of the residents. The squirrels, even though much reduced, are still of outstanding value as game. The apparently preponderant influence and interest of the fox hunters, as compared with trappers or farmers, seemingly justify inclusion in the game list of the gray and the red foxes. The writer feels that the rabbits, also, should be placed here. The jack rabbit, on the lope, is a really sporting animal for a good marksman to hit, especially with the rifle, and the cottontail and swamp rabbits are worth while in their own right as objects of food.

Seemingly each species of mammal in eastern Texas has some potential value, in some cases positive, in others negative. If our program of wildlife management is to be complete, we must give attention to each in its place.

As already indicated, the birds of Walker County and neighboring areas, as observed by representatives of the Biological Survey in 1936 and 1937, number 171. From the ecological standpoint they may be classified as follows: Perhaps sometimes injurious to trees, one; omnivores of variable ecological reference, three; water birds, fourteen; flesh-eaters, or regulators, seventeen; song birds, mostly fruit, grain, and insect eaters, eighteen; conspicuously insectivorous forms, twenty; seed- and insect-consuming species, twenty-five; game birds, twenty-five; and tree protectors, forty-eight.

Perhaps sometimes injurious to trees:
- Northern yellow-bellied sapsucker

Omnivores of variable ecological reference:
- Florida blue jay
- Oklahoma blue jay
- Southern crow

Water birds:
- Horned grebe
- Western grebe
- Pied-billed grebe
- Water turkey
- Ward's heron
- American egret
- Snowy egret
- Louisiana heron
- Little blue heron
- Eastern green heron
- Black-crowned night heron
- Wood ibis
- Purple gallinule
- Spotted sandpiper

Flesh-eaters, or regulators:
- Turkey vulture
- Black vulture
- Eastern goshawk
- Sharpshinned hawk
- Cooper's hawk
- Eastern red-tailed hawk
- Western red-tailed hawk
- Florida red-shouldered hawk
- Broad-winged hawk
- Swainson's hawk
- Marsh hawk
- Little sparrow hawk
- Barn owl
- Florida screech owl
- Great horned owl
- Florida barred owl
- Eastern belted kingfisher

Song birds, mostly fruit, seed, grain, and insect eaters:
- Eastern mockingbird
- Catbird
- Eastern brown thrasher
- Western brown thrasher
- Eastern robin
- Southern robin
- Eastern hermit thrush
- Eastern bluebird
- Cedar waxwing
- American pipit
- Southern meadowlark
- Western meadowlark
- Gulf coast red-winged blackbird
- Rusty blackbird
- Bronzed grackle
- Eastern cowbird
- Louisiana cowbird
- Dwarf cowbird

Conspicuously insectivorous forms:
- Yellow-billed cuckoo
- Road-runner
- Chuck-will's-widow
- Pacific nighthawk
- Chimney swift
- Ruby-throated hummingbird
- Eastern kingbird
- Scissor-tailed flycatcher
- Northern crested flycatcher
- Eastern phoebe
- Yellow-bellied flycatcher
- Acadian flycatcher
- Alder flycatcher
- Eastern wood pewee
- Tree swallow
- Rough-winged swallow
- Barn swallow
- Purple martin
- Migrant shrike
- White rumped shrike

Seed- and insect-consuming species:
- English sparrow
- Louisiana cardinal
- Eastern blue grosbeak
- Western blue grosbeak

Indigo bunting
Painted bunting
Dickcissel
Eastern purple finch
Eastern goldfinch
Pale goldfinch
Crossbill
Red eyed towhee
Savannah sparrow
Western grasshopper sparrow
Eastern vesper sparrow
Western lark sparrow
Slate-colored junco
Eastern chipping sparrow
Eastern field sparrow
White-throated sparrow
Eastern fox sparrow
Lincoln sparrow
Swamp sparrow
Mississippi song sparrow
Longspur (sp. ?)

Game birds:
Common Canada goose
Lesser snow goose
Common mallard
Gadwall
Baldpate
American pintail
Green-winged teal
Blue-winged teal
Shoveler
Redhead
Ring-necked duck
Canvasback
Lesser scaup duck
Ruddy duck
Eastern bobwhite
Eastern turkey[1]
American coot
Killdeer
American woodcock
Wilson snipe
Eastern mourning dove
Western mourning dove
Passenger pigeon[2]
Eastern ground dove
Inca dove

Tree protectors:
Southern flicker
Northern flicker
Boreal flicker
Southern pileated woodpecker
Red-bellied woodpecker
Red head woodpecker
Southern hairy woodpecker
Southern downy woodpecker
Red cockaded woodpecker
Ivory-billed woodpecker[3]
Louisiana chickadee
Plumbeous chickadee
Tufted titmouse
White-breasted nuthatch
Brown-headed nuthatch
Brown creeper
Western house wren
Eastern winter wren
Carolina wren
Mourning warbler
Maryland yellow-throat
Yellow-breasted chat
Hooded warbler
Wilson warbler
Blue-gray gnatcatcher
Eastern golden-crowned kinglet
Eastern ruby-crowned kinglet
Southern white-eyed vireo
Northern white-eyed vireo
Yellow-throated vireo
Red-eyed vireo
Eastern warbling vireo
Black and white warbler
Prothonotary warbler
Worm-eating warbler
Western parula warbler
Eastern yellow warbler
Western yellow warbler
Myrtle warbler
Black-throated green warbler
Sycamore warbler
Northern pine warbler
Kentucky warbler
Canadian warbler
American redstart
Orchard oriole
Baltimore oriole
Summer tanager

[1]Nearly extinct.
[2]Extinct since about 1886.
[3]Probably extirpated in Texas

As with the mammals, each species of bird is listed but once; so, obviously, the classification is somewhat arbitrary. For example, some of the game birds may be conspicuous seed- and insect-consuming forms, although they do not appear in that group as here listed. There is thus some overlapping. The classification of birds in this manner shows a large number that, on the whole, are definitely beneficial as compared with a relatively small group of uncertain or potentially harmful status.

It should be remembered that nearly every modification of original conditions by man (as timber-cutting, plowing, burning, and grazing) affects birds and mammals as well as it does the vegetation. Care should be taken that man's activities improve rather than impair his surroundings. In the main, effective conservation of soils, water, forage, and forest will promote also the conservation of game species, and, as a matter of fact, other valuable birds as well.

It will be readily apparent that the ecological connections between birds in general and game species may be close and intimate. The sapsucker, which may exercise a detrimental effect on certain trees, by so much endangers the habitat of forest-dwelling species of game. The crow and the jays, omnivores of variable ecological reference, may be, on occasions, highly beneficial or somewhat detrimental to game. This is also true of the regulatory forms, including the hawks and owls, which although ordinarily regarded as harmful to game, may be highly beneficial through control of rodents, snakes, and other serious enemies of game. The song birds are often competitors with game species for food, but they are friends of game through their consumption of insects inimical to plants. The strictly insectivorous species are practically 100 per cent beneficial to game interests. Seed-consuming forms may be of different status in different places as regards interrelationships with game. Assuming that the insectivorous birds of arboreal habit consume more harmful than beneficial insects, they are helpful to all game species that depend on a forest or woodland habitat.

Wildlife management must go farther than game management. Obviously other birds than game species must be considered. We can take better care of our game species if we know more about the others. Then, too, from the standpoint of esthetics, agriculture, and education, many of the other species are as important to the community as are the game birds.

An ecological classification was attempted of the 49 mammals and the 171 birds of Walker County, in eastern Texas. Each species is listed but once, so the classification is somewhat arbitrary because of overlapping functions. Allowances being made for this method of classification, there are among the mammals one seed eater, two house followers, three soil workers, four flesh-eaters or regulators, six insect-eaters, seven buffer species (serving as food for fur animals, game, and regulators), seven domestic animals, nine fur animals, and ten game species. The birds include one species sometimes injurious to trees, three omnivores of variable ecologic reference, fourteen water birds, seventeen flesh-eaters, eighteen song birds (mostly fruit, seed, grain, and insect eaters), twenty conspicuously insectivorous forms, twenty-five seed- and insect-consuming species, twenty-five game birds, and forty-eight tree protectors. Most of the non-game species are ecologically interrelated with the game animals, either as predators, prey, food, competitors, or otherwise; indeed, there is probably not a single species of bird or mammal that possesses no ecological connection with some of the game species. In a majority of cases the relation is probably insignificant, but in a substantial proportion it is important. In order to provide for effective game management we must know as much as possible about the non-game species as well as about the game forms. Then, also, many of the non-game birds and mammals are of substantial interest and value in their own right.

SOME BIRDS NATURALIZED IN NORTH AMERICA

MAY THACHER COOKE AND PHOEBE KNAPPEN
U. S. Bureau of Biological Survey

At the present time there are only nine species of birds which, by declaration of December 26, 1935, by the Secretary of Agriculture, under authority of the Lacey Act, may not be imported into the United States. These are the skylark (*Alauda arvensis*), starling (*Sturnus vulgaris*), common, or house, myna (*Acridotheres tristis*), crested myna (*Aethiopsar cristatellus*), English sparrow (*Passer domesticus*), European bullfinch (*Pyrrhula pyrrhula*), European yellow-hammer (*Emberiza citrinella*), greenfinch (*Chloris chloris*), and the chaffinch (*Fringilla coelebs*). Two of these prohibited species, the skylark and the crested myna, are now naturalized in the southern part of British Columbia and in all probability will spread into the adjacent parts of the United States. A few states have placed restrictions upon the importation of birds that might be destructive to agriculture or menace public health.

In the forty years since the Federal Government has been supervising the importation of birds into the United States, just less than 10,000,000 canaries and something more than 500,000 parrots have been entered under permit. The annual importations of certain of the more popular species of small cage and aviary birds average well up in the thousands.

The number of budgerigars (*Melopsittacus undulatus*), often called Australian shell parakeets or love birds, entered into the United States has averaged, during the past fifteen years, 16,000 individuals annually. The majority of these are consigned to California and Florida where the climate, eminently suited for aviculture, likewise favors the survival of birds accidentally or intentionally liberated. A number of budgerigars, evidently escaped birds, have been reported free-living in these two States, and it is possible that at some future date this hardy little native of Australia will become a naturalized citizen. All evidence available from analyses of stomach contents and from observations of this gregarious species in the Australian bush indicates that it is unimportant from an agricultural standpoint, perhaps because in Australia it does not occur close to intensively cultivated areas.

Since 1900 a total of 182,977 Java sparrows (*Padda oryzivora*) have been imported into this country. It is remarkable that the Java sparrow, which has become naturalized about seaports throughout the Orient by accidental liberations, has not yet established itself in this country. At least one attempt to introduce it by liberating some birds in Central Park in New York City met with failure, but it will not be surprising if at some future date birds of this species escape and thrive near a port of entry in California, Florida, or Texas. If such establishment should occur, the history of this weaver bird might be much the same as that of the English sparrow, though its distribution would probably be restricted to the warmer parts of the United States. In the Straits Settlements, the Philippines, and southern China, the Java sparrow is a somewhat obnoxious colonial bird, and occasionally is very destructive to rice and other grain crops.

It is remarkable that as the result of a few liberations at widely separated and indiscriminately selected points, the twelve birds listed below have become naturalized in North America:

Mute swan (*Sthenelides olor*).
Rock dove, or domestic pigeon (*Columba livia*).
Chinese spotted dove (*Spilopelia chinensis*).
Ringed turtle dove (*Streptopelia risoria*).
Australian crested dove (*Ocyphaps lophotes*).
Mexican conure (*Aratinga holochlora*).
European skylark (*Alauda arvensis*).
European starling (*Sturnus vulgaris*).
Crested myna (*Aethiopsar cristatellus*).
English, or house, sparrow (*Passer domesticus*).
European tree sparrow (*Passer montanus*).
European goldfinch (*Carduelis carduelis*).

Mute swan—The mute swan has always been considered a decorative park and aviary species despite its uncertain and often vindictive disposition. The graceful S-curve of the neck and the black boss on the upper bill render the identification of feral mute swans easy. Because of the expense of importing and maintaining these birds, persons owning swans usually clip or pinion the wings in order to keep them from escaping. This is necessary since they display a definite tendency to migrate whenever possible.

Most of the feral mute swans along the eastern coast originated from one of three sources: The Hudson River between Stattsburg and

Rhinebeck in Dutchess County, N. Y.; Long Island, N. Y., and Asbury Park and vicinity, N. J. In the Hudson River area a few pairs of mute swans were accidentally liberated, and by 1920 the wild flock numbered twenty-six birds. The mute swans reported on Long Island are probably descendants of birds released at the Southside Club near Oakdale. Mute swans have been kept from time to time on a number of estates near Asbury Park, N. J., and may now be found in considerable numbers along the northern New Jersey coast south to Seaside Park on the upper part of Barnegat Bay, where flocks numbering as many as thirty-five birds have been observed. In the January 1940 waterfowl inventory, ninety-one mute swans were reported from Long Island, N. Y., and New Jersey.

A flock of wing-clipped swans were kept on Silver Lake, near Akron, Ohio, from 1911 until 1934, when they were permitted to migrate. This flock probably accounts for most of the mute swans reported and shot at during December 1934 in Ohio, Pennsylvania, and West Virginia.

Because of the similarity of the feral mute swan to the protected, wild species, the presence of the former need not be a matter of concern unless the competition for food becomes acute.

Rock dove—The rock dove, or common domestic pigeon, like all other domestic stock, was brought into this country over such an extended period that it is impossible to say what importations resulted in its establishment. Perhaps many were concerned. The manner of keeping and breeding pigeons is such that individuals are free to revert to a wild state at any time, and they sometimes do so when sufficient food and satisfactory roosting and nesting places are available. As large cities develop, these requirements are provided, and the pigeons become feral in ever-increasing numbers. This comparative restriction to metropolitan areas subjects them to considerable criticism on account of their noisy courting habits and because of the building defacement caused by their droppings, but it tends to keep them from becoming an agricultural problem.

In some areas, however, the pigeon has established itself in a truly feral state, as, for instance, in the Black Mesa country of Oklahoma (near Kenton). There a colony, which was not in existence in 1929, now seems to be well established. Bagg and Eliot, in their Birds of the Connecticut Valley in Massachusetts (1937), mention that the domestic pigeon nests in rocky cliffs along the coast (presumably of New England). The pigeon has also been reported breeding on cliffs near Pittsburgh, Pa.

Chinese spotted dove—Nothing is known of the time and mode of the introduction or of the liberation of either the Chinese spotted dove or the ringed turtle dove. The spotted dove is, however, commonly imported from China in considerable numbers by pigeon fanciers and aviculturists. Ornithologists first became aware of the probable feral existence of this species in this country in 1917, when a dead bird was picked up in Los Angeles. Inquiry revealed that the bird was common in North Hollywood, where it has since rapidly increased in numbers. It is spreading eastward over the coastal-plain area south of the San Gabriel Mountains, and is now found in Los Angeles, Orange, and San Bernardino Counties, Calif., having been reported at Palm Springs in the latter county. Some idea of the rapidity of increase may be gained from the banding reports made by Harold Michener, of Pasadena. The first spotted dove recorded at his station was trapped and banded in December 1933; in 1934, 33 doves were banded; in 1935, 76; in 1936, 256; in 1937, 404; and in 1938, 483.

The rapid increase and spread of this dove, which seem to be limited only by availability of food and of roosting and nesting trees, may well be viewed with concern, since it, like the smaller mourning dove, apparently breeds throughout the year. Spotted doves feed on various fruits and grains, and as their numbers increase they will undoubtedly compete with the band-tailed pigeon, the mourning dove, and the white-winged dove for food, and the fruit grower and the farmer may suffer losses if the supply of wild foods is exhausted.

Ringed turtle dove—This familiar cage species, which has often been liberated by aviculturists in California, is so far removed from the parent stock as to be a true domestic form. This may account for the fact that while this bird has been able to maintain itself and even to spread throughout the park system of Los Angeles, it is extending into the suburbs very slowly. The first record in the free state is of an individual noted in Buena Park, Los Angeles, Calif., in 1909. A flock of twenty-five of these birds was observed in Central Park in 1926, and twenty pairs were seen in Pershing Square in 1929; one pair of this flock was observed tending nestlings. Harold Michener, in a letter written in March, 1940, said that two ringed turtle doves had been trapped at his Pasadena banding station.

It is probable that the ringed turtle dove, derived from a selected and domesticated stock, has lived so long under the protection of man that it is unable to escape from natural enemies, and consequently will not succeed in establishing itself away from the protection of man and his buildings. A number of observations made by Californians indicate that these birds are unable to evade attack by hawks.

Australian crested dove—Some time prior to 1925 a small colony of these frequently caged doves escaped and took up residence in the grounds of the Claremont Hotel in the foothills behind Berkeley, Calif. Reports indicate that the colony is not increasing noticeably, if it is still in existence, and that it does not at present constitute a problem. According to available information concerning the habits of these birds in the wild, they feed largely on small weed seeds and wild fruits.

Mexican conure—For twenty years at least it was rumored that a small band of Carolina parakeets still inhabited the interior of Florida. The existence of a colony of a dozen parakeets in the woods bordering the everglades west of Palm Beach and Lake Worth was verified in 1925 through the efforts of Thomas Barbour, but an individual collected from this flock proved to be a Mexican conure, an excellent but uncommon cage bird. Though there is a remote possibility that the birds of this eastern Mexican species may have reached Florida by natural means, it is much more probable that the flock was liberated through the destruction of aviaries by a hurricane such as that of 1919. The climate of Florida and the food available there approximate so closely those of its native land that this bird should have no difficulty in reproducing and increasing if not persecuted. The Mexican conure, like the extinct native conure, or Carolina parakeet, is an attractive and decorative bird, and its presence is welcome as long as its numbers are limited. Should it become numerous, however, its tendency to travel and feed in flocks might make it a pest to farmers. Since there has been no recent mention of the Mexican conure in Florida, it is probable that the flock has been extirpated.

European skylark—The skylark, for sentimental reasons, has been one of the species most favored for introduction. Like many other living things, the skylark, when removed from its natural environment, where its peculiarities are known and its destructive tendencies more or less controlled, to a new land, may become a serious agricultural pest. In New Zealand and Australia its fondness for newly planted seeds and its habit of pulling up wheat, corn, oats, and clover seedlings have made the skylark "Agricultural Enemy No. 1."

Fortunately none of the many attempts to introduce the European skylark into the United States has resulted in its naturalization, although small colonies in the vicinity of Flatbush, Long Island, N. Y., and Portland, Oreg., persisted for twenty to twenty-five years.

Some of the points at which European skylarks were unsuccessfully liberated are Montreal, Que.; Cambridge, Mass.; New York City and vicinity and Long Island, N. Y.; Bergen and Passaic Counties, N. J.; Wilmington, Del.; Detroit, Mich.; Cincinnati, Ohio; Centreville and St. Louis, Mo.; San Jose, Calif.; and Portland and vicinity, Oreg.

The only naturalization experiment that has proved successful to date is one made near Victoria, Vancouver Island, B. C. There ninety-nine skylarks were liberated in 1903, and forty-nine additional in 1913. The species just about held its own until 1925, when it began to increase and became common by 1930. In 1935 it was as abundant as any of the other small birds in the occupied area around Mount Tolmie and Mount Douglas. So far the members of the colony have not shown a tendency toward seasonal migration, and they are not yet numerous enough to spread to adjoining sections.

European starling—The European starlings now found over nearly half of the United States and parts of Canada are descendants of 160 birds liberated in Central Park, New York City, in the spring of 1890 and of 1891. Several unsuccessful introductions had been made during the previous fifty years.

In the first decade the starlings spread only about 25 miles beyond the confines of greater New York. By 1908 their range included most of Connecticut and New Jersey and southeastern Pennsylvania. The birds had crossed the Allegheny Mountains by 1916, a specimen being taken at West Lafayette, Ohio, in that year, and Canada was reached in 1919 when a few birds were observed near Brockville, Ontario. Starlings are vagrants and in many places they have appeared from time to time before becoming established. This is especially true in the South and West. The main line of spread has been southwestward, particularly in winter. In North America, as in the Old World, some of the birds migrate and others do not.

The southernmost breeding point of the starlings, as yet, is in extreme northern Florida, and they have bred north to the north shore of the St. Lawrence River and as far east as the eastern end of Anticosti Island. Any extension beyond these limits will probably be very slow, though the numbers will no doubt increase. To the west, the breeding range may be considered to include eastern South Dakota, Nebraska, and Kansas, but, of course, there are many areas from that region to the Atlantic seaboard where the species is still unknown. Outside the breeding range outlined, there are many localities in which the starling is a more or less regular winter visitant, and a few places in which it has bred. In 1938 several juvenile starlings were banded at Des Lacs Migratory Waterfowl Refuge in northwestern North Dakota, and one of these later furnished the first record for Montana. So far no starlings have been reported in Wyoming; but they have passed the Rocky Mountains, as they were observed near Salt Lake City, Utah, in February, 1939. The same winter a specimen was collected from a flock not far from Denver, Colo., and a bird was reported to have spent the winter near Montrose in the southern part of that State. Starlings have also been noted near Albuquerque, N. Mex., and have crossed the Mexican border below Nuevo Laredo.

As individual birds, their food habits are beneficial, but the immense flocks that gather in fall and winter are likely to be a decided nuisance. The birds roost on buildings wherever they can find a protected ledge, disfiguring the face of the building and the sidewalks and streets adjacent to their nocturnal roosts with droppings. Naturally pugnacious, they have a tendency to drive native birds away from the nesting shelters provided for them, and when food is put out for birds, the starlings are apt to take a large share of it.

Crested myna—Little change has occurred in the general status of the crested myna, or Chinese starling, since the publication of the bulletin on this species by Scheffer and Cottam in 1935. This city-dweller was liberated in the vicinity of Vancouver, B. C., without fanfare about 1897. It slowly increased in numbers until in 1920 no fewer than 1,200 birds were reported to resort to nocturnal roosts in the center of that city. By 1924 the birds numbered about 7,000, and in 1927 more than 20,000. Since that time there has been a noticeable diminution in the numbers of the crested myna both in the city and in suburban sections. This may be due to a decrease in available nesting holes brought about by clean-up campaigns incident to the normal expansion of the city. As the species is single-brooded in the relatively unfavorable climate of British Columbia, it is probable that there is not much to be feared in the way of numerical increase in the near future. If, however, this species succeeds in spreading southeastward through the cities of Blaine and Bellingham into the State of Washington, a dangerous situation would be presented; hence every effort should be made to prevent its penetration into the United States. If the crested myna were established in a part of the United States where the climate permitted it to become double- or triple-brooded, as it is in the Philippines and Hawaii, it would probably spread over our West Coast States much more rapidly than the European starling has over the eastern part of the continent.

English sparrow—The English sparrow has become so firmly established in our fauna that it is difficult to realize that the first individuals were liberated only ninety years ago in Brooklyn, N. Y. This species was introduced at several centers of population throughout the country, a fact in part explaining its rapid and thorough coverage of the United States and Canada.

European tree sparrow—The European tree sparrow, a congener of the English sparrow, apparently was never liberated at any other place than St. Louis, Mo., where twelve pairs were freed in Lafayette Park in April, 1870. Exactly a year later a single individual was observed in the suburbs of that city, and then the species more or less dropped from sight for a few years, being reported only from the Shaw Gardens (Missouri Botanical Garden). It has not spread very far; in fact, it has never been observed more than a hundred miles from St. Louis in the seventy years since it was liberated. The most distant records have been of single individuals reported from Fulton County, Ky., on several occasions. These were apparently birds that had traveled down the Mississippi River as stowaways on steamboats.

In recent years, however, the European tree sparrow has definitely increased in numbers, and several birds have been banded. During the winter of 1938-39 a flock of ninety of these sparrows was reported at Horseshoe Lake, Ill., where small numbers had been observed since 1934. They are now found in two Missouri counties and one Illinois county. These quiet, unobtrusive little sparrows may have been limited by a scarcity of holes for nesting, since they require deep cavities and, unlike the English sparrow, do not construct bulky nests on any available foundation. They frequent brushy, wet areas and may be noted with flocks of English sparrows and of song sparrows.

In general, the European tree sparrow is neutral, if not beneficial, in its relation to the farmer, its occasional destruction of such small grains as millet being balanced by its inveterate pursuit of moths and flies and by its large consumption of weed seeds.

European goldfinch—The more brilliantly colored European namesake of our native goldfinch has been liberated repeatedly at a number of places in the hope that it would establish itself. These efforts have met with a modicum of success in the northeastern United States. In habits, the European goldfinch is very similar to our native bird. Except during the breeding season, which occurs very late in the summer, it goes in flocks and has a definite tendency to migrate. Since it feeds principally on the seeds of weeds and of such trees as fir, alder, poplar, and birch, its effect upon our economy will probably be negligible unless it should become as abundant as the English sparrow or the European starling. In Australia and New Zealand this goldfinch survived and increased so greatly after liberation that in many areas it became a serious pest to seed crops and to fruit trees through disbudding, and a nuisance to cattlemen through the distribution of undesirable weeds. On the other hand, it is most valuable for its habitual feeding upon scale insects and aphids, or plant lice.

During the past five years European goldfinches have been observed in Brooklyn, Sands Point, and Garden City (Long Island), N. Y.; Hanover, N. H.; Manchester, Mass.; Milwaukee, Wisc.; and Larkspur and Elk Valley, Calif.

RELATION OF FRANKLIN'S GULL COLONIES TO AGRICULTURE ON THE GREAT PLAINS

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"A breeding colony of Franklin's gulls is one of the most spectacular, most interesting, and most beautiful sights in the realm of North American ornithology. The man who has never seen one has something to live for—a sight which once seen is never to be forgotten." So wrote Arthur Cleveland Bent in his *Life Histories of North American Gulls and Terns* (1921).

Early ornithologists considered Franklin's gull a rare bird, doubtless because its breeding grounds in southern Alberta, southern Saskatchewan, southwestern Manitoba, Minnesota, North Dakota, and South Dakota, were then largely unsettled, and because of its comparatively narrow migration route, extending from its breeding grounds in the north through Iowa, western Missouri, Nebraska, central Kansas, western Oklahoma, and central Texas, to Peru, Chile, and Patagonia. The narrowness of the migration route is indicated by the ninety-six recoveries so far received of 23,911 Franklin's gulls banded in Alberta, Saskatchewan, and South Dakota (Table 1).

Franklin's gulls have been breeding also in the Bear River marshes in Utah for a great number of years. As there are only four records of this bird from Wyoming and as the only Montana record previous to the recent one of birds observed at Medicine Lake and Lake Bowdoin Migratory Waterfowl Refuges in the northeastern corner of the State was of a large colony breeding on Big Lake, Stillwater County, in 1917 (Saunders), one must conclude that the Franklin's gulls from Utah probably migrate southeast through New Mexico or occasionally across Colorado (Bailey and Niedrach, 1926) rather than east over the Great Plains.

Breeding colonies of Franklin's gulls were formerly found in Dickinson County, Iowa; Brookings, Clark, Marshall, and Day Counties,

TABLE 1. DISTRIBUTION OF RECOVERIES OF BANDED FRANKLIN'S GULLS

Name of bander....	Wm. Rowan	J. E. Horning	F. E. Farley	Various Cooperators	P. A. DuMont	
Banding locality ..	Edmonton, Alberta	Morinville, Alberta	Camrose, Alberta	Saskatchewan and Alberta	Sand Lake Refuge, Columbia, S. Dakota	Total
Total banded	6,725	2,320	3,976	911	9,979	23,911
British Columbia.	1	....	....	....	....	1
Alberta	7	5	3	1	....	16
Saskatchewan	1	3	3	2	1	10
Manitoba	....	....	....	1	1	2
North Dakota	7	1	2	1	....	11
South Dakota	10	....	1	....	1	12
Minnesota	7	....	....	2	9	18
Iowa	....	1	....	....	4	5
Nebraska	1	....	....	....	....	1
Kansas	4	....	....	....	....	4
Oklahoma	....	....	....	2	....	2
Texas	4	....	1	1	1	7
Mexico City	....	....	....	....	2	2
Guatemala	....	....	....	....	2	2
Salvador	....	....	....	....	1	1
Peru	....	....	....	....	2	2
Total	42	10	10	10	24	96

TABLE 2. PRECIPITATION AND WATER LEVELS AT MUD LAKE ON SAND LAKE REFUGE

Year	Annual precipitation	Precepitation—May, June, and July	Maximum water level	Date of maximum	Deficiency from crest at maximum	Pool level July 5	Loss from maximum	Nests
	Inches	*Inches*	*Feet*[1]		*Feet*	*Feet*[1]	*Feet*	*Number*
Normal	25.39	10.41	1,272.00[2]					
1936	14.32	3.85	1,269.92	May 14	2.08	1,268.59	1.33	0
1937	25.78	12.35	1,271.25	May 2	.75	1,270 59	.66	6,000
1938	16.71	7.04	1,270.25	May 8	1.75	1,269.70	.55	6,100
1939	22.46	13.48	1,271.17	April 17	.83	1,270.90	.27	20,000

[1]Elevation above sea level.
[2]Crest, level of spillway.

S. Dak.; Stutzman, Bottineau, Nelson, and Ramsey Counties, N. Dak.; and Polk, Big Stone, and Jackson Counties, Minn. Scarcely any of these colonies have been occupied since 1900, except the famous Heron Lake colony in Jackson County, in southwestern Minnesota, where in 1916, Dr. Thomas S. Roberts (1932) estimated that at least 50,000 nests were located among the *Phragmites* along the shore of the north lake. In 1893 and in 1899 there had been between 2,000 and 3,000 nests there, but in 1898 no breeding birds could be found. Dr. Roberts confirmed the observations of Mr. Bent that Franklin's gulls were prone to change the location of their nesting colonies from year to year. His belief that this action is due to varying food and water conditions is being tested in connection with the management of these basic requirements on several newly established national waterfowl refuges. The food supply on or near such refuges has been adequate, and on those areas at least water levels alone seem to be the determining factor in controlling Franklin's gull nesting colonies.

Prior to the establishment of the 21,133-acre Sand Lake Migratory Waterfowl Refuge in 1935, Franklin's gull was not known to nest in Brown County, in northeastern South Dakota. That refuge extends for 16 miles along the James River, and its northern boundary is within 4 miles of the North Dakota state line. When acquired, the area contained three lakes covering about 1,300, 150, and 250 acres, respectively, all less than 4 feet deep. The 250-acre Mud Lake was frequently dry in the fall. One of the two major impoundment structures is a low earthen dam more than a mile in length across the broad, flat, James River bottomland along the south side of Mud Lake.

In 1937, the first year of impoundment, Mud Lake was expanded to more than 3,000 acres of water and marsh. Franklin's gulls swarmed into this newly created marsh and built about 6,000 nests. Nesting was very successful, and on seven days within the period June 8 to July 16 a total of 2,615 young gulls was banded. During 1938, with somewhat less run-off, the birds reoccupied the same area, using the old nesting mounds for the foundation of their new nests. At least 6,100 nests were found, and in fifteen days between June 15 and July 13 a total of 7,364 young gulls was banded, making a total of 9,979 birds for the two seasons (see Table 1 for distribution of the 24 recoveries). Conditions in 1939 were just as favorable as in 1937, with only 0.27 of a foot loss of water through evaporation during the nesting season. As a result, this colony, occupying the same location but extending the actual nesting area from 120 to 280 acres, increased to approximately 20,000 nesting pairs. In Table 2 are shown the annual precipitation and the water levels at Mud Lake for the years covered by this report.

River bulrush (*Scirpus fluviatilis*) provided the principal nesting cover in 1937 and 1938, although some nests were placed around the margin of *Phragmites* clumps but not within these dense stands. In 1939, however, although the bulrush was again chiefly used, the nests being closer together than before, many nests were placed also in whitetop, or spangletop (*Fluminea festucacea*), and cord grass (*Spartina*). Favorable clumps of *Phragmites* were occupied in their entirety, but more frequently by eared grebes, black-crowned night herons, and the several species of diving ducks than by the gulls. Water over much of the nesting colony averaged 3 feet in depth in 1939.

TABLE 3. PRECIPITATION AND WATER LEVELS AT UNITS NOS. 332 AND 326, LOWER SOURIS REFUGE

UNIT NO. 332

Year	Annual precipitation[1]	Precipitation—May, June, and July[2]	Maximum water level	Date of maximum	Deficiency from crest at maximum	Pool level July 5	Loss from maximum	Nests
	Inches	*Inches*	*Feet*[3]		*Feet*	*Feet*[3]	*Feet*	*Number*
Normal	16.39	8.00	1,417.00[4]					
1936	8.21	3.24	1,417.50	April 23	[5]	1,417.00	0.50	0
1937	17.37	11.35	1,416.92	April 15	0.08	1,416.84	.08	0
1938	14.60	8.62	1,416.73	May 19	.27	1,416.45	.28	300
1939	13.88	8.09	1,417.30	April 8	[5]	1,416.66	.64	1,500

UNIT NO. 326

Year	Annual precipitation[1]	Precipitation—May, June, and July[2]	Maximum water level	Date of maximum	Deficiency from crest at maximum	Pool level July 5	Loss from maximum	Nests
1939	13.88	8.09	1,419.64[6]	April 13	0.76	1,418.94	0.70	200

[1]On average middle 1/3 of state.
[2]Bottineau weather station records.
[3]Elevation above sea level.
[4]Crest, level of spillway.
[5]Full.
[6]Was maintained at this level less than one day as a public road was threatened; the maximum for all practical purposes was about 1,419.10.

The importance of stabilized water levels on extensive areas of marsh and shallow pools as a management factor in inducing colonization of Franklin's gulls has also been demonstrated on the 58,413-acre Lower Souris Migratory Waterfowl Refuge, in Bottineau and McHenry Counties, N. Dak. Five earthen dams across the Souris (or Mouse) River regulate the level of water released from Lake Darling on the Upper Souris Migratory Waterfowl Refuge, 237 river miles above the first structure on the Lower Souris Refuge. The annual precipitation and the water levels at the Lower Souris Refuge for the years 1936 to 1939 are shown in Table 3.

Franklin's gulls were abundant in 1936 on the Lower Souris Refuge as late fall migrants. They were not quite so numerous in 1937, although they remained in large numbers all summer. In 1938 they nested on the refuge for the first time, choosing a remote spot in Unit No. 332 for their 200 or 300 nests. This colony met with adversities and was finally wiped out shortly after the eggs had hatched. Minks caused most of the damage, killing the incubating birds on the nests. In some instances also eggs were smashed. About July 4 a series of cloudbursts, concentrated in that particular area, finished the colony. The following year, 1939, a much larger colony of Franklin's gulls again nested in the same spot. Another was established 4 miles upstream in the next unit, No. 326. A pure stand of whitetop, or spangletop (*Fluminea festucacea*), was selected as nesting cover both in 1938 and in 1939. A few stalks of bulrush and sedge are beginning to appear on this area, so that in all probability the grass will eventually give way to plants more nearly adapted to flooded marshland. The depth of water at these nesting colonies varied from 5 to 24 inches, the average being about 12 inches.

The development of Long Lake Migratory Waterfowl Refuge, containing 17,698 acres in Burleigh and Kidder Counties, N. Dak., and 40 miles east of Bismarck, also illustrates the effectiveness of national wildlife refuges in establishing nesting colonies of Franklin's gull.

Long Lake was completely dry in 1935 and 1936; but in 1937, when Units I and II were filled to spillway level, Unit I averaged 3 to 4 feet deep. A colony of about 4,000 birds in Unit I succeeded in hatching only 200 nests owing to repeated destruction of nests by wave action and to a lack of protective vegetation. In 1938 the water in Unit II was slightly lower than it was in the previous year, varying in depth from 14 to 24 inches. A concentration of approximately 10,000 nests in a very dense stand of hardstem bulrush (*Scirpus acutus*) on this unit was very successful. In 1939, in which year the water in Unit II varied in depth from 6 to 16 inches, the colony moved about half a mile east of its location in 1938, and made use of practically a pure stand of prairie bulrush (*Scirpus paludosus*) for some 20,000 nests.

On the Bear River Migratory Bird Refuge, of 57,283 acres in Box Elder County, Utah, the nesting population of Franklin's gulls has remained nearly constant at 1,500 pairs during the past five years. Nests were located in *Scirpus paludosus* in water about 3 or 4 inches deep. This depth does not vary more than an inch or two during the nesting season.

Small nesting colonies of Franklin's gulls have also been established on the 60,217-acre Mud Lake Migratory Waterfowl Refuge, in Marshall County, Minn.; the 2,587-acre Waubay Migratory Waterfowl Refuge, in Day County, S. Dak.; and on the 31,688-acre Upper Souris Migratory Waterfowl Refuge, in Renville and Ward Counties, N. Dak.

Franklin's gull is the only species of gull that breeds regularly in the Northern Hemisphere and migrates south of the equator. During the winter many of the birds remain in the inland lake region of Nicaragua to feed in the locust-infested fields. Their arrival in the north coincides with spring plowing, and the milling flocks "leap-frog" along behind the plow in their scramble for the up-turned grubs, larvae, and worms. During the past few years, at the time the young gulls were hatching in the Dakotas, grasshoppers had reached near plague numbers. It was found that the entire diet of week-old gulls consisted of grasshoppers. Adults covered a radius of at least 36 miles from the Sand Lake Refuge, feeding principally in fields where mowing left the grasshoppers easily available. When returning to their nests, in mid-morning and generally after sunset, they would have their gullets distended by the quantity of insects carried for the nestlings. Professor F. E. L. Beal found (McAtee, 1924) that even during September and October about 80 per cent of the diet of these birds consisted of grasshoppers.

A successful colony of Franklin's gulls, with an average production of two young birds to a nest, will double its population each summer. On the Sand Lake Refuge in 1937 and 1938 these birds had a nesting density of at least 200 birds to an acre, and in 1939 the density had increased to about 285 birds for each acre in the colony.

To the 80,000 young and adult Franklin's gulls on Sand Lake and Long Lake Refuges are added early in August great numbers of gulls moving south and east from Alberta and Saskatchewan. The resulting concentrations of these important insect-eaters reach tremendous numbers. On Lake Tewaukan, a 4,665-acre easement refuge in Sargent County, N. Dak., the gulls present in one month during the fall of 1938, reached a peak estimated at 750,000. Based upon the steadily increased use of these new refuges by Franklin's gulls during the past four years, it is reasonable to expect that this highly beneficial bird will soon become established on numerous other areas in Minnesota, the Dakotas, and eastern Montana.

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THE INFLUENCE OF BIRDS ON LOCAL GRASSHOPPER OUTBREAKS IN CALIFORNIA

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In the sixty-two years since Samuel Aughey made his pioneer report on birds in relation to the Rocky Mountain locust, great progress has been made in our knowledge of the food habits of various species of birds and of their effect on our general welfare. California has been represented in many of the published reports on bird food habits. Prof. F. E. L. Beal, veteran economic ornithologist of the Bureau of Biological Survey, published in 1907 and 1910 extensive reports on the relation of birds to California horticulture. Apparently, however, few California reports deal specifically with birds in relation to grasshoppers, an important one being that by Dr. H. C. Bryant covering studies made in the San Joaquin Valley in 1912.

Devastating outbreaks of grasshoppers in California were first recorded by the Spanish Mission fathers in 1722. As agriculture expanded over the fertile valleys and extended farther from the rivers and into the rolling grazing lands of the lower foothills, these outbreaks became steadily more spectacular. Some species of grasshoppers have proved adaptable to cultivated crop land and thrive there, while others have had their habitat restricted and have been pushed back into the foothills and distant range lands.

The area of potential sources of grasshopper invasions in California was estimated by Lockwood (1939) at approximately 30,000,000 acres, including the tracts where continued existence of grasshoppers of economic species is possible unless unfavorable local conditions inhibit their development. During the period 1935-39 grasshopper outbreaks have occurred from San Diego on the south to Siskiyou and Modoc Counties on the north, a distance of more than 1,000 miles. The seriousness of these outbreaks is shown by the density of population, which has occasionally approached a maximum of 6,000 grasshoppers to the square yard on egg-bed areas immediately after hatching, and by the losses estimated at more than $1,000,000 a year.

These frequent and extensive grasshopper outbreaks afford excellent opportunity for continued study of the relationships of birds to grasshoppers. The beneficial effect of birds feeding upon grasshoppers merits fuller appreciation by ranchers and agricultural agencies, as well as by sportsmen who frequently engage in so-called predator campaigns against bird species, some of which are beneficial in reducing grasshopper populations.

The senior author has been engaged mainly in the study of the depredations of birds on agricultural crops in California and of methods of preventing or controlling damage where the losses justify. Birds of several species locally and seasonally, sometimes consistently, attack certain fruit, grain, and truck crops with such severity that some form of protection must be devised. Grasshopper invasions from time to time, however, cause even more severe losses. Information on birds as destroyers of grasshoppers, therefore, becomes an essential part of the data necessary in determining the justification for local control of a periodically injurious bird species.

In properly appraising the factors responsible for grasshopper outbreaks, the junior author felt the need for a study of the food habits of birds. Since birds are habitual predators upon grasshoppers, a comprehensive knowledge of their value is of paramount importance in correlating the diverse factors affecting the population density of these insects. Upon this basis of their individual needs the authors began the present study in 1935. Observations and collection of study specimens have continued intermittently since that date, but during much of each grasshopper season it has been possible to visit the study areas only when field work on other problems has permitted.

In order to obtain the many records necessary in the study of the ecology of grasshoppers, the junior author in 1934 selected a number of specific study areas. Upon these an attempt has been made to investigate every measurable factor influencing grasshopper abundance, with special emphasis on the effect of parasites and predators.

Studies of birds were undertaken on three of these areas where extensive correlated information on grasshoppers was available. The San Luis Obispo area, 4 miles east of Santa Maria, is representative of some 2,000 square miles of the coastal habitat of grasshoppers. It is steeply rolling grazing land, ranging from 500 to 1,500 feet in elevation, and the vegetation is typical oak savanna. The Sacramento area, situated 9 miles north of that city, is a tract of intensively cultivated reclaimed land; here the grasshopper egg beds and the adult population are confined largely to irrigated alfalfa fields. The Michigan Bar study area is situated 20 miles east of Sacramento near the Mokelumne River. It is rolling grazing land typical of some 5,000 square miles of the Sierra foothills; forested land adjoins the area on the north and runs to the river bottoms.

Upon each visit to a study unit a survey of the birds present was made. Specimens for stomach analysis were collected at irregular intervals during the seasons when grasshoppers were active. Some species of birds are found in large numbers on and near the study areas; others occur only in limited numbers, and in order to avoid disturbing the biotic balance the taking of specimens of such species was minimized. Collecting was not restricted to the study units but was extended to adjacent fields within easy flight radius. In addition, general observations of bird activity in relation to grasshopper infestations have been made throughout the State and a few specimens have been taken.

In Tables 1 and 2 are summarized the data that have thus far been obtained from analysis of the stomachs and crops of birds collected. Table 1 lists the species of bird, the study area where collected, the number of specimens, the average percentages of animal and of vegetable food content, the number of specimens containing remains of grasshoppers, the maximum and the average number of grasshoppers per bird based on counts of paired mandibles, and the ratio of grasshopper remains to those of other insects.

Table 2 shows the frequency of occurrence of all major classes of food items identified in the 121 stomachs and indicates the relationship between grasshoppers and the other foods taken; it shows that grasshoppers were eaten by 80 of the 121 birds, seeds of wild plants by 63, beetles by 41, pentatomids by 35, and lepidopterous larvae by 25.

One hundred and twenty-one specimens, representing sixteen species of birds, were examined of which eighty, representing eleven species, contained a trace or more of grasshoppers. Of twenty-three crows examined, twenty had eaten grasshoppers; as had seven out of eight yellow-billed magpies, and nineteen out of twenty-four Brewer's blackbirds. Of seventeen tricolored redwings collected, fifteen contained remains of grasshoppers, as did four out of five desert sparrow hawks, and five out of five western meadowlarks. Of the nineteen horned larks collected, only four held any trace of grasshoppers, and of the nine additional bird species represented, only six out of twenty specimens contained grasshopper remains.

TABLE 1. SUMMARY OF STOMACH ANALYSES OF BIRDS COLLECTED ON STUDY AREAS

Species	Study area	Number of specimens collected	Average percentage of food items		Number of specimens containing grasshopper remains	Maximum number of grasshoppers in a single specimen	Average number of grasshoppers per bird	Estimated ratio of grasshoppers to other animal matter, in per cent
			Animal	Vegetable				
Western crow	San Luis Obispo	5	67	16	3	28	10	70
Do.	Sacramento	16	90	9	15	66	15	75
Do.	Michigan Bar	2	98	2	2	50	29	50
Brewer's blackbird	San Luis Obispo	10	100	T	9	20	11	60
Do.	Sacramento	6	100	T	4	20	7	30
Do.	Michigan Bar	8	92	8	6	53	18	50
Yellow-billed magpie	San Luis Obispo	4	40	45	3	22	10	50
Do.	Sacramento	3	95	5	3	13	7	45
Do.	Michigan Bar	1	62	38	1	7	....	95
Tricolored redwing	Sacramento	16	48	53	15	24	11	80
Do.	Michigan Bar	1	100	0	0	....	....	0
California redwing	Sacramento	4	40	12	0	....	....	0
Do.	Michigan Bar	3	66	33	1	13	13	66
San Diego redwing	San Luis Obispo	1	100	T	0	....	....	0
Desert sparrow hawk	San Luis Obispo	5	100	T	4	22	9	20
California horned lark	San Luis Obispo	16	41	15	4	3	0.5	5
Do.	Michigan Bar	3	T	T	0	....	....	0
Arkansas kingbird	San Luis Obispo	3	100	T	2	3	2	40
Do.	Sacramento	2	100	T	0	....	....	....
Western meadowlark	San Luis Obispo	4	100	T	4	7	5	45
Do.	Michigan Bar	1	100	0	1	1	1	5
Lark sparrow	San Luis Obispo	1	100	0	1	6	6	100
Western bluebird	San Luis Obispo	1	100	T	0	....	....	0
Bullock's oriole	San Luis Obispo	1	100	0	0	....	....	0
American pipit	Michigan Bar	1	T	0	0	....	....	0
California shrike	Sacramento	1	100	T	0	....	....	0
California jay	San Luis Obispo	2	98	2	2	19	17+	95
16 species		121	....	....	80	....	....	....

On the basis of data thus far obtained, six species of birds appear to be capable of playing an important part in reducing grasshopper populations in proportion to their abundance. Continued collecting may prove that certain other birds feed more on grasshoppers than now seems apparent, and continued field observations will greatly supplement the data. Of the species collected on the study areas, the western crow, yellow-billed magpie, Brewer's blackbird, tricolored redwing, and western meadowlark stand out as the most important grasshopper predators. On the San Luis Obispo area, on which fifty-six grasshopper egg beds have been mapped, crows have aided in reducing the population; in fact, an observer unversed in grasshopper habits would have his attention called to the egg beds by the presence of bands of crows. Contrary to expectations, the horned lark, which is the most abundant bird on two of the areas, seemed to be of minor importance, although further investigation may improve their standing. Examination of nineteen stomachs of horned larks revealed that only four had taken grasshoppers, while ten had eaten pentatomids.

TABLE 2. PRINCIPAL FOOD ITEMS AND THEIR FREQUENCY OF OCCURRENCE IN THE STOMACHS EXAMINED

Species	Study area	Number of specimens	Arachnida	Orthoptera				Homoptera		Hemiptera			Coleoptera				Lepidoptera			Diptera					Plant	
				Grasshoppers	Jerusalem crickets	Field crickets	Mantidae	Homoptera (undet.)	Jassidae	Hemiptera (undet.)	Pentatomidae	Lygaeidae	Coleoptera (undet.)	Tenebrionidae	Carabidae	Rhyncophora (undet.)	Lepidopt. larva	Prodenia (undet.)	Eurymus eurytheme	Diptera maggots	Tipulidae	Asilidae	Hymenoptera (undet.)	Vertebrate remains	Cultivated seeds	Wild seeds
Western crow	San Luis Obispo	5		3	1						2			1			2			2				1		2
Do.	Sacramento	16		15	1	1							1	1	1		1	1						2	4	3
Do.	Michigan Bar	2	2	2							1				1	1										2
Brewer's blackbird	San Luis Obispo	10		9							8		3				2									2
Do.	Sacramento	6	3	4		2	1		1	1	1		4				3									3
Do.	Michigan Bar	8	1	6				1			3		3	2			1									4
Yellow-billed magpie	San Luis Obispo	4	1	3		1				1	1		2		1	1	1			1					2	
Do.	Sacramento	3		3		1							1				2							1		2
Do.	Michigan Bar	1		1							1															1
Tricolored redwing	Sacramento	16		15					4			2	4				1	2	1							16
Do.	Michigan Bar	1											1								1					
California redwing	Sacramento	4								1	1		2				1									4
Do.	Michigan Bar	3		1							1		1													3
San Diego redwing	San Luis Obispo	1									1						1									
Desert sparrow hawk	San Luis Obispo	5	1	4	4	3							1		1		1									
California horned lark	San Luis Obispo	16		4						3	9		4	1			1									12
Do.	Michigan Bar	3									1		2				2									3
Arkansas kingbird	San Luis Obispo	3		2						2	2		2									1	1			1
Do.	Sacramento	2											3				1									1
Western meadowlark	San Luis Obispo	4		4						2	2		3				3									
Do.	Michigan Bar	1		1									1													
Western lark sparrow	San Luis Obispo	1		1																						
Western bluebird	San Luis Obispo	1				1				1			1				1									1
Bullock's oriole	San Luis Obispo	1									1		1				1									
American pipit	Michigan Bar	1											1													
California shrike	Sacramento	1								1																1
California jay	San Luis Obispo	2		2						2																2
Totals		121	8	80	6	9	1	1	5	14	35	2	41	5	4	2	25	3	1	3	1	1	1	4	6	63

On the Sacramento area crows, yellow-billed magpies, and tricolored redwings are very abundant, the last named often numbering into the thousands; because of their great density of population, these are the important species concerned in the reduction of grasshoppers.

Other students have listed many species of birds known to feed upon grasshoppers, but there has been no opportunity to collect uncommon birds that may occasionally visit the study units. In the present investigation interest was centered not so much in the length of the list of birds that feed upon grasshoppers as in the quantitative data; that is, in the assembling of sufficient information on the potential grasshopper-consuming capacity of the dominant species of birds present to enable proper correlation of the values of all factors influencing the rise and fall of grasshopper populations.

Too few data are as yet available to warrant a close estimate of the grasshopper-destroying capacity of any of the birds. In many instances they feed sporadically, leaving a plentiful supply of grasshoppers for repopulation of the area; very frequently they feed where grasshoppers are of minor economic importance. Although birds generally cannot be depended upon to control a grasshopper outbreak, in local instances they may effect substantial reductions. Their feeding upon grasshoppers acts as a check on increasing numbers. When a peak has been reached and the grasshopper is in the diminishing part of its cycle, then birds may become of major importance, hastening a return to the minimum population and lengthening the period to the next maximum.

SUMMARY

1. A brief history of the value of birds as grasshopper destroyers, with special reference to California, is presented.

2. The first recorded grasshopper outbreak in California was in 1722. During the period of study, 1935 to 1939, outbreaks occurred within a potential danger area of approximately 30,000,000 acres. The estimated annual loss from grasshopper depredations during the period covered approached $1,000,000.

3. Collections of birds were limited largely to three specific areas: San Luis Obispo, Sacramento, and Michigan Bar, the terrain, vegetation, and bird life of which are briefly described.

4. Stomachs and crops of 121 birds representing 16 species were examined. Grasshoppers were found in eighty birds of eleven species. Crows, yellow-billed magpies, Brewer's blackbirds, tricolored redwings, and meadowlarks proved the more valuable, with grasshoppers present in sixty-two out of seventy-seven specimens. Of nineteen horned larks examined, only four contained grasshopper remains; of

twenty-five other specimens representing ten species, ten contained grasshopper remains.

5. The need for quantitative data on the food and numbers of birds in order to determine their value as insect and vegetation feeders is indicated.

6. General field observations show that birds are of value in reducing grasshopper populations.

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BIRDS AS A FACTOR IN CONTROLLING INSECT DEPREDATIONS

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BIRD CONTROL: A STATEMENT OF FEDERAL POLICIES WITH A SUGGESTED METHOD OF APPROACH

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The purpose of this paper is to discuss, not details of damage by birds and methods of combating it, but rather to set forth some of the broader aspects of wildlife administration associated with the negative values of certain non-game birds, to discuss the policies and practices of the Bureau of Biological Survey in meeting its obligations in this field, and to comment briefly on one avenue of approach that seems worthy of fuller consideration. Above all, presentation of this paper before the conference does not spring from any current increased need for bird control or from a desire to emphasize it.

It does seem advisable at this time, however, to restate federal viewpoints on the subject, particularly to this group before which the subject has not previously been presented. It also is desirable to reassert policies of procedure coming, as these now do, not from the Department of Agriculture, but from the Department of the Interior. To those staunch defenders of bird life who might have some misgivings concerning any change affecting the administration of wildlife, assurance may be given at the outset that there has not been, nor will there be, under the jurisdiction of those now in charge, any lessening in the vigilant safeguarding of our beneficial species. Neither will there be hasty nor unwarranted pressure on those species that justifiably may be in need of local or temporary control.

The last-published word on federal policies pertaining to the control of injurious birds appeared as Miscellaneous Publication No. 145 of the Department of Agriculture. A brief quotation from that document, which was issued in response to a strong popular demand for information on the subject of bird control, may serve as a theme on which to reopen this discussion. Therein is found the statement that "the general policy of the Biological Survey is to hold bird control to a minimum. In individual cases the Bureau's policy is to study the situation in the field with the view of developing preventive and, when necessary and possible, control measures. These services, with subsequent dissemination of information on the results obtained, are considered a fulfillment of the Bureau's obligations. Large-scale control campaigns and far-reaching extension projects are not contemplated." In that same paper is the assertion that experimental work in the control of destructive birds is one of the functions of what was known at that time as the Division of Food Habits Research, carried out with the cooperation of other divisions of the Bureau equipped with personnel available for field inspection service.

The essentials of that policy set forth eight years ago still serve as the basis of the Bureau's approach to matters of bird control. Investigation is the first step taken in response to complaints of damage. This investigative work may take on the aspect merely of determining the validity of the complaint should it pertain to a well-understood and frequently recurring trouble. At other times it may involve studies of farm practices and bird habits not previously investigated and may call for the services of men trained in the field of avian economics and conversant with the agricultural aspects of the case. Then, if measures of crop protection or of bird control are in order, there will follow a period of experimentation with the view to develop procedures that will alleviate the situation, be they measures of avoidance, crop protection, bird frightening, or bird control. This, in turn, is followed by a program of demonstration either through the written or the spoken word, or, if personnel is available and opportunity presents itself, by actual demonstrations of relief measures. Seldom is there need for promotional programs of bird control, enterprises that, under pressure from outside sources, easily may be carried beyond the actual economic needs of the occasion.

In the solution of these problems or the alleviation of bird damage there must always be an attitude of impartial approach, sympathetic towards the correction of honest grievances, yet mindful of the consequences of hasty or unwise action taken in advance of investigation or without the benefits of qualified investigating personnel. Real grievances against wildlife must be honestly met; without such an approach public confidence cannot be maintained and in the end the cause of conservation itself will be the loser.

That the activities of wild creatures and agriculture often clash is a truism that all administrators of wildlife have encountered. That wildlife at times may be the offender and in need of regulation or suppression is indisputable. With game species there is, within broad limits, a measure of relief through appropriate regulation of the open season, the bag limit, and the removal of other restrictions regarding the kill. With unprotected non-game species the burden of protecting crops or of reducing the number of offenders rests largely on the crop owners by the application of such measures as experiments have shown to be helpful. With protected non-game species the problem becomes one of similar action carried out under sanction or regulation of governmental agencies (state and federal) entrusted with the administration of bird-protective laws.

Attempts to remedy situations of this kind may follow one of several courses. There may be direct and aggressive action against the species, involving trapping, shooting, or killing by other means. Milder action may include the employment of frightening devices which, if locally successful, may have the effect of dispersing the birds and thus diluting the damage, or merely of passing the trouble on to someone else. Protection of crops themselves may be attained by the use of deterrents, by more effective shocking, by screening, and through alteration of farm practices—measures whereby the problem is attacked through a process of avoidance rather than by combative action.

There is neither time nor reason on this occasion to go into the details of the various types of aggressive action that may be employed against bird offenders. To discuss adequately the subject of frightening devices also would take one far beyond the allotted time. Comment may be made, however, regarding one method of approach that is in need of greater emphasis and bids fair to yield results under some conditions more effective and lasting than those based on continuous suppressive action. It involves the principle of avoidance, a principle simple in itself yet one worthy of fullest consideration despite the fact that the success of its application generally will depend on a stupendous task of public education.

Farmers and others seeking a solution for problems of bird damage are usually aware of the added costs, labor, and difficulties connected with modifying farm practices. Naturally, therefore, they look toward the elimination or reduction in the numbers of the objectionable bird as a more direct and easy way out. All too frequently this logic is pursued with no comprehension of the difficulties or objections associated with such attempts. It is a sort of wishful thinking born of a lack of familiarity with another side of the question—the really effective control of bird life carried out safely, economically, legally, and *in a manner acceptable to public opinion.* These are aspects of the problem with which governmental officials entrusted with management of wildlife are constantly confronted and therein are to be found reasons for not advocating promiscuous and aggressive bird control, which to the uninformed seems so simple and withal such a direct answer to avian crop damage.

Attempts to solve problems of bird damage through alteration of farm practices offer obstacles as well as encouraging possibilities. They cannot be advocated blindly or without an appreciation of the difficulties that at times confront the farmer in attempting this method of damage avoidance. To say that sorghum crops should and can be removed from the fields before flocks of crows or ducks have congregated may, under some conditions, be sound advice, at other times, mere idle talk. A retarded growing season, late rains, and early snows, all may conspire to prevent the ripening or the removal of such a crop. The use of combines in the harvesting of small grains or field peas will no doubt place these crops out of the reach of blackbirds, crows, and waterfowl. This very thing is being done on many large farms, but what of the farmer with a small acreage who is not financially able to purchase such equipment or whose fields do not lend themselves to such harvesting methods? Following this general approach, one may find a host of borderline cases involving this or that planting or harvesting practice that might be followed but the adoption of which would add to the cost of crop production and tend to cut down if not to remove the margin of profit. Under some conditions the control problem takes on the nature of a gamble. On the one side are the added costs and labor coupled with freedom from bird damage, on the other the economy and profit of some harvesting short-cut with the possibility or even likelihood of having a part of the crop removed by the birds. The decision as to the better course must rest on the economics of each individual case, yet there is need for farm practice experimentation with which to obtain some general bases of cost appraisals in the safeguarding of the commoner crops subject to bird damage.

Still more drastic than the alteration of farm practices is the substitution of other crops for those that are particularly vulnerable to bird attack. Here again the problem of change from one to the other often is one of economics that can better be met by the farmer with financial resources than the one who might not be able to outfit himself with new equipment or invest in livestock should that move be called for. But there are on record cases where such changes have resulted in profits greater than those originally enjoyed, even though the move itself involved financial outlay of considerable proportions.

The suggested approach is nothing new, yet the method has never been subjected to earnest and persistent trial. Any attempt at solving problems of bird damage through adjustment in farm practices will call for the closest of cooperative effort on the part of the managers of wildlife and the leaders, experimenters, and demonstrators in the field of agriculture. Of these, the farm agents may have the more important function to perform. It is they who will be called on to determine the agricultural economics of any altered procedure, and it will be they who must convert a frequently conservative farm populace to acceptance of the new order of things. It will mean research by experiment station workers, farm economists, and plant culturists, and wherever promising results are forthcoming, energetic demonstration by extension agents. One cannot prophesy the results, but whatever progress is made will lessen proportionately the ever-recurring demand for bird control.

Despite the fact that these problems originate with wildlife their ultimate solution can be brought about only through a willing and interested personnel in the field of agricultural research and demonstration. The game administrator realizes that he cannot function effectively alone. He must seek the cooperation of those who hold the key to the door that is still locked. To those of us who, through dire experiences, are aware of the difficulties, the expense, and the public repercussions to aggressive bird control, the possibility of a well-guided program of avoidance holds much in promise both for agriculture and wildlife.

ENVIRONMENTAL IMPROVEMENT FOR VALUABLE NON-GAME ANIMALS

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The tradition and the law that wild animals belong to the state have for a long time deluded many into believing that wildlife has no connection with the land. In its extreme form this idea has led to the releasing of game animals on land hopelessly barren of food or cover. It has also resulted in the philosophy that the production of game for hunting amounts almost to a duty on the part of the landowner. Not so very long ago, however, an idea began to filter into wildlife literature that has had a profound effect upon wildlife management practice. This idea, even yet not commonly accepted, embodies the conception that wildlife is a product of the land, and that as patterns of land-use change, so do wildlife populations.

If most wildlife projects were undertaken on public land by public agencies, the benefits derived from them might be taken for granted as a means of furnishing public recreation. But as it happens, 85 per cent of the land in the United States is already in use for agricultural purposes, hence it follows that management must be undertaken for the most part on agricultural land by landowners.

Now game production is not in itself of paramount interest to farmers. There is never much profit and often a great deal of grief connected with the game harvest, so that the landowner can scarcely be blamed for looking upon the whole business with a somewhat jaundiced eye. But there is a type of management that seeks the improvement of environmental conditions for wildlife because wildlife in general is of value to the environment in which it lives. This is not game management. By actual count, most of the wildlife produced consists of non-game species, and wildlife management of this kind is undertaken to benefit the landowner as well as the wildlife itself. Game is a by-product.

The non-game animals produced are valuable in many ways. They include the great host of insect-eating birds of value to agriculture because they exert a considerable and continued repressive action on populations of insect pests. They include hawks and owls that perform a useful service to agriculture in their ceaseless pursuit and destruction of rodents. And they include carnivorous and insectivorous mammals, valuable in turn because they assist birds in the reduction of crop pests highly destructive to agricultural products and because some, at least, produce fur. These, to be sure, are generalities; but there is a vast literature that is most specific on such points which we cannot consider here for lack of time. It is enough to remark that the values mentioned are not intangible but real, and that if we cannot measure them in dollars and cents, then the fault lies with our method of evaluation, not with the values themselves. Let us then, proceed to specific ways in which the agricultural environment may be improved so as to enhance these values by producing larger populations of wildlife.

Strip-cropping, the practice of alternating cultivated crops with non-cultivated crops in strips placed on the contour, is usually classed strictly as a soil-conserving measure. Recently, however, counts of breeding bird populations in Ohio by Dambach and Good (1940) have disclosed that grain fields that are strip-cropped harbor nearly three times as many birds as solid grain fields do. They also show that strip-cropped meadows harbor almost twice as many birds as do solid meadows. Obviously this means that strip-cropping is a wildlife management practice technicians cannot afford to ignore.

The fencing of woodlands to protect them from grazing livestock is a soil conservation practice because it permits the development of a good soil cover. From a silvicultural standpoint it is necessary so that reproduction of woodland may take place. But fencing is also a wildlife management measure of first rank. Dambach and Good (1940) showed that there were 225 pairs of nesting birds in 100 acres of fenced woodland contrasted with 111 pairs per 100 acres in unfenced but otherwise similar woodland. Lay (1938) found that there are twice as many birds both in species and individuals along woodland edges as within woodlands. Such edges cannot reach full expression unless protected from grazing animals.

Farm ponds, built to provide livestock with water and sometimes to control gullies or even floods, are usually considered water-conserving devices. But they too are highly productive of wildlife when fenced —not only for wildlife, but also to prevent their filling with silt. Figures to show wildlife increases are not available, but observations have shown them to be rapid and spectacular in the vicinity of protected ponds.

Hedges, planted on the contour to assist in the prevention of soil washing, are of great value for wildlife. Edminster (1938) found, for example, that fields with hedges supported 60 per cent more pheasants than did fields without hedges. From the agricultural standpoint, a hedge should not be an accidental brushy fencerow maintained solely for wildlife benefit; it should be a planned and managed narrow strip of low-growing, preferably evergreen shrubs utilized no less for its value in preventing farmland from erosion than to encourage wildlife.

Field borders next to woods usually do not support a good crop because of the competition of adjacent trees. Since they have little vegetation on them, they frequently erode severely. Such borders may be planted to special types of vegetation, as vetch or lespedeza, to protect them from erosion. This is a soil-conserving practice, but where the special vegetation is selected with an eye to wildlife benefit, it is also a productive wildlife management measure (Davison, 1939).

Contour cultivation and terracing, in the minds of most, are solely erosion-control practices. But it is well-known that clear streams will support more fish than will streams heavily laden with silt. Contour cultivation and terracing then, are fish management measures of first rank, since it is obvious that stream-improvement operations are of little value unless the water can support fish.

Planting and protection of trees, shrubs, vines, and herbs on land unfit for cultivation because of an actual or potential erosion hazard is looked upon as soil conservation work. When the plants used for this purpose are selected with their wildlife food and cover values in mind, the use of such planting becomes a wildlife management practice also.

The environmental improvements for wildlife mentioned so far are undertaken to benefit agriculture. In this they differ from game management which is aimed solely at the production of game. Each of the environmental improvements is of measurable benefit to wildlife, but every one is placed on the land with several purposes in mind, of which wildlife production is only one.

The types of improvement recommended are integrated so closely with sound land use and correct agricultural practice that they become a part of agriculture itself. For this reason there can be no conflict between this type of wildlife production and agricultural production. The game produced can be harvested in any manner agreeable to the land-occupier and the hunter, but that is another problem. As long as wildlife conservation can be so combined with other land uses as to make it necessary to practice for other reasons than wildlife production, then whether or not wildlife is of immediate interest to the landowner makes little difference—wildlife is still produced.

If it ever becomes possible to appraise any given situation in terms of benefits accrued above the cost of wildlife management—and this in terms of cash, not words—perhaps landowners may undertake management measures aimed solely at wildlife production and nothing else. But until that time comes the economic establishment of wildlife production on most of the land in the United States must depend upon its integration with and contribution to agriculture.

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THE FISH-EATING BIRD PROBLEM AT THE FISH HATCHERIES OF THE NORTHEAST

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National Association of Audubon Societies

During the spring and summer of 1939 the writer conducted for the National Association of Audubon Societies a survey of the fish cultural establishments of the Northeastern States. The purpose of the survey was to determine what such establishments were doing about fish-eating birds. Every attempt was made to get detailed information concerning the species attracted, their numbers, their capacity for inflicting loss, and the methods in use for preventing such losses.

The writer traveled some 8,500 miles during the course of the survey and covered all the New England states, as well as New York, Pennsylvania and New Jersey. Every one of the fourteen U. S. Bureau of Fisheries hatcheries was visited, and ninety-one of the ninety-five state fish hatcheries and rearing stations. In addition, fifty-two of the sixty-nine licensed private hatcheries were covered, as well as forty-two bodies of water that were being operated as private fish ponds, some on a commercial basis and others as club property. A few handlers of and dealers in fish bait were also interviewed as occasion presented itself. Answers to a mail questionnaire were obtained from the owners of fifty-three additional fish hatcheries, private fish ponds and bait dealing establishments, making a total of 260 places for which data was obtained.

The list of birds definitely reported as having given trouble at the hatcheries in the area numbered thirty and some dozen or more were found to be under suspicion by certain hatcherymen. The most troublesome species at any given locality was found to depend, to some extent, on the nature of the general terrain, the character of the ponds in use, and the fish under culture, but in general it seems to be largely a matter of what species are the commonest as local residents or as migrants through the region.

The greatest number of complaints were received about the activities of the belted kingfisher, with the great blue heron and black-crowned night heron next. Most hatcheries complained about the osprey, although at only a few was it rated as the most serious predator. Here and there a hatchery would be encountered that would rate some additional species, like the common tern, herring gull or merganser, as worst.

As only a dozen out of the 260 establishments covered by the survey were found to be fully screened so that all fish-eating birds are physically prevented from reaching the fish, and practically all the rest were found to be killing the fish-eating birds, an attempt was made to determine what the kill of each species would average yearly at each establishment. It was found that, despite the fact that the keeping of detailed records is required by law in the case of most species, only a very small percentage of hatcheries have such kill records. In the absence of accurate records, an attempt was made to get the hatchery superintendent, or whoever else was interviewed, to estimate roughly from memory, or from such rough records as were available, the approximate annual kill of each species of fish-eating birds at the hatchery. These estimates, which are undoubtedly on the conservative side, as those giving them had full knowledge of the writer's connection and interests, when totaled indicate an annual fish hatchery kill of not less than 5,000 kingfishers, 1,000 great blue herons and 1,300 black-crowned night herons, in the above nine states.

When one considers that these losses are superimposed on natural losses, the seriousness of the drain is apparent. Even though these birds are at present considered common, they are none of them abundant, due to the highly specialized nature of their habitat requirements. That the toll taken by fish hatcheries is already having a noticeable effect was borne out by numerous reports from hatcherymen, many of whom said that they were no longer having the trouble with birds that they had a few years back when their hatchery was first established.

For the region as a whole, the decrease of the inland nesting osprey appears to have been most marked. This portion of the osprey population which leaves the coastal flight and progresses northward along the Appalachian ridges or up some of the numerous north and south flowing rivers of the region to reach the fresh-water lakes where they nest, appears to have suffered a 75 per cent decline in numbers over the past fifteen years. While most hatcheries report some osprey trouble, only those few fish hatcheries that lie along the migration routes of these birds report having had really serious trouble with them. These hatcheries, however, say that until recently they have had a lot of trouble with osprey and have had to kill a great many every year.

In the case of other species, the effect is not yet so noticeable, except locally, where a breeding colony or a local population that originally migrated along a water course near the present location of a hatchery has been wiped out. These local reductions, however, indicate that the trend is under way and with the continued increase in the number of federal and state hatcheries, as well as rearing stations operated by local sportsmen's clubs, and private individuals, the situation seems likely to become more serious every year.

To many, the above undoubtedly comes as a surprise. In theory most of the birds are protected by not only federal, but state law. Such laws, however, all have provisions for the issuance of permits for the control of birds when destroying property. Judging from what was learned during the course of the survey, it would appear that such permits have in the past been issued rather freely to anyone working with fish who asked for one. As far as could be determined, the recipients have never been required to do anything on their part to make their fish less vulnerable to birds. One of the most unfortunate aspects of the situation is that it places federal and state conservation agencies in a very anomalous and embarrassing position. What is the public to think when after being told that they will be fined if they kill any of these birds, they learn that the agency which stands ready to punish them is itself killing the birds in large numbers. In a great many of the government hatcheries, even the rules regarding the keeping of accurate kill records are apparently being ignored.

Is it any wonder that in view of this situation, the majority of owners of private fish hatcheries or fish ponds were found to be exercising such control as they desired in a completely illegal fashion, having no permit and keeping no kill records? In fact, the result of such a state of affairs is frequently to encourage local boys and sportsmen to go on regular hunts for these species and to shoot them whenever the occasion offers. Even game wardens were found doing the same thing themselves, condoning such illegal shooting on the part of others, and in a few cases even encouraging it.

One of the main objects of last summer's fish hatchery survey was to find possible solutions for the problem which has just been outlined. Unfortunately, most of the hatcheries were found to regard the killing of the birds as fast as they are baited in, as the only possible way of handling the matter. In fact, most of them regard this as so obviously the only solution that they seldom figure its cost or compare its actual effectiveness with other possible methods.

Here and there, however, an establishment was encountered where the problem was being solved in a different way—one that was permitting both the fish and the birds to live. In a few cases, it came about as a result of an appreciation by the hatcherymen of the values possessed by the birds, not only the esthetic values, but those which they possess as regulators of those aquatic forms on which they feed, many of which are competitive with or predatory on game fish. More frequently, though, the use of screens or wires comes about as a result of those in charge having viewed the matter from a truly practical and realistic standpoint. When they do this, they find that the cost of shooting patrols, often at overtime wages because of the odd hours, plus the fish that are lost despite them, plus the cost of guns, traps and ammunition, plus losses by diseases that may have been carried to the hatchery by fish-eating birds, amounts to a far larger figure than the maintenance and depreciation on screening and wiring which will completely exclude fish-eating birds. Unfortunately, this second approach often results in only partial screening, a practice which, while it saves the screened fish, does not save the birds. The survey revealed that at only the twelve fully screened hatcheries had the killing of fish-eating birds been completely stopped. At many of the thirty-six partially screened hatcheries, the kill of birds was not appreciably less than elsewhere, as it appears that as long as any pond containing fish remains unprotected, those birds that are baited into the hatchery will eventually find it and try to feed there.

My survey left no doubt as to the complete feasibility of these devices whereby fish-eating birds of all species can be excluded from water bodies of all the types and sizes that are actually needed for the culture of any variety of fish. For the herons, a sharp drop from an edge too far above the water for them to reach down, to a depth too great for them to wade, solves the problem. In cases of earth or gravel construction, where this is not feasible, a 2-foot high shore line fence of 1-inch chicken wire, staked just in shore from the depth that exceeds the heron's leg reach, will do the trick. For terns, osprey, kingfishers and mergansers, the answer is a chicken wire fence and strands of very fine, strong wire strung clear across the unit at intervals of a foot or less. To prevent the kingfisher from working in and out at the ends by alighting on the side support from which the wires are strung, a short spike at each interval is needed. Complete screening of this type, of course, also excludes the herons, and if it clears the water by 6 feet, it in no way interferes with the work of the hatchery.

Some few very large hatcheries are apt to point to their enormous lay-out and declare the cost of screening to be prohibitive. Actually, however, it is no more, on a percentage basis, than anywhere else and the total first cost will be only a small fraction of the investment which the present plant already represents.

It is the writer's conviction, as a result of the survey, that the problem can be solved, often at an ultimate profit to the fish culturist, and always at a profit to the public whose birds are thereby saved.

THIRD TECHNICAL SESSION

Tuesday Afternoon—March 19

Chairman: C. McC. Mottley

Cornell University

MEASUREMENT OF FISH POPULATIONS

REPORT ON THE UPPER PECOS RIVER CREEL CENSUS, SANTA FE NATIONAL FOREST

Merle A. Gee
U. S. Forest Service

During the summer of 1939, a creel census was conducted on the Upper Pecos River on the Santa Fe National Forest in New Mexico. The purpose of this creel census was to determine: (1) the fishing effort or amount of fishing, (2) the success of natural reproduction, (3) which species of trout did the best of the several species present, and (4) to gather material for food, growth rate and condition factor studies. A knowledge of all these things is essential in developing a management program for any water and is effectively obtained by means of a creel census.

The creel census station was located at the mouth of the Mora River where there was a CCC side camp. A checker was on duty from 8:00 a.m. to 8:00 p.m. every day of the week from May 15, the opening date of the trout season, to September 21, when the numbers of fishermen had decreased to a point where it was considered no longer feasible to keep a man on duty. The work was disrupted for only a short period of four days from June 15 to 19. A good many of the returns for these four days, however, were obtained by contacting campgrounds and resorts.

Although not all the fishermen were contacted because some passed through the station late at night when a checker was not in attendance,

TABLE 1—UPPER PECOS RIVER CREEL CENSUS—1939
(Includes that portion of the river above the mouth of the Mora River)

Month	Number of fish by species	No. of fishermen	Failures to catch fish	Per cent of failures	Total number of hours fished	Average number of hours fished per fisherman	Average number of fish caught per hour	Average number of fish caught per fisherman
May 17 days	Rainbow—503 Brown—543 Yellowstone native—25 New Mexico native—21	323	117	36.5%	1,140	3.5	.96	3.4
June	Rainbow—679 Brown—1,007 Yellowstone native—92 New Mexico native—5	389	92	23.6%	1,087.5	2.8	1.6	4.6
July	Rainbow—422 Brown—1,023 Yellowstone native—194 New Mexico native—77	379	46	12.1%	1,184	3.1	1.4	4.5
August	Rainbow—544 Brown—969 Yellowstone native—275 New Mexico native—15	388	36	9.0%	1,254	3.2	1.4	4.6
September 21 days	Rainbow—270 Brown—360 Yellowstone native—68 New Mexico native—28	155	16	10.0%	426	2.7	1.7	4.7
TOTALS		1,634	307	Average 18.7%	Average 5,091.5	Ave. 3.1	Ave. 1.4	Ave. 4.35

Brown trout	3,902—54.8%	Natural reproduction
Rainbow trout	2,418—33.96%	
Yellowstone native trout	654— 9.18%	
New Mexico native trout	146— 2.06%	Natural reproduction
	7,120	

The brown trout and New Mexico natives, a total of 56.86 per cent, are all natural reproduction.

it is felt that a large enough sample was obtained to be statistically accurate for the conditions existing.

A total of 1,634 fishermen's daily catch records were obtained. These fishermen caught 7,120 fish or an average of 4.35 fish per unit of fishing effort or each day's fishing. The average length of time fished was 3.1 hours and the average number of fish caught per hour was 1.4 fish. When it is considered that the average fisherman is not very proficient at angling and that the Pecos River is very heavily fished, this apparently low average catch per hour is not so bad. For the purpose of comparison, the average catch per hour is given for the Pecos and several other easily accessible streams in the Southwestern Region:

Pecos River—Santa Fe	1.4 —1939
Tonto Creek—Tonto	1.39—1936
	1.36—1937
Horton Creek—Tonto	1.61—1936
	1.36—1937
Willow Creek—Gila	1.98—1939

These figures show that the ability of fishermen as a group varies little for these four streams. The average catch per hour or per day, however, can be of value in measuring and evaluating the effects of fish management. If any of the above streams were put under special management and the average catch per hour was materially increased, then the effects of special management measures can be shown. This is considered the most important of several criteria which include average size, growth rate, and condition of the fish.

Three days before the opening of the fishing season, 799 rainbow trout, averaging 8 inches in length, were tagged by the New Mexico Game and Fish Department and planted 4 miles above the creel census station on the Pecos River. During the time that the checking station was in operation, 458, or 58.8 per cent, of the tagged fish were caught. Of those returned, 30 per cent were returned during the first ten days of the fishing season and 77 per cent were returned by July 3. Figure 5 shows the number of tags returned by ten-day periods. As many people desired the tags as souvenirs, undoubtedly many tagged fish were caught that were not reported but the above figures indicate that the legal-sized fish planted shortly before or during the open season are removed very rapidly. The very high return of 58.8 per cent of the tagged fish, i.e., if 799 fish is a fair sample, definitely shows that planting of legal-sized fish produces fishing. The question now arises as to the importance of planted fish in the total catch.

Of a total of 7,140 fish caught, 54.8 per cent were brown trout, none of which had been planted for at least eight years. Assuming that the 43.05 per cent rainbows and Yellowstone natives were all planted fish, because these species have been planted in abundance for several years, it is still apparent that natural reproduction is producing most of the fish. Planting records for brown trout reveal that none were planted in the section covered by the creel census for at least eight years. The catch of rainbow trout never exceeded that of brown trout during the entire season (Figure 1).

The effect of fishing effort on numbers of fish caught was very interesting. The three main species are brown, rainbow and Yellowstone native trout. Fishing effort increases slightly in June and then continues at a fairly constant rate until September when it drops off sharply. The number of brown trout in the catch increases rapidly in June, gradually reaches a peak in July, when it drops slightly in August, and then drops sharply in September. The curve shows that brown trout is the most abundant species and though produced by natural reproduction, falls off only slightly in August from the high in July. The big drop during September is accounted for by the sudden drop in fishing effort. This is true of the other species shown,

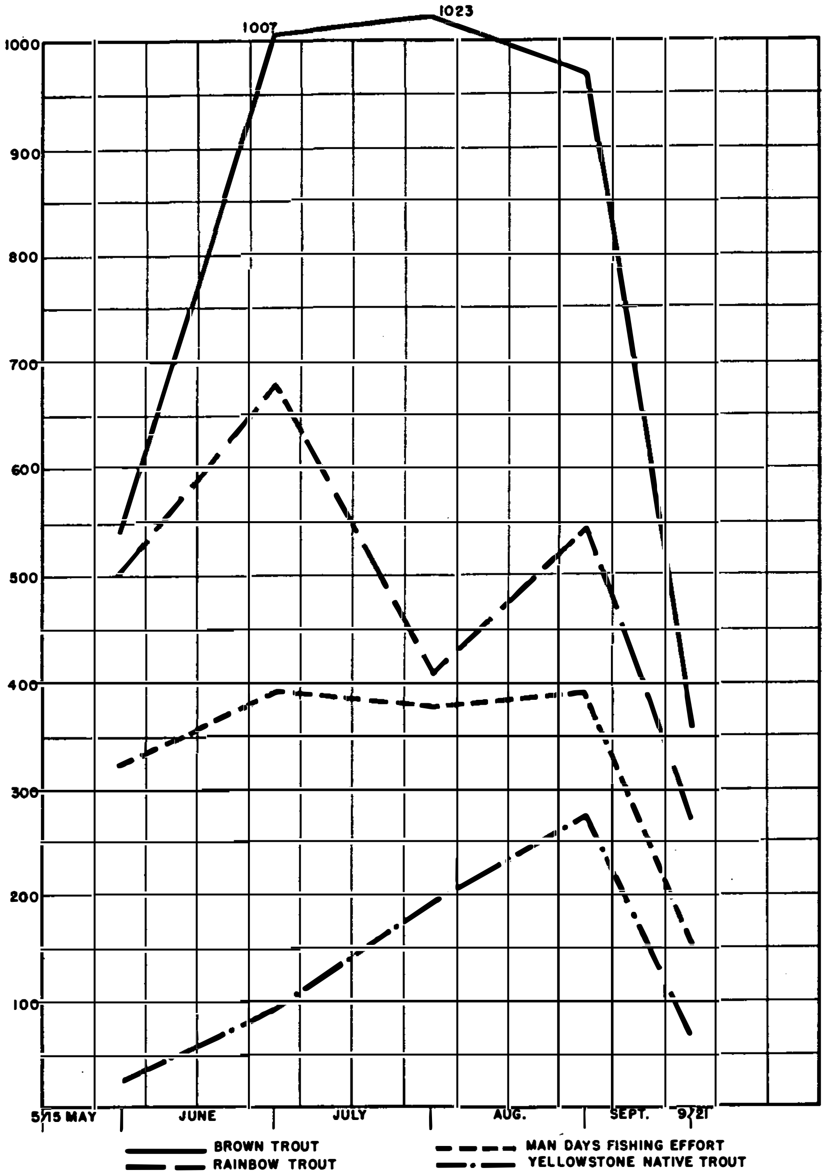


FIG. 1—UPPER PECOS CREEL CENSUS — SANTA FE N. F. 1939
GRAPH SHOWING NUMBER OF TROUT CAUGHT AND MAN DAYS FISHING BY MONTHS FROM MAY 15 TO SEPT. 21, 1939

the curve for their numbers falling off at a rate equal to the drop in fishing effort in September.

The number of rainbow trout increases to their high point in June, falls off sharply in July, and then increases again in August. This August increase does not approach the high in June, however. It is rather difficult to account for this increase in August or on the other hand, the decrease in July. Rainbows are generally considered to be mostly hatchery fish because they are planted in large numbers, both as fingerlings and as legal-sized fish. There was a planting of 3,000 legal rainbows made on July 3 but it is difficult to account for the rise in August by this planting because the returns from the tagged fish show that planted legal fish are removed rapidly after being planted. Furthermore, there was a definite drop during July following this plant. There is the possibility that a planting of 23,500 three-inch to six-inch rainbows attained legal size about this time and so caused a rise in the catch. As mentioned previously, the catch of rainbows drops sharply in September due to the abrupt drop in fishing effort.

Numbers of Yellowstone native trout comprised only 9.18 per cent of the total catch. They were apparently of little importance in the catch during May and June but in July and August they steadily increased, reaching their peak in August. Little can be said to account for this increase, unless, as was suggested for the rainbows, small fish planted in 1938 were just attaining legal size and becoming available. An argument in favor of this theory is the fact that the major increase in numbers in the catch of both Yellowstone natives and rainbows was in the smallest size class.

A graph of brown trout catches, by 2-inch size classes, shows very well the trend of the three most common size classes of a trout population, supported solely by natural reproduction, under a sustained, intensive fishing effort. The 10-12 inch size class starts falling off from the beginning of the season and goes down to zero in August. In September, two fish were caught. The 8-10 inch size class increases from May to June when there is a slight increase in fishing effort and then fals off steadily until September 21. The 6-8 inch size class increases rapidly from May 15 to August 31 and then drops off sharply because of a sharp drop in fishing effort. The continual rise in numbers of the 6-8 inch size class from month to month as the season advances shows that this smallest size class is carrying more and more the brunt of the fishing effort as the larger size classes fall off.

If this tendency of the fishing effort to be directed to an increasingly greater extent towards the brown trout of the 6-8 inch size (because the larger size classes are so reduced in numbers) continues over a

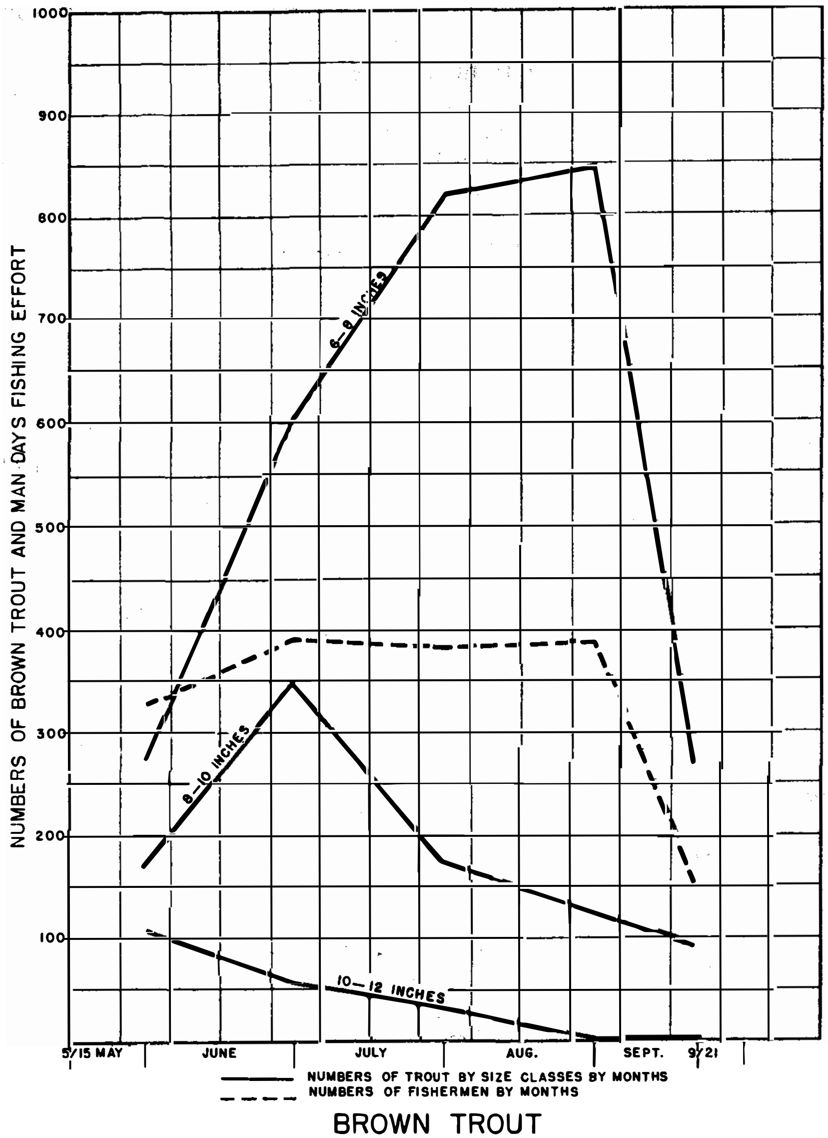


FIG. 2—UPPER PECOS CREEL CENSUS—SANTA FE N.F. 1939

period of years, the average growth rate of brown trout will decrease and the ability of that species to reproduce in as large numbers as at the present time will be impaired. The principle of natural selection

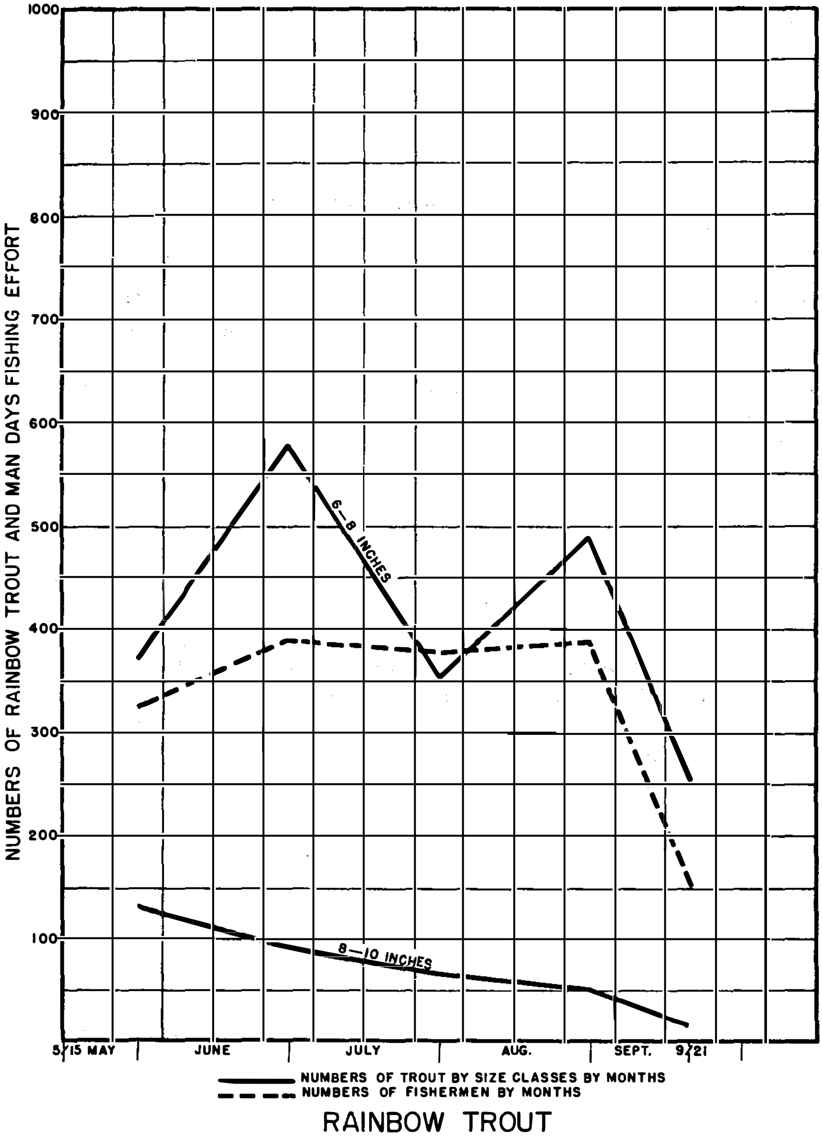


FIG. 3—UPPER PECOS CREEL CENSUS—SANTA FÉ N.F. 1939

is very definitely involved here. The intensive fishing effort leaves the smaller and only recently mature fish to carry on natural reproduction because of the rapid removal of fish after they reach the legal size of

6 inches. These small fish that spawn are either slow-growing fish that mature before they reach legal size or are fish spawning for the first time. The slow-growing spawners have a tendency to produce slow-growing fish. This is an inherited characteristic and the numbers of these slow-growing fish will increase as time goes on if the present conditions maintain themselves. Numbers of brown trout will decrease because first spawners produce few eggs and consequently not so many trout.

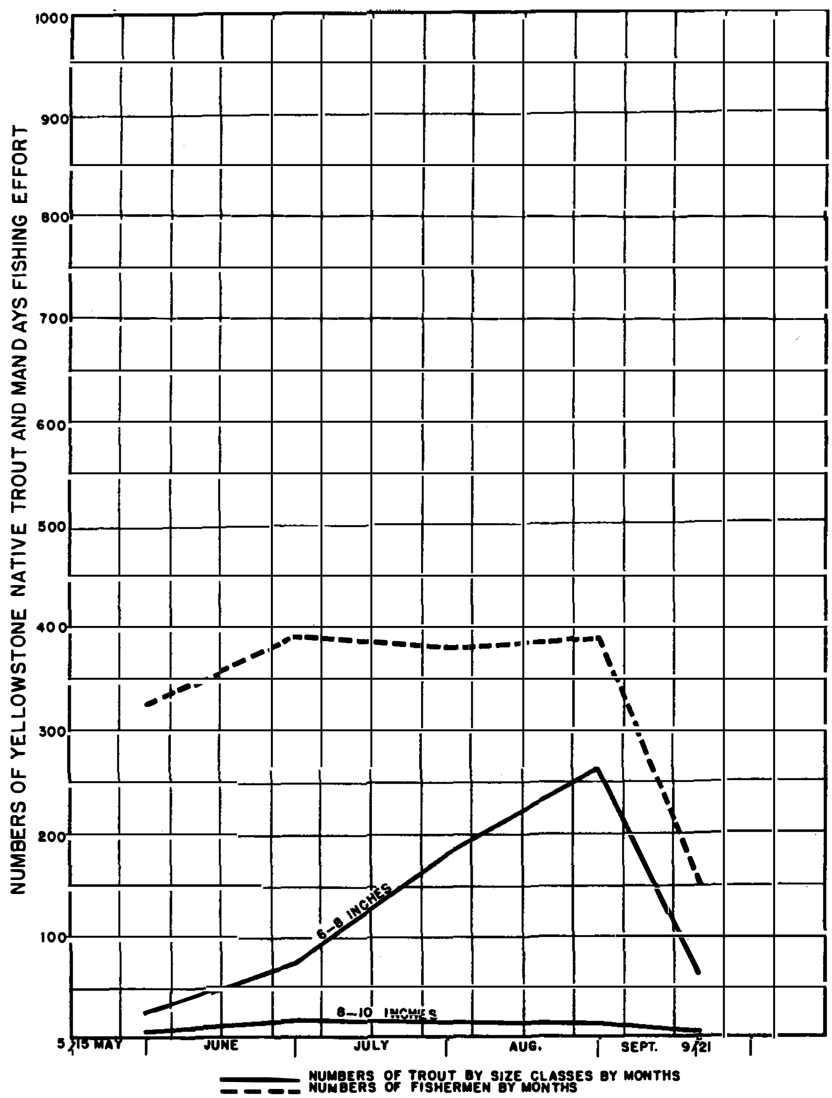
Management effort should be directed so that the fishing effort will maintain a well-balanced population of all size classes of trout in the stream at all times. If the relationship of the size classes of browns shows their relative proportions in the total population, then a very unsatisfactory condition exists in Sepember. There is a definite paucity of brown trout of the 8-10 inch and 10-12 inch size which are the "back log" of natural reproduction.

Because the bulk of the rainbows were in the 6-8 inch size class, a graph for this size class is nearly identical with that for total number of rainbows. The 8-10 inch size class represents only a small number in the total catch and drops off steadily from the start of the fishing season. This size class apparently is not supported by plantings and probably is made up of fish that were planted as legal size during 1938 and escaped being caught until 1939. Rainbows of the 10-12 inch size class were too few in the total catch of rainbows to show any definite trend in monthly catches. Only seventeen fish in this size class were reported.

Concerning the Yellowstone natives, only the 6-8 inch size class is of any importance in the catch and a graph for this size class is practically the same as one for total numbers of fish. The rise in numbers in August corresponds to the rise in the 6-8 inch rainbows and possibly can be explained the same way as the rise in numbers in the 6-8 inch rainbow size class, i.e., that fingerling Yellowstone natives planted in 1938 were reaching legal size.

The yield of fish in pounds per acre of water surface in the Upper Pecos is the highest of several southwestern streams studied to date. A comparison of the yield per acre in pounds of fish for the Upper Pecos and three other streams indicates that production per acre on the Upper Pecos River is 10 pounds greater than the best of the other three streams.

If the production of trout in pounds per acre is translated in terms of hatchery fish and wild fish, it is found that brown trout and the few New Mexico native trout caught account for a production of 39.2 pounds per acre and the rainbow and Yellowstone native trout, which



YELLOWSTONE NATIVE TROUT

FIG.4—UPPER PECOS CREEL CENSUS—SANTA FE N.F. 1939

are assumed to be hatchery fish, account for 29.7 pounds per acre. This shows that natural reproduction in the Upper Pecos produces a larger percentage of fish per acre than planted fish and indicates the

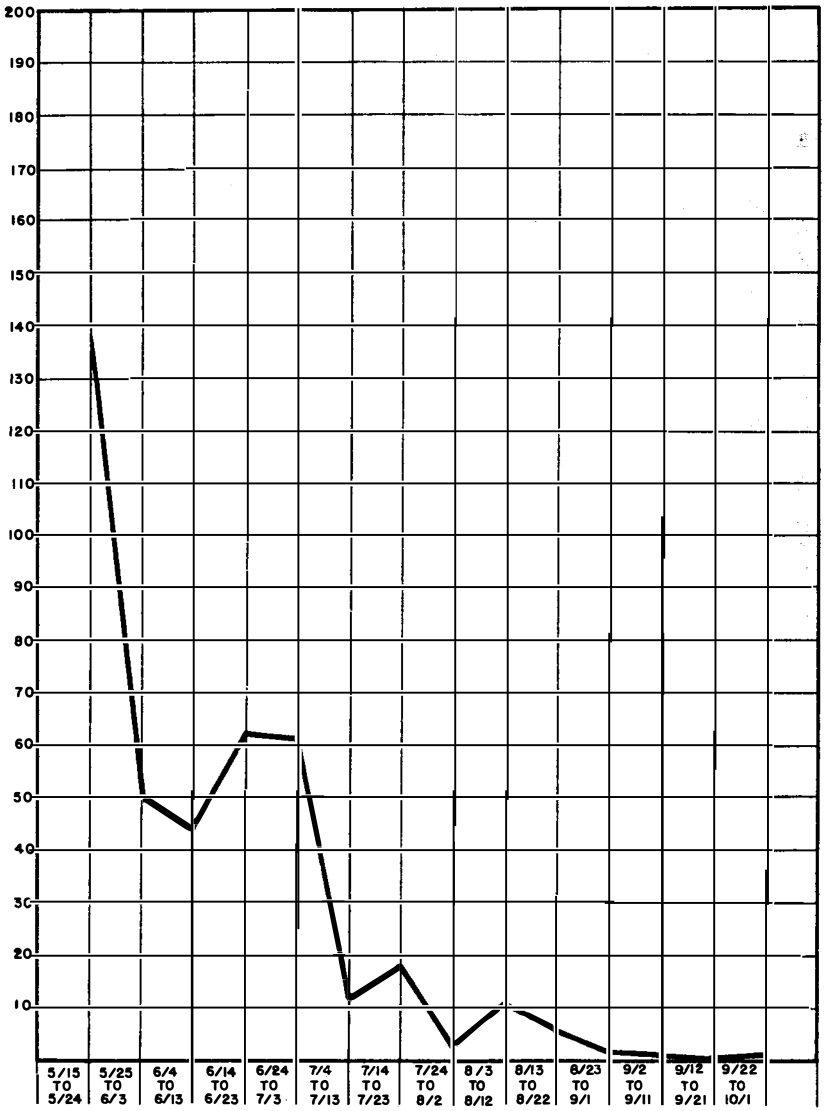


FIG. 5—UPPER PECOS CREEL CENSUS—SANTA FE N.F. 1939
GRAPH SHOWING THE RETURN OF TAGGED FISH BY 10 DAY PERIODS.

portion of the population which should be encouraged by special management measures as well as the portion of the population that would respond the best to special management measures.

CONCLUSIONS

1. Legal-sized rainbows are removed rapidly after being planted, assuming that 799 tagged fish are considered to be a fair sample.

2. Brown trout in the Upper Pecos made up 54.8 per cent, of the total catch without any assistance from planted fish.

3. Fishing effort, except for a fairly heavy concentration during the first two weeks of the season, is fairly constant until September if it is based on total numbers of fishermen per month. Fishing effort drops off sharply in September.

4. Planted rainbows apparently do not serve as an effective buffer in protecting the brood stock of browns as an undesirable trend exists in the removal of the brown trout population by size classes under the intensive fishing effort. The fishing effort is directed too hard at the smallest size class as the season advances because the larger size classes are so reduced in numbers.

5. Because natural reproduction of brown trout in the Upper Pecos is so important, it is logical that management should be directed towards its encouragement. To this end management of the fishing effort so as to maintain at the end of the season a larger population of the mature 8-10 inch and 10-12 inch brown trout seems to be one of the most important methods of management. These larger size classes represent the faster-growing and older fish which are most important as brood stock to carry on natural reproduction.

Any management to this end would automatically prevent the rapidly increasing removal of the immature fish and fish spawning for the first time and so would materially aid in maintaining a well-balanced population of all size classes of fish. It is very important to have new spawners entering the population to replace the extremely old and decadent spawners.

AN ANALYSIS OF FISHING IN THE TVA IMPOUNDMENTS DURING 1939[1]

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Tennessee Valley Authority

An inventory of fishing on Norris, a storage reservoir, was initiated in 1938. The following year it was extended to Wheeler, a run-of-the-river reservoir, and to the tailwater area below Wilson Dam. This inventory, therefore, covered each of the three general types of fish habitat created by TVA dams. This discussion is a summary of the

[1]Published by permission of the Tennessee Valley Authority.

1939 fishing data, together with recommendations for fish management based on the creel census information. The data collected totaled 34,270 usable fishing records, representing a catch of 98,495 fish.

An estimate of the amount and value of fishing in the Tennessee Valley is not available, but this resource obviously constitutes an important asset to the region. The total number of man-days of fishing on Norris is roughly calculated to be 125,000; on Wheeler it is estimated to be about 200,000; and in the Wilson Dam tailwater approximately 32,000. Fishing on these three waters alone, therefore, represents about one-third of a million man-days. In addition, fishing is known to have been heavy on Wilson Reservoir and in the tailwaters below Guntersville and Wheeler Dams. The catch in 1939 in the major waters of the Valley probably exceeded one million fish.

In 1939 Pickwick and Guntersville Reservoirs were too new to have a reasonably large fish population, and Hiwassee and Chickamauga Reservoirs were not yet impounded. On several other reservoirs dam construction has been initiated only recently. When these reservoirs are completed and their fish populations have had an opportunity to become well established, the total catch for the Tennessee River and its tributaries will undoubtedly be much greater than it is at present.

Reliable data are not available on the extent of fishing before impoundment, but the catch in the reservoirs is now undoubtedly far greater than it was in the river before the dams were built. There is little reason to believe that these impoundments will tend to become "biological deserts" after a few seasons. Wilson Reservoir has been in existence for fifteen years but is still fished intensively, and the tailwater immediately below the dam yielded about 125,000 pounds of fish in 1939.

This inventory of the fishing is taken to provide information needed to properly manage the fishing resources. Regulation is the major tool in the management of large waters, with environmental improvement and stocking probably of secondary importance. The specific purpose of the inventory is, therefore, to obtain information on which to base recommendations for regulations. These regulations would presumably maintain a desired balance among the various species so that the coarse fish do not increase in numbers and become dominant at the expense of the more valuable pan and game fish. The laws are, of course, made and enforced by the states in which the waters are located.

The data will indicate the relative abundance of game, pan, food, and coarse fish in the catch and, over a period of years, will tend to show the evolution and trend of the fish population in these new waters, making it possible to anticipate needed regulations. Another purpose of the census is to evaluate the fishery by learning the amount, kind, quality, and economic value of the fishing. The 1939 creel census is to be regarded as a preliminary step in the general inventory for it covers only three waters and, on two of these, only one major kind of fishing.

The three general types of water created by impoundment in the Valley are distinctly different. Their major characteristics are briefly mentioned:

Norris: The storage reservoirs are located on tributary streams near the upper part of the Valley. The one under consideration, Norris, has one major fluctuation each year, the water level being high in summer and low in winter. The reservoir, which is in rugged terrain, has an irregular shoreline, much of which is steep. It has an area of 34,200 acres and a shoreline of 705 miles when at elevation 1,020. The water is generally clear, but coarse vegetation is absent and bottom organisms are few due to the annual fluctuation of 50 or more feet and because of bottom stagnation. There is a decided thermal and chemical stratification and little river influence, because of the relatively large storage volume in comparison to the inflow. Hiwassee Reservoir is of this same general type.

Wheeler: Wheeler, like the other run-of-the-river reservoirs, is on the main channel of the Tennessee River. Although it resembles Norris in having an irregular shoreline, it is decidedly different in most other respects. The surrounding country, which is largely farm land, is fairly flat and shoal areas are very extensive in some portions of the reservoir. There is a major river influence and, therefore, no stratification. A definite current is present in the former river channel for over two-thirds of the length of the reservoir, and in time of flood the entire reservoir becomes a river with a perceptible current in the backwaters and a fairly rapid flow in the channel.

The water is generally murky, becoming muddy throughout the reservoir at times of increased flow. In summer there are frequent minor fluctuations in water level coupled with a gradual drawdown. In winter the level is several feet below normal summer level. Flood control is a function of this and other reservoirs, explaining the low early winter level. These drawdowns and the high turbidity are probably responsible for the absence of submerged aquatics.

Unlike Norris Reservoir, Wheeler offers considerable diversity of fish habitat and can be divided into three more or less distinct sections: an upper third where water is confined primarily to the original channel; a middle third where water overflows the banks of the stream; and a lower third where the lake extends to the fairly steep margin of the flood plain.

River conditions prevail in the upper third which differ from pre-impoundment conditions chiefly in greater depth of water. Shoal areas are largely absent, the water being confined to the former channel where the flow is not so fast as it was prior to impoundment, but a perceptible current is always present. The water is more turbid in this upper portion than in the lower reaches of the reservoir, but there is little silt deposition and the original bottom materials are still present. Fishing here has changed little from that practiced before impoundment except, of course, in the tailwater below Guntersville Dam. Setline fishing is practiced extensively and the take by this method consists mainly of catfish and drum. Bank fishing with cane poles is second in importance, and sport fishing is of minor significance. Most of the fishing is done by the plantation workers and its intensity depends considerably on the extent to which these workers are needed in the cotton fields. Fishing here is chiefly to provide food and, to some degree, to supplement the income received from farming.

The upper portion of the reservoir grades gradually into the middle section where, due to the gradual slope of the valley, the water spreads over the adjoining flats on both sides of the channel. This area is characterized by wide, shallow water areas that are separated from the main channel by natural levies which become shallowly submerged toward the lower end of the section so that the flats are confluent with the channel. The shoreline in this area is very irregular and there are many protected coves where several species of shrubs and trees are abundant. Here the tributary streams have extensive flats where swamp conditions formerly prevailed. Much of the water in these latter areas is less than 3 feet deep and the frequent small fluctuations alternately expose and cover some thousands of acres whcih have been invaded by such plants as spiney waterleaf, *Nama quadrivalve;* water purslane, *Isnardia palustris;* and lizards tail, *Saururus cernuus.* The flats exposed by the drawdown are invaded by such plants as cocklebur, *Xanthium americanum,* and other annual terrestrials. When the water rises in the spring, these plants enrich it by the addition of organic material.

In the lower portion of this section the backwater is deeper and the channel loses its identity when the flow is normal. Silting takes place here even in the original channel. Much of the fishing is concentrated in this rich mid-portion of the reservoir, and angling for pan and game fish has increased many fold since impoundment.

The middle section grades into the lower section, which is characterized by lake conditions for there are wide stretches of deep, open water which extend to the moderately steep edges of the flood plain. The water is much clearer in this section than in the upper portions of the reservoir. Wave action is more pronounced and beaches are being formed. Silting takes place in this section and the original bottom material has been covered, causing the mollusks to disappear and mollusk-eating fish, such as the drum, to be in poor condition and perhaps decreasing in abundance. Bass are common here and catfish are taken in considerable numbers. Mooneye, gizzard-shad and open-water species are plentiful.

All major reservoirs on the Tennessee River proper are of the run-of-the-river type and conditions described for Wheeler apply also on these other waters.

Wilson Dam Tailwater: Wilson Dam tailwater is actually a portion of Pickwick Lake. It differs from the lake proper primarily in the fact that rapid water conditions prevail for a mile or more downstream. The area is really a large, fast, turbulent, well-aerated river attracting fish which show a preference for, or at least a tolerance to, fast river conditions. The deep pool and the large rocks immediately below the dam are apparently very attractive to the fish, for a majority of them are taken in this moderately small area.

Each of the three habitats briefly discussed above has management problems peculiar to itself and, for this reason, the creel census and the management suggestions are considered separately.

General Creel Census: Information on the fishing and fish catch on Norris Reservoir in 1939 is based on 7,392 fisherman-days, about half of them from Norris dock and the remainder from Stiners, Cedar Grove, Andersonville, and Hickory Star docks. At Norris dock the census was taken by CCC personnel from TVA Camp No. 45, and does not include fishing on Saturday afternoons and Sundays. At the other docks the operators cooperated directly with the Forestry Relations Department in taking the census. At Stiners and Cedar Grove records were obtained for most of the fishing, but at the other two docks the records covered a smaller percentage of the fishing. The data are for the period from June 1, opening day of the season, to late November.

TABLE 1—SUMMARY OF FISHING ON NORRIS RESERVOIR FOR 1938 AND 1939

Year	Month	Number of anglers	Fish caught	Hours fished	Catch per hour
1938	August	411	654	2,615	0.3
	September	1,079	1,628	6,591	0.2
	October	1,432	2,794	8,472	0.3
	November	577	1,394	3,327	0.4
1939	June	2,658	3,635	14,643	0.2
	July	1,271	729	6,875	0.1
	August	1,345	727	6,600	0.1
	September	1,061	1,543	6,033	0.3
	October	1,011	1,937	6,201	0.3
	November	46	70	271	0.3
TOTAL (1939)		7,392	8,641	40,623	0.2

In the 7,392 fisherman-days listed 8,641 fish were caught in 40,623 hours (Table 1). Five major game fish constituted 91 per cent of the fish taken by anglers fishing out of the five docks. General data on the fishing for all docks combined are presented in Table 1, where the information is compared for 1938 and 1939. Table 2 shows the relative abundance of the several species in the catch. Eighty per cent of all fish taken were bass—50 per cent largemouth, 24 per cent smallmouth, and 6 per cent Kentucky. The walleyes constituted 9 per cent of the total catch and the saugers 2 per cent.

TABLE 2—RELATIVE ABUNDANCE IN THE CATCH OF THE VARIOUS SPECIES OF FISH, EXPRESSED AS A PERCENTAGE OF THE TOTAL CATCH, BY MONTHS. NORRIS RESERVOIR 1939.[1]

Month	Black Bass			Wall-eye	Sauger	Blue-gill	Crappie[3]	Carp	Misc.[4]
	Large-mouth	Small-mouth	Ken-tucky[2]						
June	53	21	6	11	1	4	3	1	..
July	58	16	4	6	1	9	..	3	1
August	45	29	2	5	1	15	..	1	3
September	43	30	6	9	3	7	..	..	1
October	50	26	8	6	3	5	..	..	..
November	41	23	31	3	1	..	..	..	..
Average (1939)	50	24	6	9	2	6	1	1	1
Average[5] (1938)	39	24	[6]	3	[7]	30	..	1	3

[1]Total number of fish on which percentages are based is listed in Table 1.
[2]Some Kentucky bass were probably included in the largemouth.
[3]Black Crappie (*Pomoxis sparoides*).
[4]Includes rock bass, catfish, suckers, drum. and sunfish.
[5]August to November only.
[6]Included in largemouth.
[7]Included in walleyes.

Data for 1938, August to November, and for the same period in 1939 show about a similar catch per hour. Actually, however, fishing was considerably better during the 1939 period, because 91 per cent of the fish taken then were major game fish whereas they were only 66 per cent for the previous period, and the largest of the game fish, the walleye, was three times as well represented in the 1939 catch as in the 1938 take. Observation indicates, too, that the game fish averaged larger in size in the 1939 season.

In a new reservoir, changes in the fish population are sometimes rapid. Two rather decided changes in the trend, all substantiated by observation, are suggested by a comparison of the information for the two seasons. Walleyes are apparently very much on the increase and bluegills of catchable size are rapidly decreasing in number. The increase of walleyes from about 3 per cent to 9 per cent, and the decrease of bluegills from 30 per cent to 6 per cent in the catch, show the trend of these two species. Crappie are fairly well established in a few localities, but their distribution through the reservoir has not yet become general. Except for one specimen, all 114 crappie were reported from one of the 5 docks.

An interesting correlation exists between the position of the docks on the lake and the relative abundance of largemouth and smallmouth bass in the catch from different portions of the reservoir. The ratio of largemouth to smallmouth is indicated below:

1. At the dock farthest up the arm receiving the major inflow of water, the ratio was 7:1.
2. At the dock some miles downstream on the same arm, the ratio was 5:1.
3. At the dock still farther downstream, on a large expanse of water on the same arm, the ratio was 1.5:1.
4. The dock at the dam had a ratio of 1:1, with smallmouth slightly predominating.
5. At a dock far up the arm receiving the second greatest inflow, the ratio was 3:1.

Reasons for this correlation are considered later under a discussion of chemical conditions.

Except for this relationship between the two most prominent bass species, the catch was relatively similar at each of the several docks. The percentage of game fish in the total fish catch at each of the five docks was ninety-two, eighty-nine, eighty-eight, ninety-six, and ninety-six, respectively. The catch per angler was similar at the two docks, Cedar Grove and Stiners, which provided cards for almost all fishing at their docks and apparently showed no inclination to forget to report on fishermen taking no fish. One had a catch of 1.2 game fish per angler, and the other a catch of 1.4 game fish per angler. At Norris dock, where the census was taken by the CCC and was almost complete for five and one-half days of each week, the catch per angler was only 0.8. The reason for this difference is explained later under the discussion of chemical data.

The total amount of fishing on Norris can be estimated only roughly. Between July 28 and August 14 anglers along the entire shoreline were counted, except in the extreme upper portions of several of the arms where travel by outboard was hazardous or impossible. The count, made on week days, totaled 117 anglers in boats, and 111 bank fishermen. These data are exclusive of anglers in boats out of the docks. In the count all points were passed only once. Because the average fisherman-day is only about five to six hours, either morning or afternoon, the actual number of fishermen each day for the period was probably twice the number seen, or about 400. Earlier in the season the number of fishermen was undoubtedly greater. By October, when another count was made, the number had declined to forty-four bank fishermen and ninety-two boat fishermen. About 100 and 200 bank and boat fishermen, respectively, are considered to have been fishing per day.

On the basis of an estimate of 400 anglers a day for the months of May to September, inclusive, and 300 for March, April, and October, the number of fishermen other than those fishing out of the docks is estimated at about 87,000. The August count showed that in addition to boats located at the docks there were 678 boats along the shore, all or almost all of which were used for fishing. Perhaps half of these were used for setline fishing and the other half for casting, still fishing, and trolling. In the October count the number of boat fishermen who secured their boats at the docks was about equal to all the others, the counts being eighty-six and ninety-two, respectively. In August no count was made of the fishermen in the first group. On the basis of this rather meager information, it is estimated that the total amount of fishing on Norris in 1939 was about 125,000 fisherman-days.

The game fish caught were of a large average size. Where more than two game fish of one species were caught per boat the range, rather than individual lengths, was frequently listed and information on size is therefore available for only a part of the catch (Table 3). The most common size was 14 inches for each of the three species of bass.

TABLE 3. RECORDED LENGTHS OF BASS AND WALLEYES IN THE CATCH FROM NORRIS LAKE, 1939

Lengths in Inches[1]	Number of fish			
	Largemouth	Smallmouth	Kentucky	Walleye
11	85	71	19	....
12	202	154	31	....
13	185	174	62	....
14	361	277	89	....
15	183	191	55	21
16	179	201	31	54
17	62	100	7	43
18	51	56	2	56
19	20	21	1	32
20	9	9	1	34
21	....	....	....	32
22	....	....	....	37
23	....	....	....	34
24	....	....	....	53
25	....	....	....	59
26	....	....	....	45

[1]Including also fractions; for example, all fish between 14 and 15 inches in length were listed as 14.

Two size groups are indicated for walleyes, one at 16 to 18 inches, the other at 24 to 26 inches.

Average lengths of the principal game species at the end of the 1938 growing season (Eschmeyer, 1940) are as follows:

Age in years	Average length in inches			
	Largemouth	Smallmouth	Kentucky	Walleye
2	13.0	12.5	11.5	17.2
3	....	14.5	14.0	22.1

The largemouth caught were mostly in their third year (2+), the other two basses were represented by both age groups (2+ and 3+). The tendency for the size curve of walleyes to be bimodal is explained by the catch of both year classes (2+ and 3+). The lengths recorded in Table 3 cover the entire growing season for bass and most of the growing season for walleyes. For this reason, the age groups can generally not be distinguished in the table.

Special Creel Census—Special census cards calling for more information than the regular blanks were distributed to about 200 fishermen who would presumably fish twenty times per year or more, and who would submit reports on all of their fishing trips. For the June fishing 607 cards were received and for the next four months the numbers were 193, 83, 109, and 51, respectively. In 1,043 trips these anglers took 1,970 fish, almost all of which were game species. This represents almost two game fish per trip as compared with only 0.8 game fish per trip for all fishing out of the Norris dock. Most of the fishing for the special census was in the lower portion of the reservoir.

Those who fished most frequently were more successful than the average, although they were unsuccessful in almost a third of their trips. Had the summer of 1939 been rainy instead of exceptionally dry, these consistent fishermen would probably have had a much better average catch, as indicated under a discussion of chemical and thermal conditions.

A tabulation of the kinds of bait used and methods of fishing (Table 4) shows that most of these anglers used artificial bait and that casting was the predominate fishing method in June and July, with trolling the most common method for the remainder of the season. The kind of bait and method of fishing which took the most fish per angler were used by most of the fishermen.

In June fishing was mostly by casting and trolling, with the former slightly more effective. In July casting still predominated, but trolling was slightly more effective. Trolling predominated during the next month and was decidedly the most effective for this and the following months. In this connection, an important point not indicated by the data is that in June most of the trolling was shallow, but by August it was almost all with metal lines in about 20 to 25 feet of water. The latter method was very effective throughout late summer and fall and probably would have been effective in June and early July had it been used at that time. The deep trolling with plugs took the larger smallmouth bass (of the 3+ age group) and was undoubtedly the best method of fishing.

Effect of Chemical and Thermal Conditions on Fishing—Limnological data have frequently been of little value to the fisheries worker

TABLE 4. EXTENT USED AND EFFECTIVENESS OF THE DIFFERENT BAITS AND THE VARIOUS METHODS OF FISHING, SPECIAL 1939 CREEL CENSUS,[1] NORRIS RESERVOIR

Month	Bait or Method	No. Records	No. Fish	Catch per Angler	Species					
					L.M.B.	S.M.B.	Ky.B.	Walleye	Sauger	Misc.[2]
June	Natural bait[3]	25	36	1.4	13	11	9	....	....	3
	Artificial bait[4]	465	1,068	2.3	682	228	44	82	10	22
July	Natural bait	18	20	1.1	2	11	1	....	....	6
	Artificial bait	161	182	1.1	108	43	16	13	....	2
August	Natural bait	6	4	0.7	....	....	3	....	....	1
	Artificial bait	65	99	1.5	27	41	16	11	1	3
September	Natural bait	1	1	....	....	....	1	....	....	....
	Artificial bait	107	169	1.6	43	78	27	15	6	....
October	Artificial bait	48	98	2.0	37	36	15	6	2	2
June	Still fishing	25	37	1.5	12	11	11	....	....	3
	Casting	236	840	2.5	575	186	36	30	3	10
	Trolling	59	123	2.1	46	32	5	34	3	3
July	Still fishing	13	10	0.8	2	1	1	....	....	6
	Casting	93	113	1.2	80	23	9	....	....	1
	Trolling	25	36	1.4	14	12	6	4	....	....
August	Still fishing	9	5	0.6	1	....	3	....	....	1
	Casting	24	20	0.8	9	5	1	1	....	4
	Trolling	45	103	2.3	27	44	16	12	1	3
September	Still fishing	1	1	....	....	....	1	....	....	....
	Casting	20	18	0.9	8	8	....	....	2	....
	Trolling	69	125	1.8	26	61	23	12	3	....
October	Casting	17	25	1.5	18	7	....	....	....	1
	Trolling	19	39	2.1	22	15	6	3	2	1

[1]Not including records where several kinds of bait or several methods are indicated. [2]Chiefly bluegills and crappie. [3]Chiefly minnows. [4]Chiefly plugs.

because of the inability to interpret these data in terms of fish populations or fishing. Extensive data collected by Dr. A. H. Wiebe on Norris Reservoir, however, explain the success or failure of several fishing methods at various localities and at different seasons. His finding of major interest to fishermen is illustrated diagrammatically in Figure 1. He noted a decided difference in the vertical distribution of oxygen during wet and dry seasons, and found these differences to be due to the volume, temperature, and turbidity of the incoming water (Wiebe, 1940).

Because water naturally seeks its own density level, during spring, summer, and fall the incoming water moves as a layer between the warmer circulating surface layer, the epilimnion, and the deep cooler non-circulating portion, the hypolimnion. During a wet year this stratum of silt-laden water moves all the way to Norris Dam, a distance by channel of 73 miles. Due to the silt and other materials in

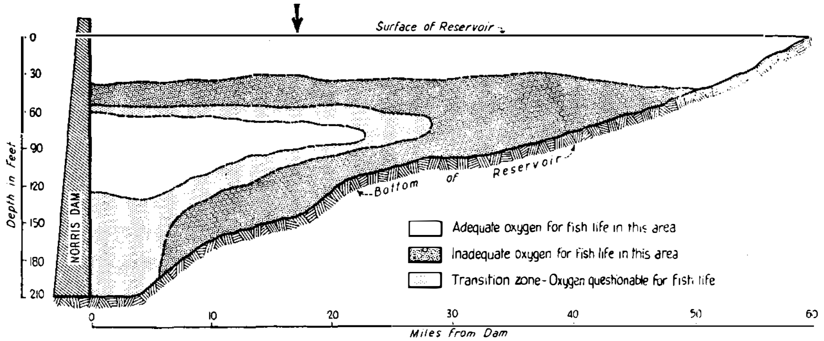

Figure 1. The oxygen profile of the Clinch arm of Norris Reservoir for September, 1937. This is a diagrammatic presentation of data collected and compiled by Dr. A. H. Wiebe. In 1939, an exceptionally dry season, the layer with inadequate oxygen extended only about to the point indicated by the arrow. For explanation see text.

this water, it loses its oxygen through decay and becomes an oxygenless[2] stratum between two aerated layers. Fish can live above or below the layer of water (Figure 1), but not in it. This situation explains a number of occurrences relative to the fishing.

It is known that smallmouth bass prefer clear, cool water, and that largemouth are more tolerant of warm, silty water. In the upper portion of the reservoir the water is not so clear as it is at the dam, and the cool, deeper water is generally without adequate oxygen during the fishing season. This condition explains why the ratio of largemouth to smallmouth ranges from 7:1 some distance up the Clinch arm to 1:1 near the dam where clear, cool aerated water is generally available.

In 1939 the middle, oxygenless layer on the Clinch arm extended

[2]Oxygen is entirely lacking. or at least in quantities too small to support fish life.

only about to the portion known as Loyston Sea (indicated by the arrow in Figure 1). Above this arm the fish tended to be concentrated in the warm, upper layer. Below that point they could live at all depths and apparently preferred to be in the cool water immediately below the warm, upper layer. Deep trolling was, therefore, by far the most effective method in the lower portion of the lake, but was very ineffective in the upper portion because the bait, at a depth of about 25 feet, was traveling in the silty, oxygenless layer. Casting and shallow trolling were probably much more effective in the upper portion, though in warm water in midsummer bass and walleyes are not so readily taken as at other seasons. During a rainy summer, the fish throughout the lake are concentrated near the surface and casting, shallow trolling, and still fishing can be expected to be more successful than deep trolling, unless possibly the deep trolling is very deep, below the oxygenless layer.

Because the vertical distribution of the fish depends on the length and thickness of the oxygenless layer, and the movement and thickness of this layer depends on the amount of inflowing water, the amount of rainfall determines the location of the fish with reference to depth. Suggestions for fishing, based on the chemical data and substantiated to some degree by fishing records, may be summarized as follows:

In early June casting and shallow trolling are best if the spawning season was late; deeper fishing is best if the spawning season was early.

In midsummer deep fishing is recommended in the lower portion of the reservoir; shallow fishing (surface to about 5 feet) in the upper end of the reservoir.

In late summer and fall the best methods are deep trolling in the lower end of the reservoir if the season was fairly dry; shallow fishing if rainfall was heavy during earlier summer; and shallow fishing in the upper end regardless of rainfall.

The catch per angler would probably have been much better early in 1939 had the fishermen known how and where to fish. Because of the absence of lakes in this general area, few of them had fished in such waters before the construction of Norris Reservoir. However, even previous experience would probably have been of little value to those fishing in Norris because the oxygen conditions here are different from those generally found, due to the unusual shape of the reservoir.

Management Suggestions—Except as indicated earlier, the catch appears to be similar throughout Norris Reservoir. No one dock has decidedly better fishing than the other docks. Over half of the anglers fishing from the five docks were from Knoxville, and proximity and accessibility to this city is probably of considerable importance. It happens, however, that a number of the docks are about the same generel distance from Knoxville. The relative success of any one of the docks about equal distance from Knoxville, therefore, may depend on the scenic aspects, the road conditions, quality of service rendered by the dock, the personality of the operators, the catching of an exceptionally large fish, advertising, or any other of a number of factors which might not be of very great significance if distances from Knoxville or the quality of fishing differed decidedly for the docks.

Eventually, the nearness to a major highway may be of more importance than at present, especially if sportsmen en route to and from Florida in winter learn that fishing tends to be good in late fall and early spring. These comments can hardly be considered as fish management, but the number and location of docks is determined by the Authority and information on the residence of the anglers and on the quality of the fishing in various localities may be of some significance.

Bluegill (bream) fishing has dropped decidedly since 1938. The percentage of this fish in the total catch from the docks dropped from 30 per cent in 1938 to only 6 per cent for the next season. The fish are small in size and stunted in growth. Stringent regulations might be suggested if it were not known that the small bream are relatively old fish, that growth of these insect-eaters is very slow and that, because of the annual drawdown, these fish cannot be expected to be both large and abundant. Any regulations made to protect the bluegill would be of little value.

The crappie, now common only in some portions of the lake, is growing rapidly and may eventually be the chief pan fish. It should be given protection during the spawning season and its spread should be encouraged by introducing it in various localities in which it is now absent or at least too rare to be caught by the anglers.

In 1939 there was a closed season on the major game fish, but not for all fishing. Examination of the evidence indicates that a closed season on all fishing is desirable for there is no unfavorable balance between game fish and coarse or undesirable fish. Census records show that most of the fish taken, even with live bait, are game fish. The growth of the fish is very rapid, suggesting that the game fish population has not yet reached its peak and that food is plentiful. In addition, the closed season can be better enforced if the lake is closed to all fishing. Spawning is generally near shore and only a very narrow belt around the lake is of suitable depth. The fish are, therefore, concentrated at spawning time. The shoreline is long and irregular and mostly wooded, making enforcement difficult. The ease with which game fish can be caught at bass spawning time is indicated by the special creel census cards prepared by anglers who assisted in obtaining specimens for growth-rate studies in May, 1939, under our immediate supervision. The three most successful of the half dozen or so who assisted have records as follows:

Angler	No. of trips	Total hours fished	Catch of game fish per trip	Catch of game fish per hour
Craig	3	24	18.3	2.3
Bristow	8	54½	15.9	2.3
Glenn	7	50½	10.3	1.4

The number taken by the average angler would be lower per trip, but some hundreds of anglers could readily deplete the bass supply if allowed to fish during the spawning season. The Tennessee Conservation Department has recently decided to close Norris to all fishing during the bass spawning period.

Wheeler, which is a run-of-the-river reservoir, has a length of 74 miles, an area of 67,100 acres, and a shoreline, including islands, of over 1,000 miles. Here fishing is of three types: sport fishing, meat or subsistence fishing, and commercial fishing. Sport fishermen generally troll or cast from boats, or wade and cast from the bank. The most sought for species are the black basses, the crappie, the white or striped bass, and the sauger.

Over the reservoir as a whole, the subsistence fishing is mainly by negroes who are primarily interested in obtaining fish as food. This type of fishing is mainly from the bank, each angler using two to eight cane poles. The common earthworm ranks first in importance as bait, with cut bait ranking second. The catch is chiefly carp and dogfish but also includes bluegills, sunfish, suckers, buffalo, drum, catfish, or most any species which can be caught. Here, as in the Southwest, the carp seems to take live bait more readily than in the North. The dogfish, locally known as ''scaley cat,'' is highly esteemed by the negroes and is not regarded as an undesirable predator as it is in some other localities. Subsistence fishing is heaviest in March and April. The extent of this kind of fishing at any one time depends on the amount of time required in the cotton fields.

Commercial fishing is by setline only, as all nets are prohibited. Food fish (catfish and drum) are predominant in the catch, but carp are very abundant in some localities. The species taken depends somewhat upon the bait used. It is judged that commercial fishing accounts for a good portion of the total fish take. Our records for 1939 are confined to the first two types of fishing, but it is planned to secure records of the commercial fishing during 1940.

Information on the fishing in this reservoir was obtained largely by the operators of six boat docks which were opened in April, 1939. The TVA leases these dock sites to individuals and enforces the necessary regulations. On Wheeler Mr. William Rice of Reservoir Property Management, who is in immediate charge of the Wheeler Reservoir properties, greatly aided the project by requiring the boat dock operators to keep the census records. Five of these docks were in the central section of the reservoir where pan fish predominate in the catch; the other dock was in the lower section, presumably the better habitat for bass. Some data were also taken at four docks which began operation late in the season, and by one of the Alabama game wardens. The data from these latter sources are recorded as "miscellaneous."

Fishing records for the dock immediately below Guntersville Dam are discussed with those from the Wilson Dam tailwater.

Information on the fishing and fish catch on Wheeler for 1939 is based on the recorded catch for 8,054 fisherman-days. These fishermen took 20,840 fish in 48,759 hours, an average of 0.4 fish per hour and an average catch of 2.6 fish per trip. Twenty-eight per cent of all the fish taken were game fish (25 per cent bass and 3 per cent white bass); forty-two per cent pan fish (16 per cent bluegill and 26 per cent crappie); fourteen per cent food fish; and sixteen per cent coarse fish. General data for the fishing for each month is presented in Table 5. Table 6 shows the relative abundance of each species in the catch and the abundance of the different types of fish.

TABLE 5. SUMMARY BY MONTHS OF SPORT FISHING ON WHEELER RESERVOIR DURING 1939

Month	No. of fishermen	Fish caught	Hours fished	Catch per angler	Catch per hour	Fisherman-day in hours
April	1,880	4,508	10,602	2.4	.4	5.6
May	2,131	5,117	12,833	2.4	.4	6.0
June	1,510	3,957	9,155	2.6	.4	6.1
July	1,283	4,183	8,011	3.2	.5	6.2
August	491	1,314	3,285	2.7	.4	6.7
September	474	1,138	3,228	2.4	.4	6.8
October	247	467	1,526	1.9	.3	6.6
November	29	97	153	3.3	.6	2.3
Totals and Averages	8,045	20,782	48,759	2.6	.4	6.0

Certain definite trends are noted in the catch (Table 6), including the usual crappie-bluegill relationship. The crappie catch is bimodal, the peaks coming in spring and fall while the mode of the bluegill catch comes in midsummer when the crappie catch is low. This relationship was found at all docks and has been noted in other waters where the two fish are represented. The crappie presumably move to deeper water in midsummer and failure to take them at that time in appreciable number may be partly attributed to the anglers' lack of knowledge regarding their habits. The changes in the relative abundance of bass in the catch are partially due to a difference in the number of records from various docks. A high percentage of bass was taken at one dock, and on months when this dock submitted a large number of records the relative abundance of bass noticeably increased in the combined returns for all docks. During the period of the census, the average catch and the average fisherman-day, as well as the average catch per hour, varied only slightly from month to month. In November the catch increased to 0.6 fish per hour, and the time spent fishing dropped to an average of 2.3 hours. This may be explained by cooler weather and more expert fishermen. As indicated in Table 5, fishing was heaviest in May and declined as the season advanced.

The catch in different portions of Wheeler Reservoir differs considerably. This is probably due to the different habitats in various parts of the reservoir. The catch in the middle portion of the reservoir is somewhat dissimilar at the various docks, but it differs considerably from that in the lower portion of the reservoir where game and pan fish constituted almost the entire catch. The percentages of game fish in the total fish catch at each of the six docks having the best records were 64, 9, 30, 32, 42, and 62 per cent, respectively. Listed in the same order, with the catch at the dock in the lower section listed first, the percentages of pan fish in the catches were as follows: 34, 66, 26, 48, 42, and 62. The percentages of food fish in the catches were as follows: 0, 9, 21, 6, 4, and 14, and the percentages of coarse fish were 1, 15, 22, 14, 11, and 13. The catch per hour and the catch per angler differs considerably at the various docks, varying from 0.9 fish per angler and 0.1 fish per hour to 5.5 fish per angler and 0.9 fish per hour. The better catches were made in the middle portion of the reservoir where pan fishing was dominant, and the poorer fishing was in the lower section where bass were dominant in the catch. A comparison of the fishing at three docks is made in Table 7. Dock A is in the lower third of the reservoir, and Docks B and C are in the middle portion where most of the docks are located. Dock B is in the shallow backwater area where cover is abundant and where the minor water fluctuations exert a considerable influence. Dock C is on the backwater of a tributary stream some distance from the main river. Dock A is located on a large open bay having deep water and a restricted connection with the main reservoir. Largemouth bass were predominant in the catch at this dock. Because many large fish were taken, a great number of fishermen came to this dock and this operator did more business than all the other docks combined, even though the catch per hour and the catch per angler (Table 7) were lower than at any other dock. Pan fish were dominant in the catch at Dock B, being 66 per cent of the total catch, while game fish constituted only 9 per cent. Food and coarse fish were well represented in the catch, but were not nearly as abundant as at Dock C, where the food fish represented 21 per cent of the catch and coarse fish 22 per cent. The catch of game and pan fish was accordingly lower at Dock C than at any of the other docks, being

TABLE 6. RELATIVE MONTHLY ABUNDANCE OF THE DIFFERENT SPECIES IN THE CATCH EXPRESSED AS A PERCENTAGE OF THE TOTAL CATCH FROM WHEELER RESERVOIR DURING 1939

Month	Game				Pan				Food fish						Coarse			
	White bass	Bass	Sau-ger	Total	Blue-gill	Crap-pie	Sun-fish	Total	Chan-nel cat	Blue cat	Yel-low cat	Bull-head	Drum	Total	Carp	Dog-fish	Misc.[1]	Total
April	2	15	1	18	11	55	..	66	..	1	3	1	1	6	7	3	..	10
May	4	26	..	30	10	38	..	48	1	6	2	1	2	12	6	4	..	10
June	8	34	..	42	14	14	1	29	2	5	3	2	2	14	10	4	1	15
July	..	22	..	22	26	4	..	30	1	7	8	2	3	21	22	2	1	25
August	1	14	1	16	21	1	..	22	6	6	24	..	2	38	20	2	1	23
September	..	27	..	27	23	17	..	40	..	1	4	2	3	10	16	3	4	23
October	..	52	..	52	14	8	1	23	..	..	3	4	..	7	8	3	7	18
November	..	26	..	26	1	72	..	73	..	..	..	..	..	..	..	..	..	..
Per cent of total	3	25	..	28	16	26	..	42	1	5	5	1	2	14	12	3	1	16

[1]Mostly Buffalo.

only 56 per cent of the total catch, while at the other docks the catch of these fish ranged from 75 to 98 per cent of the total take.

Dock B was more readily accessible than Dock A and the catch per hour was twice as great as at Dock A, but its gross income from fishing was, nevertheless, poor compared with Dock A. Dock C, with the highest catch per hour and per angler, was discontinued in August because it was an economic failure. Catch per hour and accessibility are apparently of secondary importance on Wheeler. Docks in the area where game fish rank high in the catch may be expected to be the most successful. Pan, food, and coarse fish can be taken by bank fishing and the renting of boats is not essential for the catching of these types of fish. The game fish, chiefly largemouth bass, are obviously more sought for and of more value to the dock operators than the other species and should be given special consideration in any management program.

The total amount of fishing on Wheeler can be only roughly estimated. Early in October, during the cotton picking season when fishing is light, anglers along the entire shoreline were counted. The count, which was made on week days, indicated the presence of 294 fishermen at that time. Because each portion of the shore was passed only once and the average angler fishes only a half day (either morning or afternoon), the number of fishermen at this time was about 500 per day. The number fishing from April to September averaged much higher, possibly twice as much. On the basis of this meager information, the total number of fisherman-days is roughly estimated at about 200,000 for the year. At the time of the fishermen counts, boats were also counted. Eight hundred eighty-five boats were noted along the banks of the reservoir. These are all used for fishing. Possibly half of these are used for setline fishing.

Management Suggestions—On the basis of our incomplete knowledge of the fishing and fish conditions in Wheeler, only a few recommendations can be made for the management of the water. The introduction of white and yellow bass has been successful, but the introduction of other species appears to be undesirable at this time. Environmental improvement in such large waters is necessarily limited. However, spawning conditions for catfish have been locally improved by putting out cans to serve as nests for these fish. This work should probably be extended to other localities in the reservoir.

A constant water level would be desirable from the standpoint of food production, the establishment of aquatic vegetation, and the spawning of certain species of fish, but constant levels cannot be maintained because functions such as flood control, which requires fluctuations, must be given priority. Efforts have been made, however, by

TABLE 7—A COMPARISON OF THE FISHING AT THREE BOAT DOCKS ON WHEELER RESERVOIR DURING 1939

Month	Dock	No. of fishermen	No. of fish	No. of hours fished	Catch per angler	Catch per hour	Hours per fisherman-day	—Percentage of each type— Game	Pan	Food	Coarse
April	A	379	1,071	2,452	2.8	.4	6.5	26	73	....	....
May		338	825	2,732	2.4	.3	8.1	86	13	....	1
June		481	464	3,502	.9	.1	7.2	77	18	1	4
July		299	278	2,171	.9	.1	7.2	83	15	....	1
August		173	86	1,187	.5	.1	6.8	84	15	....	....
September		213	189	1,668	.9	.1	7.8	91	8	....	....
October		147	170	1,006	1.2	.2	6.8	98	2	....	....
Total		2,030	3,083	14,718	1.5	.2	7.2	64	34	....	1
April	B	605	1,479	3,831	2.4	.4	6.3	8	83	4	5
May		306	819	2,480	2.7	.3	8.1	9	83	2	5
June		77	389	504	5.0	.8	6.5	14	70	4	12
July		225	1,229	1,320	5.5	.9	5.8	4	64	16	16
August		156	604	1,085	3 9	.5	6.9	8	36	20	36
September		202	823	1,242	4.1	.7	6.1	12	49	11	27
October		76	246	375	3.2	.7	4.9	19	36	14	30
November		23	97	119	4.2	.8	5.2	26	73	....	....
Total		1,670	5,686	10,956	3.4	.5	6.5	9	66	9	15
April	C	107	500	733	4.7	.7	6.8	14	25	23	37
May		636	1,791	3,099	2.8	.6	4.8	18	38	27	17
June		500	2,466	2,726	4.9	.9	5.4	40	23	19	18
July		349	1,491	1,972	4.2	.7	5.7	36	15	19	30
Total		1,592	6,248	8,530	3.9	.7	5.3	30	26	21	22

the Water Control Board to maintain constant pool levels during the spawning time of the game fish. Stabilization of water levels during this period, when even small fluctuations may be disastrous to the year's hatch, should be especially beneficial to the bass. Another factor tending to limit productivity is the muddy water entering the reservoir. Not only does this condition limit the plankton, but it also has an adverse effect on bottom organisms. Reduction of the amount of mud entering the reservoir is a long-time project as it depends on controlling the erosion on the watershed. This work is now being promoted by the TVA under its forestry and agricultural programs.

The reservoir should be closed to bass fishing during the bass spawning season, but can perhaps remain open to fishing for most of the other species. Bass fishing is especially heavy during the spawning season and there is reason to believe that this is at least partially responsible for the low percentage of bass in the catch. Population studies in various portions of the reservoir indicate that bass comprise only about 4 per cent of the total fish population, exclusive of the abundant gizzard-shad and gambusia. Stocking as now practiced can be expected to be of very little benefit in such large waters, and any appreciable increase in the abundance of bass must result from natural reproduction.

Eventually, management will consist primarily of controlling, through regulation, the fish population in order to maintain a desirable balance between the game, pan, food, and coarse fish. When fishing is concentrated on the most popular species, and when these may be taken during their most vulnerable season, this fishing naturally tends to reduce the numbers of the preferred species and to favor the less desired species. When such conditions exist, it may be wise eventually to have fewer restrictions on commercial fishing in order to control the coarse fish. At present coarse fish can be taken only by hook and line or setline. In some localities coarse fish may already be far more abundant than some of the more valuable species as indicated by the census returns. At one of the docks 95 setline lifts yielded 2,699 fish, 93 per cent of which were carp. Continual studies to determine trends of population and relative abundance of the different species from year to year are essential for the formation of regulations needed to maintain the desirable balance among the different species. In addition, growth-rate studies and a census to determine quality and quantity of fishing furnish information basic to fish management. The problem of commercial fishing would be less difficult if all commercial fishermen were required to submit monthly records of their catch as is done in some other localities. A more thorough creel census covering commercial and subsistence fishing, as well as sport fishing, is now in progress, and some information on the trends will be available by the close of the current season. Once the trends in fishing are known, further management suggestions can undoubtedly be made.

Wilson Dam, which was built by the army, is the oldest dam in the TVA chain. Water was impounded in April, 1924. Inquiry regarding the fishing below the dam indicates that sport fishing was negligible prior to 1932, though bank and setline fishing such as had been practiced in the river for many years were common. Sauger are reported to have entered the catch in 1928 and 1929, and to have reached their maximum abundance in 1932. They have declined in the catch since 1935 and in 1939 represented only 5 per cent of the total catch. White and yellow bass, according to our informers, were first introduced into the Tennessee River in Wilson Reservoir in 1926. They entered the catch at Town and Big Nance Creeks, tributaries of Wilson Reservoir, in 1932 and reached their maximum there about three years later. They appeared in the catch below Wilson Dam in 1936 and since that time have rapidly increased in the take, representing 40 per cent of the catch in 1939. White bass were prominent in the catch below Wheeler Dam shortly after impoundment, and were immediately taken below Guntersville and Hales Bar Dams. The white bass is already one of the most important fish in the Valley, and it may be expected to spread to all run-of-the-river reservoirs. It will probably become the most commonly caught species in the tailwaters, although the sauger may exceed it in abundance for the first few years after a dam has been completed.

The 1939 creel census for the Wilson Dam tailwater was taken by CCC Camp TVA No. 13 under the general supervision of the Biological Readjustment Division. The entire area covered by the census is from Wilson Dam downstream to the railroad bridge, a distance of about 2 miles. However, most of the fishing was done in a small area of about 110 acres immediately below the dam. Boats were used by most of the fishermen and were rented from liveries some distance below the dam. This simplified the census, as men stationed at these liveries could get records of the catch as the fishermen returned. The census was gathered at four points by two shifts of four men each who were on duty from 7:00 a.m. to 6:00 p.m. each day. These men were engaged in the census continuously from April 11 to December 31, with the exception of two days in July and five days in December. It is estimated that they contacted about 60 per cent of the anglers for the period of the census and about half of the fishermen for the entire year. Their records cover 16,094 fisherman-days of sport fishing representing a catch of 50,013 fish in 73,401 hours, and 1,198 setline "lifts" by commercial fishermen representing a catch of 14,334 fish. The commercial fish weighed over 25,000 pounds and the sport fish over 56,000 pounds. As only about half of the sport fishermen were contacted, it is estimated that the sport catch was over 100,000 pounds. It should be noted that in this instance no distinction is drawn between sport and subsistence fishing, and the two are combined. Data given for the commercial fishing are somewhat lower than the actual catch because the census was not initiated until April 11.

Sport Fishing—Information collected on the sport fishing in 1939 is summarized in Table 8. Each angler took on the average 3.1 fish which weighed 3.4 pounds in an average fishing day of four and one-half hours. This is a catch of 0.7 fish per hour. Fishing was heaviest in May, declining somewhat each month for the remainder of the year. While the catch varied somewhat from month to month, on the whole it was fairly uniform. The average catch, the catch per hour, and the average weight of the catch were the greatest in November. The data on the relative abundance of the different species of fish are summarized in Table 9. The white bass is the dominant species in the tailwater, as it comprised 40 per cent of the total catch for the period of the census and represented as high as 53 per cent of the total catch in November. Over half or 54 per cent of the fish taken were game fish, the percentage being lowest in August when it was 38 per cent and highest in November when it was 75 per cent. Many of the bass taken in this area are the Kentucky bass which are now seldom taken elsewhere in these run-of-the-river reservoirs. Saugers are reported to have formerly been much more abundant in the catch.

Pan fish represented 22 per cent of the entire take. The catch of these fish was highest in June and lowest in November. The bluegill-crappie relationship was not as prominent as in Wheeler. The bluegills were three times as abundant as the crappie, and were especially abundant in the catch for July. Food fish comprised 19 per cent of the catch, with drum and blue cat predominating. Most of the drum were taken by bank fishermen and were very small. Coarse fish, which were mostly carp, represented only 5 per cent of the catch. These fish were taken by bank on subsistence fishermen.

TABLE 8—SUMMARY, BY MONTHS, OF GENERAL DATA ON SPORT FISHING FOR 1939, WILSON DAM TAILWATER

Month	No. of fishermen	Catch	Hours fished	Per cent weighed	Average weight per fish	Average No. caught per angler	Catch per hour	Average weight of catch	Total weight of fish	Hours per fisherman-day
April	1,867	5,303	7,984	53	1.1	2.8	.7	3.1	5,772	4.3
May	3,490	11,384	15,647	70	1.0	3.3	.7	3.3	11,951	4.5
June	2,313	7,398	10,745	79	1.0	3.2	.7	3.2	7,616	4.6
July	2,185	6,563	10,772	96	1.1	3.0	.6	3.3	7,058	4.9
August	2,196	7,450	10,727	95	1.1	3.4	.7	3.7	8,469	4.9
September	1,711	4,775	7,976	98	1.4	2.8	.6	3.9	6,389	4.7
October	963	2,546	4,398	100	1.4	2.6	.6	3.6	3,575	4.6
November	731	2,688	2,932	90	1.3	3.7	.9	4.8	3,416	4.0
December	638	1,906	2,220	100	1.3	3.0	.9	3.9	2,519	3.5
Totals	16,094	50,013	73.401	84	1.1	3.1	.7	3.4	56,765	4.5

Commercial Fishing—Commercial fishing is by setline. Records secured on this type of fishing show that 14,334 fish were taken in 1,198 lifts. The average catch was twelve fish weighing a total of 22 pounds. The total weight for all fish recorded was 25,147 pounds, which had a value to the fishermen of about $2,500.00. The average haul was, therefore, worth about $2.20 and, as setlines are generally lifted twice a day, the gross daily income per fisherman was about $4.40. The catch varies decidedly from day to day and many commercial fishermen tend their lines irregularly.

The data suggest that fishing was best in June, when the average haul weighed 32 pounds. General fishing data, by months, are listed in Table 10; the catch by species is shown in Table 11.

The fish catch consisted primarily of catfish and drum (food fish), as these represent 83 per cent of the take compared with only 11 per cent coarse fish and 5 per cent game fish. The game fish were presumably used by the fishermen for their own consumption because they

TABLE 9—RELATIVE MONTHLY ABUNDANCE OF THE DIFFERENT SPECIES OF FISH TAKEN FROM THE WILSON DAM TAILWATER DURING 1939 EXPRESSED AS A PERCENTAGE OF THE TOTAL CATCH (SPORT FISHING)

	Game				Pan				Food					Coarse			
Month	White bass	Black bass	Sauger	Total	Bluegill	Crappie	Sunfish	Total	Channel cat	Blue cat	Yellow cat	Drum	Total	Buffalo	Carp	Miscellaneous	Total
April	32	12	10	54	12	13	3	28	1	2	1	7	11	1	3	1	5
May	46	9	9	64	10	5	3	18	1	3	1	9	14	..	3	2	5
June	34	3	4	41	21	6	3	30	2	5	2	14	23	..	4	2	6
July	37	3	2	42	26	2	1	29	1	6	1	16	24	..	3	1	4
August	31	6	2	39	21	..	4	25	1	7	1	25	34	..	2	1	3
September	51	13	2	66	11	1	1	13	..	2	1	11	14	1	6	..	7
October	42	24	2	68	7	5		12	1	1	..	9	11	..	8	..	8
November	53	18	4	75	4	6	1	11	1	4	1	1	7	..	7	..	7
December	51	9	12	62	5	6	1	12	..	6	1	4	11	1	4	..	5
Totals	40	9	5	54	15	5	2	22	1	5	1	12	19	..	4	1	5

cannot be legally sold. Drum comprised almost half the catch, and nearly one-fourth of all fish taken were blue catfish.

Comparison of the Fishing—A comparison of the catches of sport fishermen and commercial fishermen (Tables 9 and 11) shows that the two differ decidedly, and that the fish primarily taken by one group are of secondary importance to the other. Game and pan fish represented 76 per cent of the catch of the sport fishermen and only 5 per cent of the take of the commercial fishermen. For food fish the percentages were 18 and 83 per cent, respectively, and for coarse fish 5 and 11 per cent, respectively.

Because commercial fishing removes some fish which are competitors of the young of game species, there is a possibility that the commercial fishing is definitely beneficial to the sport fishing, provided, of course, that the regulations pertaining to the taking of game fish by commercial fishermen are rigidly enforced.

The catch of about 125,000 pounds of fish from this one locality suggests that fish are concentrated in large numbers immediately below the dam.

TABLE 10—SUMMARY BY MONTHS OF COMMERCIAL FISHING FOR 1939 IN WILSON DAM TAILWATER

Month	No. of fishermen	No. of fish	Total weight in pounds	Per cent fish weighed	Catch per angler	Weight of average catch	Average weight per fish
April	141	1,073	1,824	64	7.6	13	1.7
May	242	2,619	3,929	82	10.8	16	1.5
June	179	3,000	5,700	99	16.8	32	1.9
July	118	1,684	3,180	87	14.3	27	1.9
August	117	1,296	2,270	100	11.1	20	1.8
September	154	2,197	3,946	91	14.3	26	1.8
October	92	905	1,655	100	10.0	18	1.8
November	99	1,092	1,845	100	11.0	19	1.7
December	56	468	798	100	8.4	14	1.7
Total	1,198	14,334	35,147	....	12.0	22	1.8

TABLE 11—RELATIVE MONTHLY ABUNDANCE OF THE VARIOUS SPECIES IN THE CATCH, EXPRESSED AS A PERCENTAGE OF THE TOTAL COMMERCIAL CATCH, WILSON DAM TAILWATER, 1939

	Game				Pan			Food						Coarse			
Month	White bass	Bass	Sauger	Total	Bream	Crappie	Total	Channel cat	Blue cat	Yellow cat	Willow cat	Drum	Total	Buffalo	Carp	Miscellaneous	Total
April	12	1	6	19	1	2	3	9	9	1	..	5 2	71	..	7	1	8
May	5	1	1	7	..	..	..	6	11	3	1	67	82	..	3	3	6
June	1	1	..	2	1	..	1	7	29	12	1	39	81	1	8	1	10
July	1	..	..	1	..	..	..	25	26	13	..	26	65	..	7	..	7
August	2	..	..	2	..	..	..	6	29	6	1	47	83	1	6	..	7
September	1	..	..	1	..	..	..	2	19	6	1	44	70	4	24	..	28
October	..	5	..	5	..	1	1	4	9	3	1	62	75	2	13	..	15
November	5	2	4	11	..	..	..	1	46	9	..	23	78	1	7	..	8
December	3	..	3	6	2	..	2	1	39	13	..	36	88	2	1	..	3
Average	3	1	1	5	..	..	..	7	22	7	1	46	83	1	9	1	11

Guntersville Tailwater—Data taken by the dock below Guntersville Dam in Wheeler Reservoir, representing fishing immediately below the dam, differ decidedly from those taken below Wilson Dam. Guntersville was impounded in January, 1939, and fishing below the dam was exceptionally good during a portion of the first year. Information on the fishing is rather fragmentary, but some data (Table 12) are available on the relative abundance of various species in the catch for a portion of the 1939 season. In midsummer game fish comprised only a small percentage of the recorded catch. Much of the fishing at that time was some distance below the dam and some of it was with setlines. After September, game fish comprised almost the entire catch. Over half the fish recorded for October were white bass, and sauger increased from less than half of one per cent in August to 87 per cent of the catch in December. Apparently, the sauger in the water below a dam are attracted to the tailwater soon after the dam is operative. White bass, too, tend to concentrate in these waters immediately below the dam. Records for the catch per angler and the catch per hour are not available except for 487 collected during November and December.

TABLE 12—RELATIVE ABUNDANCE OF THE VARIOUS SPECIES OF FISH, EXPRESSED AS A PERCENTAGE OF THE TOTAL CATCH FROM GUNTERSVILLE TAILWATER AND VICINITY, 1939

Month	Total No. of fish	White bass	Bass	Sauger	Bream	Crappie	Blue cat	Yellow cat	Drum	Buffalo	Carp	Scaley cat
August	932	1	5	..	15	4	4	1	33	3	30	3
September	494	6	11	1	7	29	1	..	4	2	30	8
October	814	57	5	16	1	17	1	..	1	..	2	..
November	1,993	10	2	85	..	2	..	..	..	..	..	..
December	1,475	7	4	87	..	2	..	..	..	..	..	..
Total	5,708	14	4	54	3	7	1	..	6	1	8	1

These records indicate a catch of 2,722 fish in 2,621 hours, an average of over one game fish per hour. If fishing below Guntersville follows the usual trend for the tailwaters, sauger fishing may be expected to be good for several seasons after which it will be largely replaced by white bass fishing.

Norris Dam Tailwater—The tailwaters in the Valley are of two distinct types. Below the run-of-the-river dams the water is warm, but the release below the storage dams is cold in summer as well as in winter, generally between 45 and 55 degrees Fahrenheit. In the latter the temperature is suited for trout for some distance below the dam. The Clinch River below Norris contains trout though it cannot be regarded, for the present at least, as a good trout stream.

The number of trout taken below Norris in 1939 probably did not exceed a few hundred. These were rainbow trout varying between 14 and 20 inches in length, almost all of which were taken at very low water level. One of the most successful and consistent fishermen of Norris took twenty-three rainbows, averaging almost 17 inches in length, in eleven fishing trips totaling forty-two and one-half hours, an average of one fish every two hours.

Management—As the run-of-the-river reservoir tailwaters attract fish which tend to be poorly represented in the catch in the reservoir proper, there is no assurance that closing the tailwaters to fishing would improve the catch in the reservoirs. Fishing in the tailwaters may be expected to provide a yearly revenue of about $30,000 to $50,000 at each dam, assuming that the value per pound for fish taken by sport fishermen is $0.50 and assuming that fishing below other reservoirs will be about equal to that below Wilson Dam. Closing the tailwaters would, therefore, tend to destroy an asset having a potential income of several hundred thousand dollars per year. From a biological viewpoint, such closing could not be recommended. Fishing in the tailwaters by boat is hazardous, however, and the development of safety regulations might be necessary, which would drastically curtail the fishing.

To date the sauger have declined in abundance within a few years after a dam has been installed. Whether this decline is due to fishing or to biological changes is not known, but the restriction of ten per day placed on sauger by the State of Alabama seems to be a very desirable one. Enough is not yet known about the sauger to determine whether or not a closed season would be beneficial.

The white bass appears to be "holding its own" below Wilson, even though fishing for that species is extensive. Restrictions other than those now in effect are apparently not needed. Commercial fishing should be regarded as second in importance to sport fishing and should be curtailed when and if definite evidence becomes available, suggesting that commercial fishing has a deleterious effect on the abundance of game fish. Certain methods of illegal commercial fishing, such as "snatching," should preferably not be permitted. Illegal methods are frequently very effective in taking fish. Thirty fisherman-days of snatching yielded forty-six spoonbills and fifty-five yellow cats having a total weight of 1,305 pounds. It is possible that many fish are removed by illegal means and that the commercial take, including the commercial catch of game fish, may therefore be higher than our records indicate. A rather strict regulation of the commercial fishing here is desirable, because this fishing is secondary in importance to the sport fishing.

The Clinch River below Norris Dam produces a limited number of trout which are generally taken during low water. Large plantings have been made, but to date the results are uncertain. Because of the migratory tendency of the rainbow, brown trout were stocked in 1939. Both gigging and setline fishing are practiced in this stream at present. The desirability of using these methods of fishing in a trout stream is open to serious question. The major impediments in establishing a good trout supply, however, are probably the decided and relatively sudden fluctuation in flow and the decided changes in water temperature resulting therefrom. These cannot be controlled for fish management as fishing in the Clinch is obviously secondary in importance to flood control and navigation. A good large trout stream would be a very important asset to the area, but whether or not any practicable management program could change the Clinch into a good trout stream must still be determined.

Our information shows that the catch differs decidedly in the waters under consideration. In the storage reservoir and the tailwaters game fish predominated, but in the run-of-the-river reservoir pan fish outnumbered the game fish in the catch. The data suggest that the sauger is the most important species in the tailwater of a relatively new dam, and that in time this fish is replaced by the white bass. The differences in the recorded catch for the three different habitats are shown in Table 13.

Fishing is similar in the various portions of a storage reservoir and the degree to which an area is fished depends primarily on accessibility. In the run-of-the-river reservoir, the catch varies in different localities. White bass and sauger are taken mostly in the tailwaters, pan fish tend to be abundant in the wide, shallow areas of the middle section of the reservoir, and the largemouth bass appears to be most common in the deep, clear water found in the lower third of the reservoir. Species which are common in the tailwater below a dam are not abundant in

TABLE 13—RELATIVE ABUNDANCE OF FISH, EXPRESSED AS A PERCENTAGE OF THE TOTAL CATCH, IN EACH OF THE MAJOR KINDS OF FISH HABITAT DURING 1939[1]

	Norris	Wheeler	Guntersville Dam	Wilson Dam (Sport)	Wilson Dam (Commercial)
Type of water:	Storage	Run-of the-river	Tailwater	Tailwater	Tailwater
Game fish					
White bass	..	3	14	40	3
Bass	80	25	4	9	1
Walleye	9	..	..	..	..
Sauger	2	..	54	5	1
Total	91	28	72	54	5[3]
Pan fish					
Bluegill	6	16	3	15	..
Crappie	1	26	7	5	..
Sunfish	..	..	..	2	..
Total	7	42	10	22	..
Food fish					
Channel cat	..	1	..	1	7
Blue cat	..	5	1	4	22
Yellow cat	..	5	..	1	7
Bullhead	..	1	..	..	1
Drum	..	2	6	12	46
Total	..	14	7	18	83
Coarse fish					
Carp	1	12	8	4	9
Dogfish	..	3	1	..	..
Miscellaneous[2]	..	1	1	1	2
Total	1	16	10	5	11

[1]Percentages based on total recorded catch for 1939.
[2]Includes a few fish under other groups.
[3]Presumably not sold; may be taken by the fisherman for his own use.

NOTE: In the text the species are referred to by common name only. Scientific names are as follows: Bass: All three species of black bass—the smallmouth, *Micropterus D. dolomieu;* largemouth, *Huro salmoides;* and the Kentucky, *Micropterus p. punctulatus;* white bass: Chiefly *Lepibema chrysops* but including also the yellow bass, *Morone interrupta.* The two were grouped under one form because of some census taker's inability to differentiate between the two; walleye: *Stizostedion vitreum.* Reported taken only in one of the three waters (Norris Lake). Sauger: locally called jack salmon, *Stizostedion c. canadense*; bluegill: locally called bream, *Lepomis m. macrochirus*; Crappie: both *Pomoxis nigro-maculatus* and *Pomoxis annularis.* The former only is taken in Norris, both occur in the other two waters. Warmouth bass: *Chaenobrythus gulosus;* sunfish: locally called sunperch, includes several species of *Leponis* (*cyanellus, microlophus, megalotis megalotis,* and *punctalus miniatus.* Channel cat: *Ictalurus lacustris punctatus;* Blue cat: *Ictalurus furcatus furcatus;* Yellow cat: *Pilodictis olivaris*; Bullhead: locally called willow cat, includes three species of *Ameiurus; melas catulus, natalis natilis,* and *nebulosus marmoratus;* Carp: *Cyprinus carpio;* Drum: *Aplodinotus grunniens;* dogfish: locally called scaley cat, *Amia calva;* miscellaneous includes buffalo (*Ictiobus niger, Ictiobus bubalus,* and *Megastomatobus cyprinella*), pike (*Esox niger*), rock bass (*Ambloplites rupestris*), and several genera of suckers including *Catostomus, Minytrema,* and *Motostoma*.

the catch for the reservoir proper, and those which are most prominent in the catch in the reservoir are generally not taken in the tailwater. Regulations on fishing in the tailwaters should preferably be made for the benefit of fishing in that area only, and should not be expected to influence fishing in the major portion of the reservoir immediately below.

The creel census information suggests that storage reservoirs should preferably be closed to all fishing during the spawning season, but that on the run-of-the-river reservoirs year-round fishing should be permitted for most of the species, with a closed season placed only on those which prove most desirable and which are declining in the catch. Restrictions will be of little value if the reasons for decline are biological;

for example, no kind or amount of legislation will make Norris a good bream fishing lake or will greatly increase the drum in the lower third of the run-of-the-river reservoirs.

Coarse fish are not abundant in the catch in the storage reservoir and will probably not be of much significance there, but on the run-of-the-river reservoirs some commercial fishing restrictions may need to be removed if the coarse fish are to be kept within bounds. Commercial fishing should probably be encouraged in the run-of-the-river reservoirs, but any fishing other than hook and line fishing should be discouraged in storage reservoirs unless kept under close control by the fisheries agencies.

The construction of more dams will tend to improve fish conditions in the water below, because silt is deposited in the lower portions of each reservoir and the water becomes clearer as more reservoirs are created. Erosion control, too, has a beneficial influence on the fishing. Muddy water not only makes the water less productive by removing the light needed for photosynthesis, but gives an advantage to carp and other less valuable species which tend to thrive better than bass under those conditions.

Fishing has very decidedly increased since the TVA impoundments have been made and the Tennessee and its tributary, the Clinch (Norris Reservoir), are producing many times the fish produced prior to impoundment.

The more extensive 1940 census, covering most of the major impoundments, will probably provide more detailed information of value to the management of the fisheries in the Valley. A knowledge of the trend of the fishing is needed to solve many of the problems, and this information can obviously not be obtained from data for a single year.

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THE FISH POPULATION OF A SMALL POND IN NORTHERN ALABAMA[1]

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Determinations of the standing crop, or total fish population, in lakes and streams have received increased attention during the past few years. Such studies have been made on streams in a number of states including New York, Illinois, Michigan, Montana, and New Hampshire. In Illinois investigations were conducted in warm-water streams, but in the other states the studies were made largely in trout waters. Sections of streams were shut off with barrier seines and the fish removed by seining. Although these counts indicate the populations in the sections studied, they are not of great value in determining the total stream population unless, as pointed out by Shetter and Hazzard (1938), many sections are counted.

More uniform success has been obtained in determining the total population of lakes and ponds by the use of poison. Titcomb (1914) was the first to use copper sulphate to kill undesirable fish so the water could be stocked with desirable species. In an effort to eliminate the coarse fish, Catt (1934) applied copper sulphate to Lake Jesse, Nova Scotia. In connection with this project, Smith (1935) studied the effects of this treatment on the flora and fauna and checked the fish population. Later his studies were extended to Tedford and Boars Back Lakes. Although the copper sulphate kills most of the fish, it does not seem to be as effective as powdered derris root used by Eschmeyer (1936) in several Michigan lakes. Derris root is now being used in several states for studying fish populations. Because this poisoning method destroys all the fish, its use is obviously generally restricted to certain waters where undesirable species are present or over-population exists.

Fish managers now recognize that a knowledge of the total fish population, its constituent species, relative abundance, size, growth rate, and interrelations is essential to the management of a water. Eschmeyer (1938) has pointed out the value and use of such knowledge in practical fish management. Those engaged in the fisheries investigations on the impounded waters formed by the TVA dams realize that statistics on the standing crops, the turnovers of residual populations, and the annual increase or yield of the various food and game species are pertinent to the formation of a fisheries management program, but they realize too that such information is not easy to obtain

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in the large TVA reservoirs. To obtain at least an idea of the carrying capacity of the waters in the South, they are examining the populations of some small ponds in the vicinity of the large impoundments. During August, 1939, the population of Boddie Pond was studied. This study is apparently the first examination of a complete fish population in the Southeast.

Boddie Pond is about 1 mile north of Pickwick Reservoir in Lauderdale County, Alabama, Sec. 19, T. 3, S., R. 12, W. The soil in this area is red clay, and erosion has been rather severe. As a result, there has been considerable silting in the pond, which was originally formed by placing a small dam across the natural line of drainage. Early in 1939 the owner decided to remove the silt and deepen the pond. As this operation would destroy the fish, he was agreeable to having the fish poisoned before drainage in order that the species present, their relative abundance, and the production of fish in pounds per acre might be determined. The pond was poisoned on August 9, 1939, by the application of 25 pounds of powdered derris root having a rotenone content of 5 per cent. This is an application at the rate of 14 pounds per acre of water surface.

At the time of treatment the pond had an area of 1.78 acres, a shoreline length of 1,013 feet, an average depth of about 1.4 feet, and a maximum depth of 3 feet. Eleven lines of soundings were run across the lake, and measurements of depth were made along these lines at 10 foot intervals. The pond contained 108,076 cubic feet of water, or 808,408 gallons. In October, which is the dry season, the water level had dropped a foot and the pond had an area of only 1.27 acres. It is probable that the water level in the pond drops in this manner each fall so that the smaller area would be the effective fish producing area. The larger area, however, was arbitrarily used in determining the pounds of fish per acre.

The basin of the pond was somewhat circular and there was a fringe of trees around it. The original bottom was covered with 10 to 36 inches of soft red clay mud settlings. While the fish were present in the pond, the water was so turbid that objects could not be seen an inch or two below the surface. There was no submergent or emergent aquatic vegetation, due in part perhaps to the constant muddy water.

For poisoning, the dry derris root powder was mixed with water in a tub and the mixture sprinkled over the surface of the pond from a boat. The application was heavy, the water temperature was high, and the fish began to die immediately. A representative portion of the fish was preserved. It was possible to count almost all of the fish because the weather was hot and they soon came to the surface. The pond contained only three species of fish; the brown bullhead *Ameiur-*

us nebulosus marmoratus (Holbrook), the yellow bullhead *Ameiurus natalis natalis* (LeSueur), and the golden shiner *Notemigonus crysoleucas.* The latter fish is considered by Dr. Carl L. Hubbs to be an intergrade between the northern and southern subspecies *auratus* and *bascii.*

A total of 2,145 bullheads were found and all but 56 of these were weighed. The weight of the latter was estimated. The bullheads had a total weight of 313.5 pounds. Length measurements to the nearest half centimeter were made on 521 of them and 141 were preserved for study. Of the 521 bullheads measured, 394 were brown and 127 were yellow. It is believed that the ratio of brown to yellow in the total population was about three to one. The yellow bullheads attained a larger size than the brown bullheads as the largest individual of the latter species was 8.6 inches long and weighed slightly over 0.3 pound, while the largest of the former species had a length of 13.4 inches and weighed 1.25 pounds. Eleven yellow bullheads were over a foot long, and eighteen were in the 10 to 12 inch group. Only thirty-four of the

TABLE 1—LENGTH FREQUENCY OF THE BULLHEADS FROM BODDIE POND

Total length in centimeters	*Ameiurus natalis natalis*	*Ameiurus nebulosus marmoratus*
8.6 to 11.5	25	2
11.6 to 14.5	13	46
14.6 to 17.5	45	222
17.6 to 20.5	16	114
20.6 to 23.5	8	3
23.6 to 26.5	6	..
26.6 to 29.5	3	..
29.6 to 32.5	1	..
32.6 to 35.5	2	..

young of the year were present in the pond, which is a small number in comparison with the older groups. The total length measurements of the bullheads studied are grouped in 3 centimeter classes in Table 1. The brown bullheads did not have as great a range in size as the yellow ones, as almost all were in the groups between 14.6 and 20.5 centimeters.

Stomach examinations were made of 141 bullheads which were seined from the pond before it was poisoned. Of these, forty-six yellow and forty-one brown bullheads contained food. Data on the stomach contents are tabulated in Table 2. Chirnomids were the most abundant organisms found. They comprised 64 per cent of the total number of organisms in the yellow bullheads and 84 per cent in the brown. They also occurred in thirty-one, or 67.4 per cent, of the stomachs of the former and in thirty-five, or 85 per cent of the stomachs of the latter. Corixidae ranked second in importance both in the number taken and in the number of stomachs in which they were found.

Other important groups were the Ceratopogonidae, the Anisoptera, and the Zygoptera. The yellow bullheads had taken more golden shiners than the brown bullheads as 17.4 per cent of the former contained shiners, while they were found in only 2.4 per cent of the latter. This may be due in part to the larger size of the yellow bullheads. Although only a few shiners were taken, they furnished more bulk than all the other organisms.

No study was made of the abundance of bottom food in the pond, but Chirnomids and dragonflies were observed to be fairly abundant both before and after poisoning. There was a large emergence of dragonflies several weeks after the pond was poisoned.

TABLE 2—FOOD OF BULLHEADS IN BODDIE POND

	Food of 46 Yellow Bullheads				Food of 41 Brown Bullheads			
	Organisms		Stomachs		Organisms		Stomachs	
	No.	Per cent Total	No.	Per cent Total	No.	Per cent Total	No.	Per cent Total
Chironomidae	172	63.94	31	67.39	213	83.86	35	85.37
Ceratopogonidae	1	.37	1	2.17	9	3.54	5	12.19
Tabanidae	1	.37	1	2.17	....	....	....	....
Corixidae	57	21.20	28	60.87	20	7.87	13	31.71
Gerridae	....	....	....	....	1	.39	1	2.44
Belostomatidae	2	.74	2	4.34	....	....	....	....
Cicadellidae	1	.37	1	2.17	....	....	....	....
Dytiscidae	8	3.00	7	15.22	....	....	....	....
Gyrinidae	1	.37	1	2.17	....	....	....	....
Coleoptera larvae	1	.37	1	2.17	....	....	....	....
Caenis	1	.37	1	2.17	....	....	....	....
Anisoptera	1	.37	1	2.17	4	1.59	2	4.88
Zygoptera	3	1.11	3	6.52	2	.79	2	4.88
Orthoptera	2	.74	2	4.34	....	....	....	....
Trichoptera	3	1.11	2	4.34	1	.39	1	2.44
Lepidoptera	1	.37	1	2.17	....	....	....	....
Oligochaeta	1	.37	1	2.17	3	1.18	3	7.32
Golden shiner	13	4.83	8	17.39	1	.39	1	2.44
Totals	269				254			

Although for many years Boddie Pond had been very muddy, after the fish were removed the water cleared up so the bottom could be seen any place in the pond. A dense growth of algae formed in only a few days. The continued turbidity of this pond, which is judged to be due to the activity of the bullheads, is a fact deserving consideration in the management of such small clay-bottom ponds. In similar ponds, a better production might be obtained by preventing the introduction of those fish which limit vegetation and food production by stirring the bottom and keeping the water continually roiled.

The total population of golden shiners was found to be 20,112. Of those, 3,470 were weighed and preserved for study. The average weight of the golden shiners not weighed was assumed to be the same as that of the sample which was weighed. On this basis, the total weight of the golden shiners was calculated to be about 77.4 pounds. The shiners which were preserved were measured to the nearest sixteenth of an inch, placed in groups of one-fourth inch, and weighed. Age determi-

TABLE 3. AGE GROUP DISTRIBUTION, AVERAGE WEIGHTS, RANGE IN SIZE, AND CONDITION FACTORS OF 3,470 GOLDEN SHINERS FROM BODDIE POND

Summers of Life	No. of Fish	Range of Size in Inches	Av. Weight in Grams	Average Condition Factor*
1	3,283	1-3.25	1.5	1.7
2	173	2.25-3.75	4.9	2.0
3	9	3.75-5.0	17.2	2.1
4	1	4.6	23.5	2.5
5	4	5.0-5.5	34.2	2.1

*Cofficient of condition — $K = \frac{W \times 10^5}{L^3}$ where W = weight in grams and L = standard length in millimeters.

nations were made for fish in these size groups, also determinations of the range in size, the average weight, and the average condition factor of each age group. Most of the fish were in their first summer. Their range in size indicates that spawning had continued throughout the summer. The data on these fish are summarized in Table 3.

The standing crop of 22,257 fish found in Boddie Pond is considered too large a population for such a shallow pond. The very large number of golden shiners and the poor condition of the bullheads indicate overcrowding and stunting. Although the pond furnished some fishing, it contained very few fish of a desirable size. Better fishing would perhaps have resulted if more fish had been removed so the others could have had a chance to grow. Large numbers of bait minnows could have been removed.

Although the fish were in poor condition the total standing fish crop was large, 391 pounds, which is 219 pounds per surface acre. The number and weight of the fish found in the pond are recorded in Table 4. In addition to the fish, there was a great number of tadpoles. These were killed by the derris and their total weight was estimated to be over 100 pounds.

Considering the depth of the water, the carrying capacity of Boddie Pond compares favorably with that of other lakes and ponds which have been studied. It has a larger standing crop per acre than the lakes which Smith (1937) studied in Nova Scotia, and the Michigan lakes reported upon by Eschmeyer (1938). The standing crop in pounds per acre is exceeded, however, by that reported by Thompson and Bennet (1939) for Illinois ponds, and that reported by Viosca (1935) from a roadside borrow pit in northern St. Tammany Parish, Louisiana. However, as Boddie Pond was very shallow, perhaps a bet-

TABLE 4. NUMBER AND WEIGHT OF THE BODDIE POND FISH

Fish	Number	Total Wt. in Lb.	Fish per acre	Lb. per acre	Lb. per Million Gal. Water
Bullheads	2,145	313.5	1,205	176	389
Golden shiners	20,112	77.4	11,303	33	96
Totals	22 257	391.	12,508	219	485

TABLE 5. A COMPARISON OF THE PRODUCTIVITY OF LAKES AND PONDS ON THE BASIS OF THE NUMBERS AND POUNDS OF FISH PER ACRE AND PER MILLION GALLONS OF WATER

Lake or Pond	Area in Acres	Max. Depth in Ft.	Fish per Acre	Lb. per Acre	Lb. per Million Gallons
Lake Jesse, Nova Scotia..	45.0	21.5	776	19.9	7.6
Boars Back, Nova Scotia	55.8	31.0	498	17.0	6.1
Tedford, Nova Scotia......	52.0	20.0	1,658	36.0	13.8
South Twin, Michigan......	4.3	42.0	955	29.0	*
Ford, Michigan	10.7	33.0	3,987	49.0	....
Section Four, Michigan....	3.3	71.0	526	23.0	....
Howe, Michigan	13.4	24.0	1,754	34.0	....
Clear, Michigan	11.3	9.0	2,224	194.0	....
Standard, Michigan	31.0	31.0	1,262	21.0	....
Delta Pond, Illinois	....	....	....	232.0	....
Sportsmens, Illinois	....	....	....	341.0	....
Waldon Spring, Illinois..	....	....	....	409.0	....
Homewood, Illinois	....	....	....	518.0	....
Fork, Illinois	1.38	9.0	3,877	539.0	290.0
Bucks Pond. Illinois........	....	....	....	1,143 0	....
Boddie Pond. Alabama....	1.78	3.0	12,508	219.0	485.0
Borrow Pit, Louisiana	.10	3.0	....	860.0	1,290.0**

*Since average depth is not given, the volume is not known.
**This is based on an estimated average depth of 2 feet.

ter method for the comparison of productivity would be in pounds of fish per million gallons of water as suggested by Langlois (1934).[2]

A comparison of the productivity of lakes and ponds studied to date is recorded in Table 5. These figures suggest that southern waters have larger standing crops than northern waters, and that the standing crop tends to increase with a decrease in latitude. If this is true, southern waters can stand heavier fishing than northern waters because of their greater productive capacity and population density. The study of Boddie Pond indicates, however, that over-population is not confined to northern waters and that, even in the productive South unmanaged fish populations may be relatively worthless to the angler.

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[2]When comparing fish populations and productivity, it is also desirable to take into consideration the species of fish present. There are some indications that coarse, rough fish. such as carp, will give a larger yield in ponds per acre than will the food, pan, or game fish.

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ESTIMATION OF A BREEDING POPULATION OF CHUB SUCKERS

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In estimating breeding populations of fish there are two main problems: (1) characterization of the breeding population and (2) using an efficient method to obtain the estimate. It is the purpose of the present paper to tackle these problems with particular reference to the chub sucker. It seems more expedient to discuss Number 2 first.

Schnabel (1938) investigated the mathematics of several methods of handling the tag and recapture method of estimating fish populations. During the spring of 1939, the writer had an opportunity to apply one of these methods to a breeding population of chub suckers (*Erimyzon oblongus oblongus*).

The study was conducted in Glover's Pond near Cincinnatus, New York. This is a brown water, muck bottom pond of approximately 35 acres; it reaches a maximum depth of about 20 feet. The shoreline vegetation is composed largely of alder, shadbush, swamp rose, huckleberry, buttonbush, leather leaf, etc., which are in or over the water in a fairly advanced stage of plant succession. There is no inlet other than springs in the bottom, and there is a small dam across the outlet.

The fish present are: common bullhead (*Ameiurus nebulosus*), golden shiner (*Notemigonus crysoleucas*), chub sucker (*Erimyzon oblongus oblongus*), chain pickerel (*Esox niger*), yellow perch (*Perca flavescens*), common sunfish (*Eupomotus gibbosus*), and a few introduced largemouth black bass (*Huro salmoides*).

Two 1-inch stretched mesh fyke nets were placed in the pond April 26, 1939, the day after the ice went out. One, with a 50-foot leader, was located just off the outlet channel, the other, with a 100-foot leader, at the opposite side of the pond. The leaders ran out from shore with the fykes set at the outer end.

From the start, chub suckers were moving along the shores; this is characteristic of this species before and during spawning. The greatest concentration was off the outlet in the vicinity of Trap 1, where the best spawning facilities were located, but there was a mixing of the population around the whole pond as fish marked in Trap 1 were recaptured in Trap 2 and vice versa. The writer thus feels justified in assuming that the samples were fairly representative of the breeding population of the whole pond. It must be understood that the following handling of the data is worthless if this assumption was not justified.

The fish were measured, the sex was determined, and, after scales had been taken, they were released. Sex determination was simple owing to the presence of pearl organs on the males. The removal of two or three adjoining scales from the side served as a mark for the period of the experiment. In Trap 1, scales were taken from the right side, and in the other from the left side. In general the traps were visited morning and night. Forty-three samples were taken, twenty-five in Trap 1 and eighteen in Trap 2. The total number of fish and the number of recaptures were recorded for each sample; all unmarked fish were marked before release. These data were then used in the formula $N = \dfrac{t_1M_1 + t_2M_2 + {*}{*}{*} + t_nM_n}{r_1 + r_2 + {*}{*}{*} + r_n}$

Where N equals the population estimate; t_1 equals the total number of fish in the first sample, t_2 the total number in the second sample, etc., to n samples; M_1 equals the total number of marked fish in the ponds at the time the first sample is taken, M_2 the total when the second sample is taken, etc.; and r_1 equals the number of recaptures in the first sample, r_2 the number in the second, etc. This formula is a weighted formula, based on the expectation that the number of recaptures in any sample is most likely to be in the same ratio to the total fish in that sample as the total number of marked fish in the pond is to the total population. Thus $\dfrac{r}{t} = \dfrac{M}{N}$ or $N = \dfrac{tM}{r}$ for each sample. The above formula merely combines all these ratios, making the final estimate the best estimate obtainable from all the data. Table 1 presents these results for Traps 1 and 2. Each trap is handled as a separate unit. The application of this method to either Trap 1 or Trap 2 gives approximately the same population estimate. However, the figures for Trap 1 will be used as it affords a much larger sample. The results from Trap 2 may thus serve as a check.

Because the number of marked fish increases throughout the experiment, it is better to use this method instead of a simple proportion

TABLE 1. ESTIMATE OF THE CHUB SUCKER POPULATION IN GLOVER'S POND BASED ON TAGGING AND RECAPTURE

Traps 1 and 2 Sample	M	Trap 1 t	r	tM	Trap 2 t	r	tM
1	0	17	0	0	....	....	....
2	17	5	0	85	1	0	17
3	23	17	0	391	6	0	138
4	46	15	0	690	....	....	....
5	61	32	5	1952	3	0	183
6	69	9	1	721	....	....	....
7	77	19	6	1463	3	0	231
8	90	1	1	90	....	....	....
9	90	6	1	540	....	....	....
10	95	7	2	665	....	....	....
11	100	7	2	700	1	0	100
12	105	5	2	525	....	....	....
13	108	10	3	1080	7	3	756
14	119	4	2	476	1	0	119
15	122	8	3	976	1	0	122
16	128	2	1	256	3	2	384
17	130	11	3	1430	2	2	260
18	138	6	3	828	2	1	276
19	142	11	4	1562	3	1	426
20	151	3	2	453	3	1	453
21	154	15	6	2310	....	....	....
22	163	48	26	7824	2	2	326
23	167	16	9	2672	....	....	....
24	174	14	9	2436	9	6	1566
25	182	19	15	3458	12	7	2184
Totals			106	33583		25	7541

$N = \frac{33583}{106} = 317$ $\qquad N = \frac{7541}{25} = 302$ $\qquad N = \frac{\Sigma tM}{\Sigma r}$

M is the number of marked fish in the pond when the sample is taken.
t is the total number of fish in each sample.
r is the number of recaptures in each sample.
N is the total fish population of the pond.
Note: For any sample the previous tMs and rs can be totaled and used to get a value of N based on the data to that point.

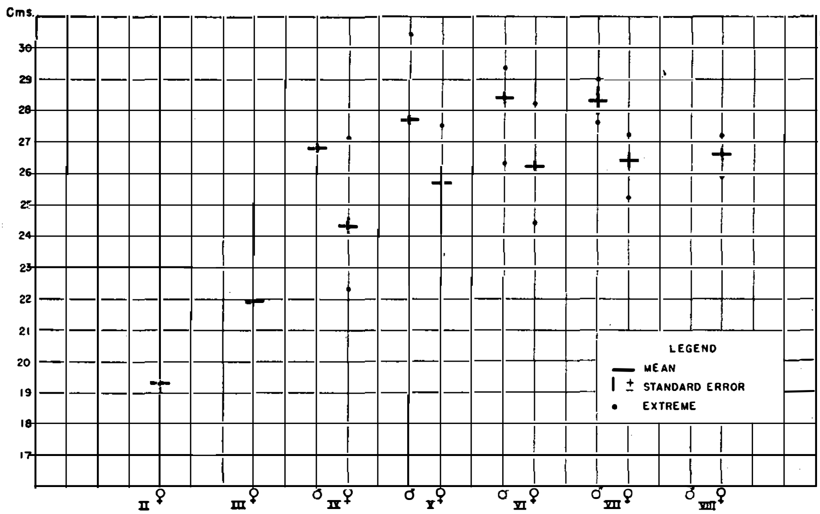
based on the catch for each sample ($\frac{M}{N} = \frac{r}{t}$). However, if a separate population estimate is made for each of these samples, a mean and a standard error can be obtained which should give a clue to the precision of the final estimate. Handled in this manner, the mean is 322 ± 29. As stated above, the population estimate of 317 is arrived at more soundly, but the standard error of 29 gives a rough idea of the accuracy of this estimate. Fisher (1936): "It may often happen that an inefficient statistic is accurate enough to answer the

TABLE 2. AGE, SEX, AND STANDARD LENGTH IN CENTIMETERS OF 200 CHUB SUCKERS

Age and Sex	Mean	Standard Error	Number of Individuals
II Females	19.3	1.5	2
III Females	21.9	....	1
IV Females	24.3	.22	27
IV Males	26.8	.16	24
V Females	25.7	.22	27
V Males	27.7	.16	32
VI Females	26.2	.13	42
VI Males	28.4	.16	25
VII Females	26.4	.23	11
VII Males	28.3	.4	3
VIII Females	26.6	.18	6

FIGURE 1

AGE, SEX, AND STANDARD LENGTH
THE MEANS, STANDARD ERROR, AND EXTREMES ARE SHOWN



particular questions at issue.'' It should be pointed out that this standard error is not as indicative of the population limits as one derived from data which are better fitted to the use of present statistical methods. It is reasonably safe to state that the true breeding population of chub suckers in Glover's Pond at the time of this experiment fell within twice the standard error or 317 ± 58, or somewhere between 260 and 375 fish.

Now the problem of characterizing the population which has been estimated may be undertaken. Table 2 presents the size composition of the captured fish grouped by sex and age. Figure 1 presents the same material graphically.

It will be seen that practically all of the fish are large for this species. The absence of I's and the near absence of II's and III's may be due to a number of factors. Based on growth estimates made from the scales of the older fish and on the growth of this species in ponds at the Cornell Hatchery, even the one-year-olds should be too large to pass through the mesh of the fykes. Whether the fish in this pond do not mature until the fourth spring after hatching or whether the younger fish spawn at a later date, the writer is not in a position to say.

The breeding population sampled between April 26th and May 10th was made up largely of IV's, V's, and VI's. In each of these age

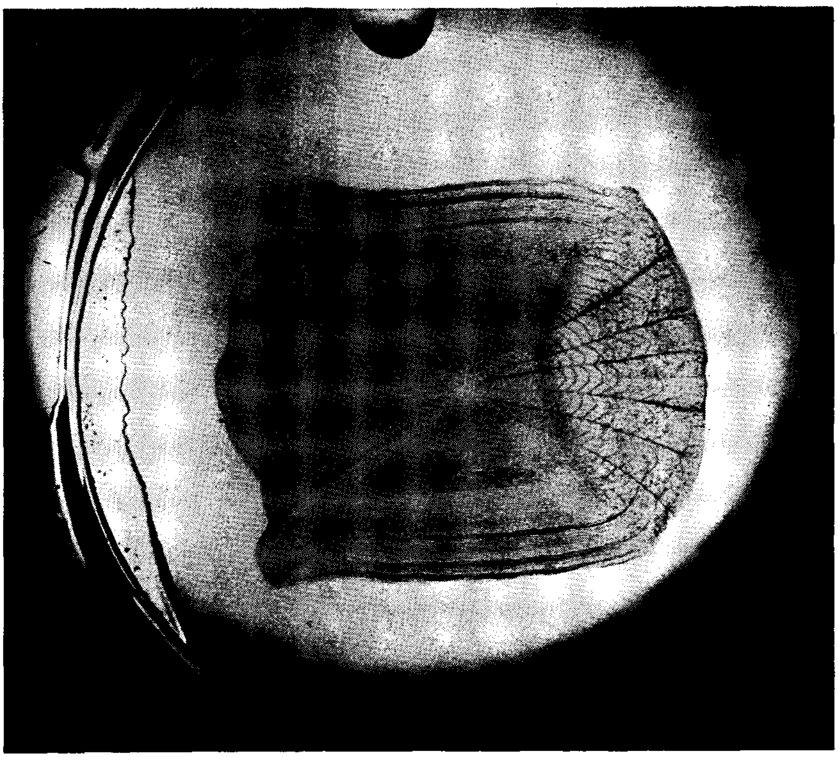


Figure 2—Scale of male chub sucker 28.6 cms. standard length.

classes, the males were significantly larger than the females. This dimorphism is the opposite to that usually exhibited by fishes which broadcast their eggs.

The scales indicate rapid increase in length for the first three to four years. (Figure 2.) From this point on, the rate of increase in length tends to decrease considerably. There is a significant difference in size between fish of 4, 5, and 6 years, and this is due to the uniformity of size among the fish of each sex in each age class; in no instance is the difference between the means of two adjoining age classes more than 1.5 cms.

One other fact should be pointed out. The proportion of the sexes of all fish caught was 99 males to 128 females. (This includes twenty-seven fish which were not marked.) The odds are very slightly less than 19 to 1 that such a difference may be due to chance. In other words, it is probable that the population from which this sample was drawn is made up of more females than males.

SUMMARY

1. Based on an application of the tagging and recapturing method, the conclusion is reached that there is a high degree of probability that the total early spring breeding population of chub suckers in Glover's Pond in 1939 was 317 $\pm$ 58.
2. This population is composed largely of fish 4, 5, and 6 years old.
3. In each of these age classes, the males are significantly larger than the females.
4. Scale readings indicate rapid increase in length for the first three or four summers and very slow increase in length beyond this point.
5. Ninety-nine males and 128 females were captured. The odds are slightly less than 19 to 1 that this population contains more females than males.

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BEAVER-TROUT RELATIONSHIP IN THE ROCKY MOUNTAIN REGION

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Wherever beavers occur in numbers, numerous questions arise concerning the effect of their activities on the streams they inhabit and the adjacent terrain. Many observations have been made on this very interesting mammal and its life history. Fewer investigations, however, have dealt with the beaver as a modifier of environment. Johnson (1927) studied the economics and natural history of Adirondack beavers treating in detail the effects of the reintroduction and increase on streams and vegetation, and on other wildlife species both aquatic and terrestrial. Salyer (1935) made a detailed study of beaver activity in relation to trout waters and trout populations in Michigan. Both these investigations showed the beaver to be neither entirely beneficial nor harmful to trout waters, and in Michigan particularly a number of conditions adverse to trout developed in ponds impounded by beavers and streams stocked with them.

The findings of these studies are not entirely comparable, owing, no doubt, to differences in the areas covered. And conditions neither in

[1]The U. S. Biological Survey, Utah Fish and Game Department, American Wildlife Institute, and Utah State Agricultural College cooperating.

the Adirondacks nor in Michigan are believed comparable with those usually prevailing in sections in the mountainous regions of the western United States in which beavers are present.

Under the Pittman-Robertson Project, Utah 2-R, the first approved Federal Aid to Wildlife Research Project, a detailed study of beavers and beaver habits was outlined. The investigation was undertaken for the purpose of obtaining fundamental information for use in a management and transplanting program. The study dealt with the numbers, distribution, and activity of beavers, and their effects on streams, water run-off, water chemistry and physics, soil erosion, timber, range forage, and wildlife and fish populations on a typical mountain area in northeastern Utah. This study area of 625,000 acres in the Uinta Division of the Wasatch National Forest in the western end of the Uinta Mountains contains the headwaters of several distinct river systems, including the Weber, Provo, and Bear in the Great Basin drainage; the Blacks Fork of the Green, draining northward into Wyoming; and the Duschesne and Rock Creek of the Green draining southward. The last three drainings are part of the Colorado River system. The entire area was above 6,500 feet in altitude, and beavers were found as high as 10,300 feet.

The field survey, conducted by three members, was begun during the latter part of August, 1938, and was continued until mid-November, when storms in the mountains prevented further work. It was resumed again June 4, 1939, and was continued until September 5.

A preliminary report of that part of the study dealing with water conditions and with trout and trout food found in beaver habitats follows.

In the area studied, there are approximately 620 miles of streams, 403.6 miles of which were surveyed and mapped. Of these, 232.3 miles were determined to be suitable for beavers, and all but 68 miles were stocked with them at the time of the survey. The distribution of the animals, however, was not uniform, and there were marked variations among the major drainages. The Provo River drainage was 82 per cent stocked, whereas the Blacks Fork contained only 28 per cent of its estimated carrying capacity. The entire area contained 380 active colonies, 1,505 dams, 1,143 ponds, and an estimated population of 1,976 beavers. Much of the tract was unsuitable for beavers because of stream gradient, volume of water, or lack of a sufficient quantity of their preferred (and almost sole) foods—aspen (*Populus tremuloides*) and several species of willow (*Salix* spp.). The average size of the ponds was 0.314 acres, and the average volume of water per pond was 29,383 cubic feet, or 0.675 acre-feet. The ponds covered 358.5 surface acres, or 0.057 per cent of the total area; the total volume of water stored was 771 acre-feet.

Stations were established on the various drainages throughout the study area, at which water-chemistry, physical, and biological observations were made of the beaver ponds and streams. For these observations the older and more ecologically mature ponds were selected, and water samples were taken from the top 6 inches of water over the deeper, still parts. Stations on streams were located on the main branches and on the tributaries just above their mouths. Observations were made on air and water temperature and on oxygen and carbon dioxide content, and hydrogen ion, phenolphthalein alkalinity, and methyl-orange alkalinity determinations were made. In addition to these, the character of the subsoil, vegetation, and bottom, the water color and turbidity, and the weather conditions were noted. Some of the data obtained are summarized in the following tables.

TABLE 1. CHEMICAL ANALYSIS OF STREAMS AND PONDS
Sept. 4 to Oct. 20, 1938, by Rampton

	Stream stations (64)				Pond stations (14)			
	Number of samples	Max.	Min.	Arith. mean	Number of samples	Max.	Min.	Arith. mean
Air temperature[1]	60	73	35	59.7	13	68	44	59.2
Water temperature[1]	59	62	39	47.6	13	52	42	47.9
Oxygen p.p.m.[2]	62	10.5	6	9	14	11.8	7.5	8.8
Hydrogen ion (pH)	64	7.5	6.4	7.1	14	7.4	6.5	7.1
Methyl orange alk. p.p.m.[2]	44	250	10	67	13	220	20	104

[1]Temperatures are in degrees Fahrenheit.
[2]Methyl orange alkalinity, carbon dioxide, and oxygen are expressed in parts per million.

TABLE 2—CHEMICAL ANALYSIS OF STREAMS AND PONDS
June 6 to Sept. 12, 1939, by Hobson

	Stream stations (33)				Pond stations (36)			
	Number of samples	Max.	Min.	Arith. mean	Number of samples	Max.	Min.	Arith. mean
Air temperature[1]	32	78	54	64.3	36	78	53	66.7
Water temperature[1]	32	65	41	53	36	72	46	57.9
Oxygen p.p.m.[2]	33	12.2	4.5	8.5	36	12.9	3.1	7.5
Carbon dioxide p.p.m.[2]	33	9.5	18.5	1.4	36	14	7.7	4.7
Hydrogen ion (pH)	19	8.2	6.5	7.3	27	8.2	6	7.3
Methyl orange Alk. p.p.m.[2]	32	237	5	66	35	228	6	78

[1]Temperatures are in degrees Fahrenheit.
[2]Methyl orange alkalinity, carbon dioxide, and oxygen are expressed in parts per million.

The samples were taken at different times of day, although there is a preponderance of late forenoon and early afternoon samples. The data are thus subject to criticism because of the lack of 24-hour records.

Records of the color of water show 102 streams clear, 1 murky, 1 gray, and 1 brown; of the ponds 29 were clear, 4 green, 1 gray, and 5 brown.

As to turbidity, ninety-four stream stations were recorded as clear,

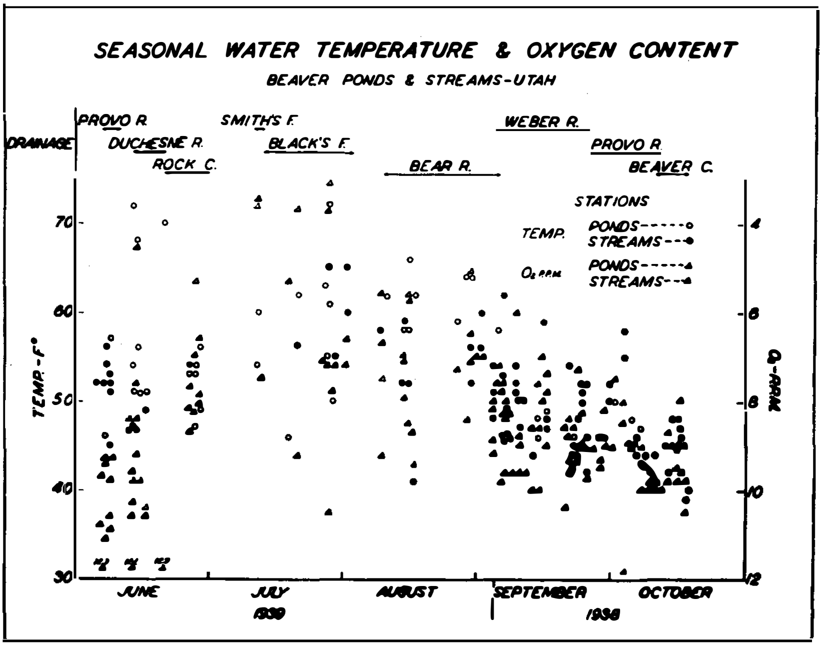

FIGURE 1—Records of water temperature (degrees Fahrenheit) and oxygen content (parts per million) of beaver ponds and streams, shown in relation to date of sample and drainage; 147 stations—50 beaver ponds and 97 streams. Data recorded from June 6 to September 5, 1939, and September 4 to October 20, 1938. Uinta part of Wasatch National Forest in Utah.

ten slightly turbid, one moderately turbid, and one turbid; and twenty-seven pond stations were clear, twelve slightly turbid, and five turbid.

At ninety out of ninety-seven stream stations, the stream bed was composed of gravel, rubble, or boulders; at the remaining seven it was of sand, silt, and clay.

Records of fifty pond stations show that forty-three had silt or silt-and-sand-covered bottoms; and seven had sand and gravel.

TEMPERATURES

The maximum air temperature recorded at any of the stations were 78° F., the minimum 35°, although temperatures of 32° or lower occurred on the area during all months of the investigation. Water temperatures similarly were low, ranging from a maximum of 72° to a minimum of 39°. Figure 1 shows all water temperatures taken. Only three pond temperatures were 70° or more, two in mid-June and one in late July. No stream temperatures exceeded 65°. In general, the distribution of the 140 recorded water temperatures (91 stream and 49 pond), shows the expected seasonal trend. Pond temperatures had a wider variation than those of streams.

Only a few of the pond temperatures were in excess of what is believed desirable for cutthroat trout. Most of the stream temperatures taken during June were about 50°—a suitable temperature for the spawning of this species.

The oxygen content of the ninety-five stream samples varied from 12.2 to 4.5 p.p.m., the mean being approximately 8.8 p.p.m.; in the fifty beaver ponds the maximum was 12.9 p.p.m. and the minimum 3.1 p.p.m., with a mean of approximately 7.9 p.p.m.

The oxygen content of ponds varied more than that of streams, as is shown in Figure 1 (O_2-p.p.m. scale on the right reads from top to bottom). The maximum reading taken in June was for water containing an abundance of aquatic plants. Only five pond samples taken in July showed less than four parts of oxygen per million.

Figure 2, illustrating the relation of water temperature and oxygen content, shows that the bulk of the samples were near or above the saturation point for oxygen. In the streams this is explainable by their being swift mountain streams with an average gradient of approximately 115 feet to the mile. The ponds act as stilling basins on these streams.

The minimum oxygen content of ponds were associated with the higher temperatures, and the conditions were not desirable for trout. Trout were often present, however, where the stream channel or pond bottom contained water of more favorable temperatures.

Chemical analysis of the water indicated that only a few of the ponds were undesirable for trout life. These ponds either were especially small, old, or abandoned by beaver; contained an abundance of aquatic plants; or had little or no inflowing water; or they were on very small streams or impounded springs, the waters of which were chemically undesirable. In neither of these cases did the ponds decrease the amount of trout waters, because no stream that was of sufficient size and chemically and physically suited for trout prior to beaver establishment was undesirable after beaver occupation.

The following is a tabulation of average pH readings:

	June	July	August	September	October
Streams	7.2	7	7.2	7.2	7.1
Ponds	7.3	6.2	7.3	7.1	7.1

In 51 pond analyses the maximum pH was 8.7 and the minimum 6, the arithmetical mean being 7.3; in 102 stream analyses, the maximum pH was 8.5, the minimum 6.4, and the arithmetical mean 7.5. The pH content was determined by the colorimetric method. The exact sig-

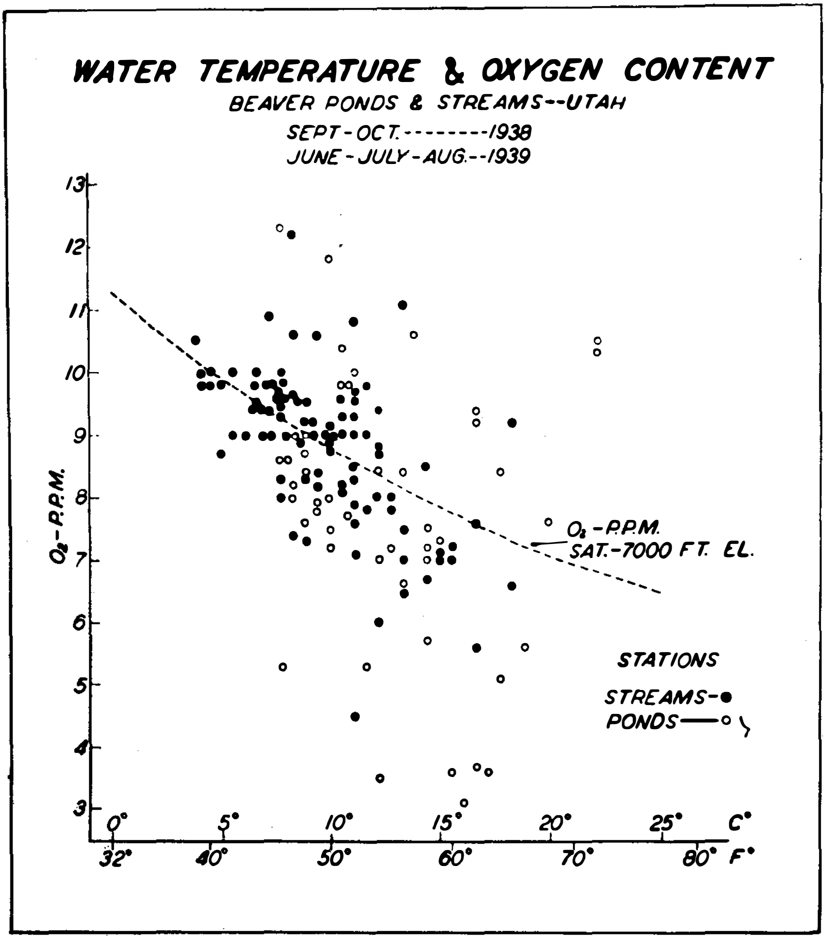

FIGURE 2—Relation of temperature and oxygen content of water from Utah beaver ponds and streams. From the data shown in Figure 1.

nificance of pH on biological productivity is still little understood. There was no indication that the differences present were enough independently to influence the occurrence of trout.

All samples showed alkalinity by the methyl orange test. Analyses of forty-eight ponds disclosed a maximum of 228 p.p.m. and an average of 85 p.p.m.; the maximum of 76 stream samples was 250 p.p.m., and the average was 66.5 p.p.m.

Only 5 of the 147 stations showed phenolphthalein alkalinity. Two of these were in ponds (maximum 7.7 p.p.m.), three in streams (maximum 18.5 p.p.m.).

Only the 1939 data are summarized here. CO_2 occurred in ponds to a maximum of 14 p.p.m. and average 4.7 p.p.m. In streams the maximum was 9.5 p.p.m., and the average 1.4 p.p.m. These maximums should not prove serious unless associated with other unfavorable conditions. Certain streams arising from springs contained considerable quantities of CO_2 and at times contributed to the CO_2 content of the beaver ponds.

Comparison of the stream area between beaver ponds with the ponds themselves showed a marked difference in the invertebrate and aquatic inhabitants. The intervening areas of stream were usually riffles over a rocky bed, the water containing a small quantity of algae and an abundance of stream organisms. The ponds appeared to be equal to the fast moving water in food production per unit area. Quantities up to 5 grams to the square foot were taken in routing samples. The better stream samples averaged about 2 grams to the square foot.

The more common invertebrates inhabiting the beaver ponds were in order of their abundance: Coleoptera, Ephemeroptera, Crustacea, Odonata, Diptera, Mollusca, Hemiptera, and Trichoptera.

Often much aquatic plant growth was present. The most abundant kinds were *Chara, Potamogeton,* and *Batrachium.*

As part of a study of beavers in northeastern Utah, data were collected on a series of factors believed to influence the numbers and distribution of trout.

The study area of 625,000 acres contained approximately 620 miles of stream, practically all inhabited by native cutthroat trouts (*Salmo utah, S. pleuriticus,* and *S. lewisi*). The general distribution of the cutthroats in these cold, high-velocity streams indicates their suitability for the habitat. Numerous plantings of other species of trouts, particularly eastern brook and rainbow, have not been successful in this area.

In contrast to the findings of the Michigan investigation, the study of beavers in the intermountain area disclosed few adverse results from their activity.

Beavers were responsible for the impoundment of 1,143 ponds and 358.5 acres of water, practically all of which was utilized by trout, in an area in which the total water surface of the streams was approximately 600 acres. Beaver structures definitely aided in stabilizing and maintaining stream flow. Beaver ponds made available for trout a variety of conditions not commonly found in the streams, providing deep, still, well-protected pools with shade and cover. These pools situated on shallow streams are particularly valuable for overwintering trout.

Lack of knowledge of the physiological tolerances of the cutthroat troutss makes a critical review of the data on water chemistry impracticable. Records of losses in high mountain lakes and reservoirs of the area, however, indicate that the native trouts are more tolerant of adverse winter conditions than are the rainbow, brook, or brown trouts.

A study of the water chemistry and temperatures showed very few factors that might be adverse to native trout. Conditions were comparable with those found by Brown (1935) for Utah trout streams. As in other studies, definite rises in temperature were recorded in beaver ponds. These were never great and are believed to benefit trout growth, inasmuch as the average stream temperatures were low.

No depletion of trout food as a result of beaver activity was observed. The beaver ponds produced more microscopic organisms suitable for fry and fingerlings than did the streams and thus served as rearing ponds for small fish.

Deposition of silt occurred regularly in the beaver ponds but its effect in destroying spawning beds was minimized by the fact that even with maximum numbers of beavers, extensive areas of gravel bottom were still available. The average stream gradient of 115 feet to the mile precluded the possibility of beavers flooding the entire stream bed.

No evidence was obtained of an increase in predation or disease in the beaver ponds, other than the fact that kingfishers were attracted to the pools.

Beaver dams produced definite obstructions to fish movement in the streams and this appeared to be the most harmful effect of beaver activity on the trout. During the increased spring run-off, native trout moved up stream with little difficulty to spawn, but were often prevented from returning to the lower and larger waters with the decrease in stream volume.

During the time of year when the stream flow is at the minimum, a large number of the dams were effective in preventing the movement of trout in or out of the ponds.

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MEASUREMENT OF FISH POPULATIONS IN THE RUSSIAN RIVER, ALASKA

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In 1939 Ranger Dennison and George H. Brooks, Fire Guard, compiled information on the catch of sport-fishermen on the Russian River, Chugach National Forest, Alaska. Management of game fish has an important relation to this type of work and, as far as known, this is the first and only attempt that has been made to secure a complete seasonal record of the game fish taken on the Russian River, or on any Alaskan waters.

The Russian River is internationally known for the excellent rainbow trout obtained there. Sporting magazines and newspapers have given it wide publicity. Sportsmen from over the entire continent have been attracted by the promise of a fisherman's paradise. Its tourist attraction is also very great.

Russian River fishing begins customarily as early in the spring as weather and other circumstances permit. The spawning season of the rainbows begins in early May and apparently extends into June. The exact period has not been determined but it would vary from year to year according to weather conditions. The early spring fishermen therefore catch principally spawning fish. In addition to the drain on spawning fish by sportsmen, it has been reported that numbers are taken with gaff hooks, spears and other hand means. The effect of this practice is decidedly detrimental. Considering the small size of the river and the concentration of fishermen at the most accessible points, it is subjected to fairly intense fishing throughout the entire season and the quality of fishing is therefore reported to have declined rapidly in recent years, although records of fishing intensity or success are not available to check against popular report.

TABLE 1—1939 RUSSIAN RIVER CATCH RECORDS*—RAINBOW TROUT CHUGACH NATIONAL FOREST, R 10

Date***	May 17-31	June 1-15	June 15-30	July 1-15	July 15-31	Aug. 1-8	Total period
Number of fishermen	17	52	74	91	104	20	358
Total number of hours fished	105	315	335	424	746	106	2,031
Average number of hours per fisherman	6.2	6.0	4.6	4.7	7.2	5.3	5.7
Total number of rainbow trout caught	29	127	354	476	634	90	1,710
Average number caught per fisherman	1.7	2.4	4.8	5.2	6.1	4.5	4.1
Average length of trout in inches	26.6	17.3	14.0	13.1	11.9	12.4	15.8
Largest fish caught, in inches	34½	30	31½	32	30	31	34½
Success factor in terms of inches of fish per hour**	7.3	6.9	14.6	14.5	10.1	10.5	11.4

*Estimated to include 90 per cent of actual catch and stream use.
**Not a true criterion as weight of fish is not considered. Weight figures not available. Success factors should be based on pounds of fish per hours fishing.
***Forest Guard not on duty and no records obtained prior to May 17 or after August 8.

The records obtained in 1939 showed there were a total of 358 fishermen on Russian River from fifteen points in Alaska, fourteen in the United States, one in Canada and nine fishermen were from points unknown. Seward contributed nearly 67 per cent of the Alaska fishermen and Washington State about 55 per cent of those from the States. Two were from Toronto, Canada. The recording began on May 17 and closed August 8. Table 1 shows the detail and plan of the records obtained.

The records compiled in May showed that 10 per cent of the fish taken were 24-26 inches in length; 20 per cent 26-28 inches; 40 per cent 28-30 inches; and 15 per cent over 30 inches. Only 10 per cent were in smaller sizes. The June records showed 61 per cent in sizes ranging from 12 to 18 inches; the first half of July catches showed 34.6 per cent under 12 inches; 25.9 per cent in the 12-14 inch lengths; and 15.9 per cent in the 14-16 class. The second half of July showed 51.5 per cent under 12 inches, 19.8 per cent between 12 and 14, and 7 per cent 14-16 inches. The records for August 1-8 give 55 per cent under 12 inches; 9 per cent in the 12-14 inch class and 15.7 per cent 14-16 inches; with 4.5 per cent 28-30 inches; and 1.1 per cent over 30 inches. The May catches showed the greatest percentage of larger sized trout taken.

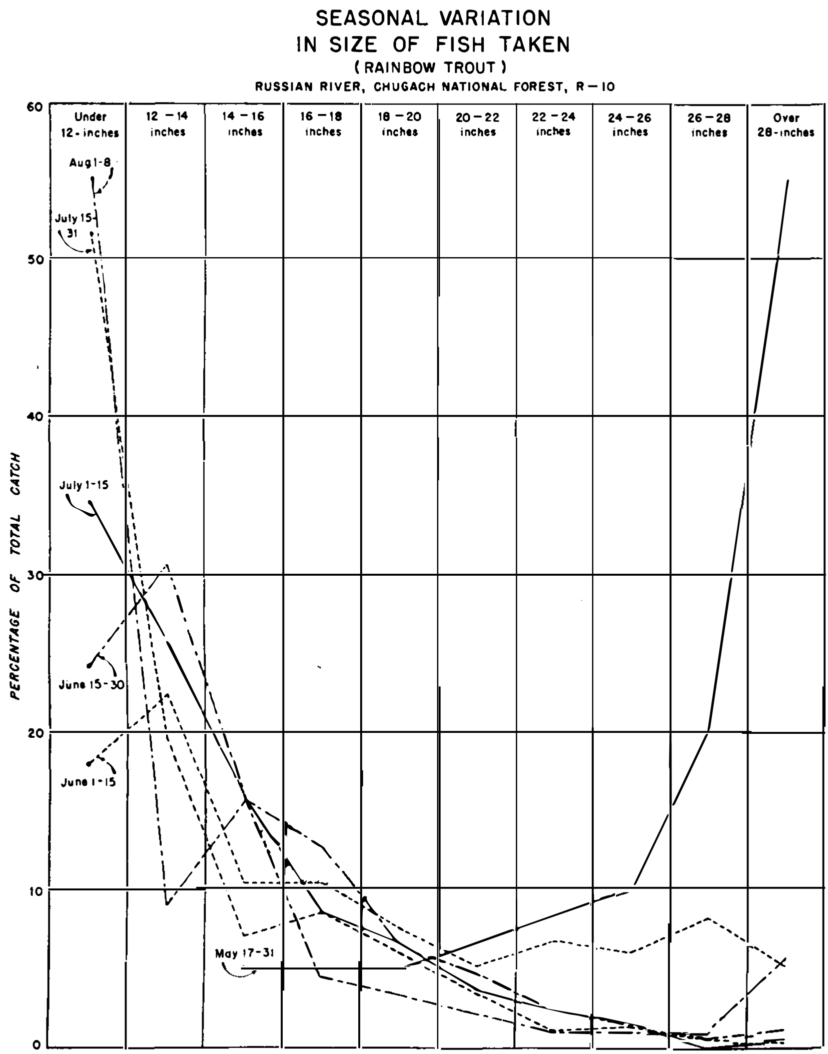
Dolly Varden trout records on 154 fish taken showed 11 per cent under 12 inches; 18.8 per cent 12-14 inches; 22.8 per cent 14-16; 22.8 per cent, 16-18; 10.4 per cent 18-20; 11 per cent 20-22; 1.9 per cent 22-24; and 1.3 per cent 24-26 inches. Table 2 shows the comparison in percentages and numbers of fish of the two species recorded:

TABLE 2—RUSSIAN RIVER—1939 FISHING SEASON CATCH RECORD

Species	Rainbow trout	Dolly Varden trout	Total
Number	1,710	154	1,864
Percentage of catch	91.7	8.3	100%

From a study of the records, it is apparent that, while the total number of fishermen and fish taken (358 fishermen and 1,710 rainbow trout) were not large, there is sufficient use to warrant the inauguration of management measures. Fishing during May is primarily for spawning rainbows, 55 per cent of the catch being fish 28 inches or more in length. Early June fishing likewise takes a disproportionate number of large fish and indicates that the spawning season carries over into this period. As the season advances, the percentage of small fish in the catch increases greatly. This may be due to several factors:

1. Return of spawners to deep waters.
2. Reduction of volume in stream flow.
3. Change in fishing methods and type of fishermen.
4. Progressive reduction in numbers of large fish due to take.



The regulations governing the taking of rainbow trout on the Russian River are at present as follows:

Season—No season defined, unrestricted.

Legal methods—No restriction, except commercial fishing is prohibited.

Limits—Daily limit, forty fish or 10 pounds and one fish. Possession limit, eighty fish or 20 pounds and one fish.

Dolly Varden trout may be taken at any time, by any method, in any numbers and commercial fishing is permitted. This status is universal throughout the territory.

Recommendations: It is recommended that fishing on the Russian River be so regulated as to provide the maximum yield from these waters. To secure this end it is imperative that the following restrictions be placed in effect on this stream:

1. Prohibit the taking of trout of all species by any method other than rod and line.
2. Establish a closed season on all species prior to June 5.
3. Reduce bag limit on rainbow trout to twenty fish or 10 pounds and one fish, and possession limit to forty fish or 20 pounds and one fish.

Regulations should be duly publicized in the territorial newspapers and suitable notices posted in the vicinity.

It is important that accurate catch records from the Russian River be secured annually with the use of standard forms and instructions such as were employed in the 1939 study.

It is planned to investigate conditions on the Russian River during the spring and summer of 1940 in conjunction with other work on the Kenai. The primary objective of such an effort will be to determine ways and means of securing a maximum sustained yield and utilization of the sport fishing resources. It is not believed that a detailed technical stream survey is either necessary or desirable at this time.

EXPERIMENTS ON THE STOCKING OF FISH PONDS

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The great increase in the number of fishermen during the past twenty years has resulted in the overfishing of many streams and natural lakes. As the number of fishermen further increases, it becomes evident that adequate fishing can be provided only by the construction and proper management of artificial ponds. Thousands of these ponds have been constructed, and hundreds of new ones are being made each year, especially throughout the Southern and Mid-Western States. No information, based upon actual experiments, has been available as to the most suitable combination of species, the sizes, and the numbers of each which should be used in stocking these ponds or lakes. As a result, ponds have been stocked in any fashion appealing to the owner,

[1]Published with the approval of the Director.

often with extremely poor results from the standpoint of the fishing. In some of these ponds, good fishing has resulted within one or two years after the pond was stocked, while in others, fishing was extremely poor even after a 4, 5 or 10 year period. This great variation in results has been found to be due almost entirely to the initial method of stocking the pond.

In order that a body of water may provide good fishing it must meet the following conditions:

1. It must be capable of producing sufficient food to support in excess of 100 pounds of fish per acre.
2. Most of the weight of fish in the pond must be in the form of desirable game and pan fish.
3. Most of the weight of game and pan fish in the pond must be in the form of legal-sized fish.

Most natural ponds and lakes in the South and elsewhere are capable of supporting in excess of 100 pounds of fish per acre. Where an increase in the yield of fish is desired, this can be obtained by the fertilization of the pond waters (Swingle and Smith, 1939). Thus most ponds and lakes can be made to meet the first condition.

The second and third conditions can be met only by the elimination of undesirable species and by the proper stocking of ponds. In artificial ponds, provided with a means for draining, the removal of undesirable species is a relatively easy matter. When draining is not possible, poisoning all species and restocking with desirable fish only is becoming a recommended practice (Thompson and Bennet, 1939). The proper stocking of these ponds is of great importance if fishing in them is to be improved.

Experiments on various methods of stocking fish ponds were begun at the Alabama Agricultural Experiment Station in 1934. These experiments were conducted in ponds ranging in size from 0.5 acre to 12 acres. The ponds were stocked in the winter or early spring with various combinations of species of fish, and the results determined after an interval of one or more years by draining the ponds and counting and weighing the fish. While the results reported herein must be considered largely as a progress report, sufficient information has been gained to enable pond owners to enjoy excellent fishing within less than a year after the ponds have been properly stocked.

The fish used in these experiments were the bluegill bream (*Lepomis macrochirus* Rafinesque), the white crappie (*Pomoxis annularis* Rafinesque), the largemouth black bass (*Huro salmoides* Lacépède), the top minnow (*Gambusia affinis* B. & G.) and the golden shiner minnow (*Notemigonus crysoleucas* Rafinesque).

Stocking with bluegill bream—The bluegill bream (*Lepomis macro-*

chirus Rafinesque) is one of the best pondfish and should be stocked in all ponds. It provides good sport for pole or fly-fishing, is one of the best flavored of the fresh-water fish, and has a sufficiently high reproductive capacity to serve as a forage fish for use with the carnivorous species.

Numerous analyses over a 5-year period have been made of the stomach contents of bluegills from various types of ponds. Aquatic insects were found to make up over 95 per cent of the total volume of food consumed. Chironomid larvae were the most important single group of insects. Small bluegills, weighing less than one gram, were found to be feeding upon the same organisms as the legal-sized bream. While large bluegills were occasionally found to have fed upon other fish, such cases were rare. Even in heavily overstocked ponds, these fish did not feed to an appreciable extent upon their own young.

It therefore would appear logical that, due to the high reproductive capacity of the bluegill bream and to its lack of cannibalistic habits, ponds containing this species only would soon be so overcrowded with young fish that growth would be impossible.

This was found to be the case in all ponds stocked with bluegill bream only. For example, a 0.5 acre pond was stocked in March, 1938, with 750 fingerling bluegills. This pond was moderately fertilized (Swingle and Smith, 1939) and when drained the following November was found to be supporting 388 pounds of fish per acre. The pond was seined periodically to determine the rate of growth of the fish originally added. The results are briefly summarized below:

Date	*Average weight of bluegills collected*
March 24 (when stocked)	5.8 grams
June 15	70.0 grams
July 13	68.9 grams
August 13	56.0 grams
November 30	54.2 grams

It will be noted that the bluegills added grew rapidly until spawning occurred. By June 15, thousands of small bream were observed in the pond, and, from this time on, competition for food became so severe that the bream originally added lost weight during the remainder of the summer and actually weighed approximately 20 per cent less when the pond was drained in November than they had weighed in June.

Even after five or ten years, ponds stocked with only bluegills contain very few legal-sized fish. Carnivorous fish must be added to eat up most of the small fish if the pond is to be successful.

Stocking with bluegill and white crappie fingerlings—The white crappie (*Pomoxis annularis* Rafinesque) feeds largely upon aquatic insects and small fish. There is no sharp transition point during the life of the crappie at which it changes from one type of food to the other. The food of the smaller crappie consists largely of insects and that of the larger crappie mainly of fish. However, a 1-pound crappie may be found to have fed entirely upon insects and a 5-gram crappie may have made its meal on a smaller fish. Crappie, therefore, compete with bream for food over a rather extended period in their life, but will eat a considerable number of small bream whenever the latter are available.

In order to determine the value of a bluegill-crappie combination, a 1.2-acre pond was stocked in March, 1938, with bluegill and crappie fingerlings at the rate of 1,500 and 200 per acre, respectively. Top minnows (*Gambusia affinis* B. & G.) were added for mosquito control. This pond was fertilized lightly during 1938 and 1939 to increase fish production. Unfortunately the area of the pond was reduced to approximately 0.3 acre during the drought of 1938. The pond was drained that fall, half the legal-sized bream and crappie removed and all the rest of the fish returned to the pond. The pond was drained again and the fish counted and weighed one year later (December, 1939), when the experiment was closed.

The results of this experiment (Table 1) indicate that crappie cannot be depended upon to balance a pond containing bluegill bream. At the end of two years, the total weight of young bream was twice that of the older bream, and but few of the large bream had reached a size in excess of 2 ounces. A few of the oldest crappie had reached a size of 1.5 pounds, but the medium-sized crappie averaged less than a quarter-pound. In addition, the crappie had not eaten a sufficient number of their own young, with the result that, after a 2-year period, the pond was overstocked with both bream and crappie. With this combination, however, a considerable number of each species may reach a legal size by the end of the first year after stocking. It is believed that trouble will be experienced in maintaining a proper balance after fishing begins and the large crappie are removed.

TABLE 1—FISH POPULATION IN A 1.2-ACRE POND STOCKED WITH BLUEGILLS AND WHITE CRAPPIE

Fish	Stocked March, 1938. with		Recovered on draining pond, Dec., 1939	
	Number	Weight Pounds	Number	Weight pounds
Bluegills (large)	......	......	2,462	114.6
Bluegills (small)	1,800	18.4	15,554*	229.6
Crappie (large)	......	......	135	35.7
Crappie (small)	240	2.5	2,368*	52.6
Gambusia	100	0.2	10,397	14.6
Total fish	......	21.1	......	447.2
Tadpoles	......	......	......	470.0

*Hatched during 1939.

Stocking with bluegill and largemouth black bass fingerlings—The largemouth black bass (*Huro salmoides* Lacépède) does well in ponds, but is often objected to, especially in small ponds, because of its voracious appetite and cannibalistic habits. It competes with bream only until it reaches several inches in length. Growth thereafter is extremely slow unless a diet of small fish is available. Where food is abundant, bass are capable of making very rapid growth.

In order to determine the value of a bluegill-largemouth bass combination, a 1.3-acre pond was stocked in February, 1939, with bluegill and bass fingerlings at the rate of 1,500 and 100 per acre, respectively. Top minnows (*Gambusia affinis* B & G) were added to the pond for mosquito control. The pond was fertilized with inorganic fertilizer to increase production. The following December, the pond was drained and the fish counted and weighed (Table 2).

TABLE 2—FISH POPULATION IN A 1.3-ACRE POND STOCKED WITH BLUEGILL AND LARGEMOUTH BLACK BASS FINGERLINGS

Fish	Stocked Feb., 1939, with		Recovered on draining, Dec., 1939	
	Number	Weight pounds	Number	Weight Pounds
Bluegills (large)	......	......	1,663**	432.4
Bluegills (small)	1,950	65.4	8,216	49.0
Largemouth bass (large)	......	......	90***	71.8
Largemouth bass (small)	127	5.3	193	28.8
Crappie (large)	......	......	4	4.5
Crappie (small)	4*	0.3	241	36.3
Gambusia	4,721	10.9	207	0.4
Total fish	......	81.9	......	623.2
Tadpoles	None	......	......	None

*Apparently overlooked when pond was drained in 1938. Number and weight estimated.
**51 bream removed previously for samples.
***5 bass removed previously for samples.

The results of this experiment indicate that largemouth black bass can effectively balance a pond containing bluegill bream when the pond is stocked with fingerlings of both species at the same time. The number of small bream in the pond was kept down by the bass and consequently the bream originally placed in the pond continued to grow throughout the year. When the pond was drained, the number of small bream left was approximately sufficient to carry the bass through the winter and replace any bream removed by fishing. Over 89 per cent of the total weight of bream was in the form of legal-sized fish.

In addition, the bass had reduced their own young from the thousands which hatched in the spring to approximately the correct number for the size of the pond. If all the legal-sized bass had been removed, just the right number of bass would have remained to properly balance the pond the next spring. Similar results have been obtained upon draining several other ponds containing bass. Cannibalism among bass causes much concern in fish hatcheries, but without this cannibalism in ponds, lakes, and streams, the production of legal-sized fish would be impossible. Because of its carnivorous and cannibalistic habits, the bass must be regarded as the ''boss'' of the pond and must be depended upon to keep a proper balance between the number of fish and the food supply. In the above pond, over 81 per cent of the total weight of fish was made up of legal-sized bass and bream (Figure 1).

Figure 1. Fish from a 1.3-acre fertilized pond 10 months after stocking with the correct numbers of fingerling largemouth bass and bluegill bream. This pond contained 623 pounds of fish and over 80 per cent of this weight was in the form of legal-sized bass and bream. Properly stocked ponds provide good fishing within less than a year.

When a pond is stocked in the above manner, the bass should be as small as, or smaller than, the bream so that the bream added in stocking cannot be eaten. The bass will then be unable to feed upon bream until after spawning occurs. Previous to spawning they must feed upon tadpoles and gambusia minnows. While they will not grow much on this diet, it will keep them alive until the young bream hatch. While this procedure is admittedly somewhat hard on the bass, it gives much better results than waiting a year or two for the building up of a large population of bream before adding the bass, as is often recommended. By this time, the pond is overcrowded with bream and since young bream and young bass feed upon the same food organisms, bass have an extremely hard time getting started and may require three or more years to properly balance the pond. Ponds stocked in this manner may never produce good fishing.

Stocking with adults of bluegills, white crappie, yellow bullheads, and largemouth black bass—The stocking of ponds with adult fish is occasionally recommended, especially when it is difficult to secure sufficient hatchery fish. In order to test this method of stocking, a 1.8-acre unfertilized pond was stocked in December, 1936, with ten adults of each of the following species: bluegill bream, yellow bullhead, white crappie, and largemouth black bass. One year later (November, 1937) the pond was drained and the fish counted and weighed. The ten bluegills had produced 20,615 young; the ten bullheads had produced 668 young; the ten crappie had produced 3,848 young, and, finally, the ten largemouth black bass had produced none, probably because of the lack of food for the adults prior to spawning. In this 1.8-acre unfertilized pond, therefore, there were enough bream for a 60-acre pond, enough catfish for a 12-acre pond, enough crappie for a 70-acre pond, and insufficient bass for one acre. All these fish were replaced in the pond and the experiment continued for two more years. In December, 1939, the pond was drained and the fish again counted. At this time there were still sufficient bream for a 70-acre pond, sufficient crappie for a 34-acre pond, and enough catfish for a 6-acre pond. Throughout this period only three small bass were produced by the ten adults. After getting a late start in the pond, small bass were unable to survive due to the intense competition for food. Very few fish in this pond reached legal size during the 3-year period of this experiment.

These results are summarized below:

Legal-sized fish added to pond Dec., 1936		Legal-sized fish present in pond Dec., 1939
10	Bluegills	28
10	Crappie	8
10	Bass	9
10	Yellow bullheads*	212

*One-half pound or larger. There is no legal size for this species.

It is evident that this method of stocking cannot be depended upon for good results.

Stocking with bluegills, golden shiners, and largemouth bass—The golden shiner minnow (*Notemigonus crysoleucas* Rafinesque) has been recommended by Davis and Wiebe (1930) for use as a forage minnow for bass. A large portion of its food may consist of phytoplankton, but it also feeds to a considerable extent upon microcrustacea, aquatic insects, and to some extent upon small fish. It therefore competes more or less with bream for food.

A 1-acre pond was stocked with a combination of bluegills, golden shiners, and bass in January, 1936. It was drained in January, 1939. This pond produced 200 pounds of bass, 238 pounds of bluegills, and 134 pounds of golden shiners. While the bass production was excellent, the presence of the golden shiners apparently reduced the weight of bluegills which the pond could support, and consequently reduced the total poundage of desirable fish which could be caught in the pond.

The ratios of forage and carnivorous fish in ponds—In addition to stocking with the best combination of species in a pond, it is extremely important to stock with as near the correct numbers of each species as possible. Since the carnivorous species are directly dependent upon the forage species for food, the proper balance between the two should be secured by proper stocking.

Little information is available as to just what constitutes the proper balance between the forage and carnivorous species in ponds. This is a problem which can be solved only by extensive experiments. In order, however, to establish an approximate ratio for stocking purposes, the weights of forage and carnivorous species present in eight ponds were determined by draining the ponds and counting and weighing the fish (Table 3).

In these ponds, the ratio of the weight of forage to carnivorous fish varied from 1.9:1 to 3.5:1. The average was a ratio of 2.8:1.

In stocking ponds, the ratio of 2:1 was arbitrarily accepted. If a pond can support 150 pounds of fish per acre of water, this ratio means that bream or other forage fish will make up 100 pounds of this weight, and bass or other carnivorous species 50 pounds. Since bluegills can reach a weight of 4 ounces or better in one year and bass a weight

TABLE 3—RATIOS OF FORAGE AND CARNIVOROUS FISH IN VARIOUS PONDS

Size of pond acres	Age of pond years	Forage Fish (F) Kind	Forage Fish (F) Weight pounds	Carnivorous Fish (C) Kind	Carnivorous Fish (C) Weight pounds	Ratio F:C
1.8	1	Bluegills, Yellow bullheads, Chub suckers	230	Largemouth bass & white crappie	65	3.5:1
1.8	1	Bluegills, Yellow bullheads, Chub suckers	173	Largemouth bass & white crappie	68	2.5:1
1.8	2	Bluegills, Yellow bullheads, Chub suckers	280	Largemouth bass & white crappie	105	2.7:1
1.8	3	Bluegills, Yellow bullheads	358	Largemouth bass & white crappie	120	3.0:1
1.5	2	Bluegills	256	White crappie	88	3.0:1
1.0	3	Bluegills, Golden shiners	380	Largemouth bass	200	1.9:1
25.0	13	Bluegills	1,326	Largemouth bass	607	2.2:1
1.3	1	Bluegills	482	Largemouth bass	141	3.4:1

of approximately a pound, the above pond should support 400 bream (averaging a quarter-pound) and not more than 50 bass (averaging one pound) per acre. Similarly, if a pond will carry 600 pounds of fish, it should support approximately 1,500 bream and not over 200 bass of the above sizes. In actual stocking, the above numbers of bream are used, but only half the above numbers of bass. This reduction in the number of bass is advisable for the following reasons:

1. Little food is available for the bass until bream have spawned.
2. The above ratio is only approximate.
3. The young bass produced in the pond will also require forage fish for food.

Where ponds have been stocked in the above manner with fingerling bluegills and bass, both have reached a legal size in less than a year after the pond was stocked.

SUMMARY

Experiments have been conducted over a 5-year period upon methods of stocking ponds for the most efficient production of fresh-water fish. These experiments have been conducted in ponds ranging in size from 0.5 to 12 acres. Ponds were stocked in various ways during the winter or early spring and the results determined, after an interval of one or more years, by draining the ponds and counting and weighing the fish.

Stocking with adult fish (a combination of bluegills, white crappie, yellow bullheads, and largemouth black bass) gave extremely poor results. This procedure resulted in overcrowding the pond with some species and in the total failure of others to reproduce.

Stocking ponds only with bluegill bream fingerlings resulted in rapid growth of the bream until spawning occurred. Growth then ceased entirely, due to the increased competition for food by the thousands of small fish produced. Very few fish ever reach a legal size in ponds stocked in this manner.

Stocking ponds with various combinations of bluegill bream and white crappie gave better results, but usually resulted in ponds overstocked with either bream, or crappie, or both.

Stocking ponds with a combination of bluegill bream fingerlings and largemouth black bass fingerlings gave the best results, measured both by the growth of bream and bass. In these ponds, the bass had reduced the numbers of small bream and small bass, leaving approximately the right numbers for rapid growth. Good results were secured only by the addition of the correct numbers of fingerlings of both species; the basis upon which these numbers are calculated is given.

Properly stocked ponds provide good fishing within less than a year,

while improperly stocked ponds have required as long as five or more years to reach this condition.

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AN ATTEMPT TO EVALUATE THE EFFECT OF STREAM IMPROVEMENT IN CONNECTICUT

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Since 1932 when federal aid became available for the purpose, stream improvement has become a recognized part of the trout restoration program in Connecticut as well as in a number of other states. Various types of structures, as advocated by Hubbs, Greeley and Tarzwell (1933), Davis (1935), Davis, Hazzard and MacIntyre (1935) and James (1935), have been installed and tested for durability. During these years it has been considered as self-evident that these devices did, indeed, improve conditions for trout but actually few data based upon experimental evidence were available to support this assumption (Greeley, 1936; Hazzard, 1937; Hubbs, Tarzwell and Eschmeyer, 1934; Tarzwell, 1938).

Connecticut is forced to provide fishing in streams that are, in general, relatively poor trout water. Summer temperatures often reach the upper limits of tolerance of trout, water levels become exceedingly low exposing wide expanses of stream bed, considerable anchor ice may be formed in winter and the spring break-up is usually followed by excessive flooding and scouring. For this reason the foundation of the program rests in the hatcheries producing legal-sized trout which are liberated just prior to, and during, the fishing season. The problem is primarily one of attaining the greatest possible catch in relation to plant.

In 1933 over 15,000 legal-sized brook and brown trout were marked with the Nesbit internal tag (Cobb, 1934) and planted in thirty-six representative streams of the state. On the basis of returns from these tagged trout, Elkins (1934 unpublished) reported that between 58.2 per cent and 66.7 per cent of the legal-sized trout liberated were lost from the streams some time between the end of one fishing season and the beginning of the next. From these data it becomes evident that if stream improvement were effective in decreasing the annual loss of hatchery trout even 50 per cent, it would improve fishing to a tremendous extent within a short period of years and at a lower cost to the angler.

In 1937 the senior author suggested the desirability of cooperating with the Connecticut State Board of Fisheries and Game in an attempt to check the effect of stream improvement on a typical Connecticut stream. It was desired to know what effect certain types of stream improvement had on the physical condition of the stream bed, the chemistry and temperature of the water and the change, if any, in bottom fauna. It was hoped that these data would indicate the practicability of extensive stream improvement work on the principal streams of the State. It was not feasible, however, to check all of the numerous stream improvement devices. Consequently, it was decided to confine the work to the "V"-dam as modified by Thorpe from James (1935). This type of structure created striking physical changes in the character of streams and seemed to hold promise of being best adapted for use in Connecticut.

After examining several brooks, it was decided to place the experimental dam on a portion of the Blackledge River. In years gone by this body of water was a natural trout stream of some reputation but due to environmental changes it has now become rather poor trout water, particularly during the summer months. At the present time it is heavily stocked by the State with legal-sized trout, but few trout hold over from year to year.

After examining several portions of the stream, an area was selected that possessed a relatively uniform depth, width and slope. The bottom was quite uniformly of the gravel-rubble type and so flat and unattractive that it was consistently avoided by experienced fishermen.

The area chosen for study was 53 feet in average width and had an average depth of 1½ feet.

The velocity varied from 1.65 feet per second (March, 1937) to 1.38 feet per second (May, 1939) although this does not represent maximum velocity in flood periods. Two volume flow determinations were made using the formula advocated by Hoover (1937). In March, 1937, the volume was 118 cubic feet per second, and in April, 1939, it was 65.3 cubic feet per second.

Three areas 25 yards long were marked off—the lower two here-

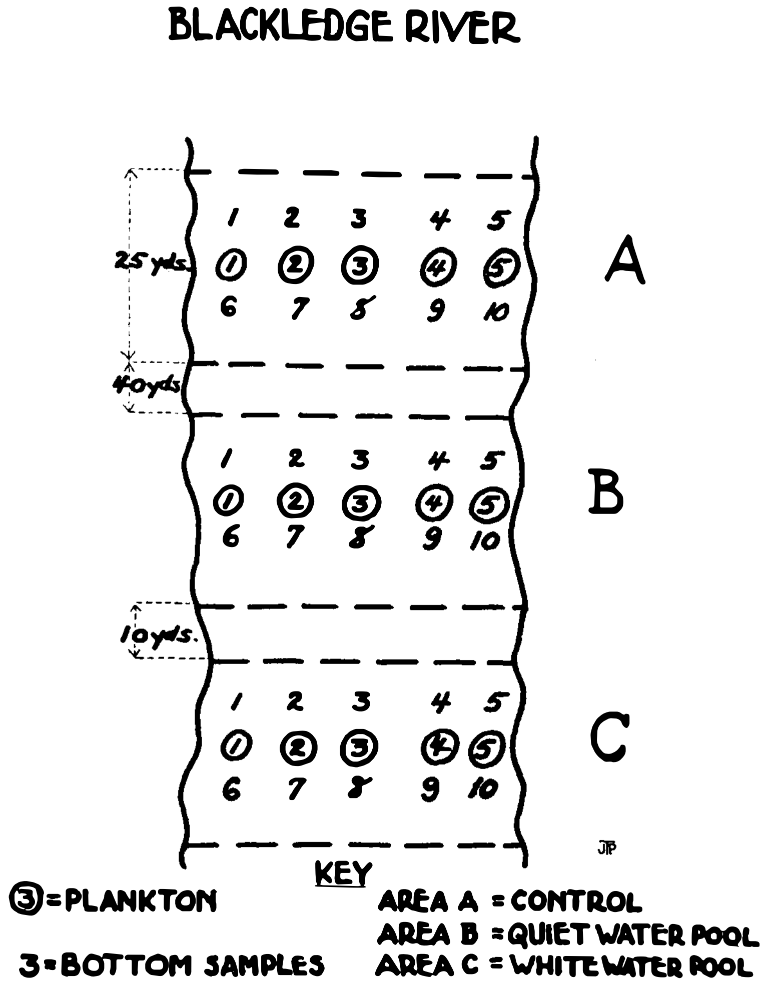

Figure 1. Plan of areas and stations in stream improvement experiment.

inafter known as Areas B and C, being 10 yards apart, while the third, hereafter designated as the control area (Area A), was about 40 yards further upstream. It was planned to place the modified "V" dam between Areas B and C, thus creating a "white water" pool below the dam in Area C and a quiet pool above in Area B (Figure 1). Since Area A, the control, was not affected by the changes in the stream produced by the erection of the dam, it might be used as a basis for comparison at any time that the other regions were studied. Comparisons could then be made between all three regions, *assuming that the data* *furnished from the study of Area A would represent a fairly accurate picture of that unimproved portion of the stream at that particular time of the year.*

The first series of collections was made at the end of March, 1937, prior to the installation of the dam. The following data were determined at this time and upon subsequent visits:

*(1) Temperature—air and water.
*(2) Dissolved oxygen.
†(3) pH of the water.
†(4) Volume of flow.
†(5) Plankton.
‡(6) Number and weight of bottom organisms per square foot quadrats. Classification of the organisms.
§(7) Chemical analysis.
§(8) Carry over of tagged trout.

Examinations were carried on over a period of two and one-half years at fairly regular intervals. A total of thirty-seven visits were made for the determination of dissolved oxygen, temperature of the air and water. Ten visits were completed to obtain data on the bottom fauna, ten samples being taken in each area each visit and the entire sample was counted. Only occasional trips for plankton, rate of flow and the pH of the water were made.

RESULTS

Physical Changes.—As a result of the construction of the modified "V" dam, the water level in Area B was raised thus creating a quiet-water pool having a constant summer average depth just above the dam of approximately 1 to 1½ feet. The new water level was such that trout could take advantage of the protection offered by overhanging banks and stream-side shrubs. The increased depth also afforded improved cover for trout. It was determined that there was a complete turnover of water in this area about every 50 seconds during normally high water.

The cutting action of flood water flowing over the apron of the "V" dam into Area C has excavated a lively, white-water pool between the supporting cribs and extending downstream nearly 50 feet. The maximum depth of this pool is 6½ feet and it extends well back under the apron and supporting cribs which provide excellent hiding places for trout. There is a constant swirling current of well-aerated water in this pool. The bottom is now partly composed of large boul-

*Indicates samples taken at every visit to the stream.
†Taken twice a year.
‡Ten series of samples of ten samples each from each area were taken during the experiment and all samples were counted in entirety.
§Based upon a single determination.

ders which were too heavy to be moved by the current. The smaller boulders and gravel have been sorted by the current and deposited some distance below the dam to form an attractive riffle.

Temperature.—Although the air and water temperatures were regularly checked and recorded, usually in mid-afternoon, no significant differences were noted during most of the year in the three areas. The most marked changes appeared in the summer when the volume flow was extremely low. In such cases the flow over the apron of the "V" dam and through the pool in Area C was greatly reduced and there was no appreciable whirlpool effect that was so characteristic when a greater volume of water passed over the dam. When the flow was thus reduced, the water in Area C was cooler (up to 3° F.) than that in the control area upstream.

It is currently believed that eastern brook trout have a maximum toleration limit of 75° F. (Embody, 1928) while rainbow and brown trout are supposed to tolerate a peak of about 80° F. Although these figures are only approximations, they are undeniably useful when interpreted cautiously and intelligently.

The highest temperature recorded in the Blackledge River during the summer of 1937 was 78° F., while in 1938 it was 68.9° F. and in 1939, 81° F., although there is good reason to believe these figures are below the summer maximum. The summer of 1938 was relatively cool and consequently conditions were unusually good for carrying over trout. The following summer, however, was quite dry and hot and conditions were not so satisfactory. Even under such unfavorable conditions it is interesting to note that the upper limits of toleration for trout apparently had not been passed in the experimentally improved regions. While a daily record of these temperatures is not available, it should be pointed out that summer visits were made during the most unfavorable periods possible.

Plankton.—Plankton is known to be less plentiful in flowing streams, particularly in streams of the Blackledge type, than in ponds. Nevertheless, a limited number of plankton samples were taken in order to measure any change in the productivity of the stream that might result from the formation of a quiet-water pool. Fifty liter samples were taken by means of a bilge pump which delivered 500 cubic centimeters per stroke. The water was pumped through a No. 20 silk bolting cloth net. Samples were taken prior to construction of the dam and again in 1939, two years later. No plankton organisms were recovered either before or after improvement.

Dissolved Oxygen.—Much has been written about the importance of dissolved oxygen for aquatic life, and deservedly so. Welch (1935) in his text *Limnology* regards a minimum oxygen requirement for

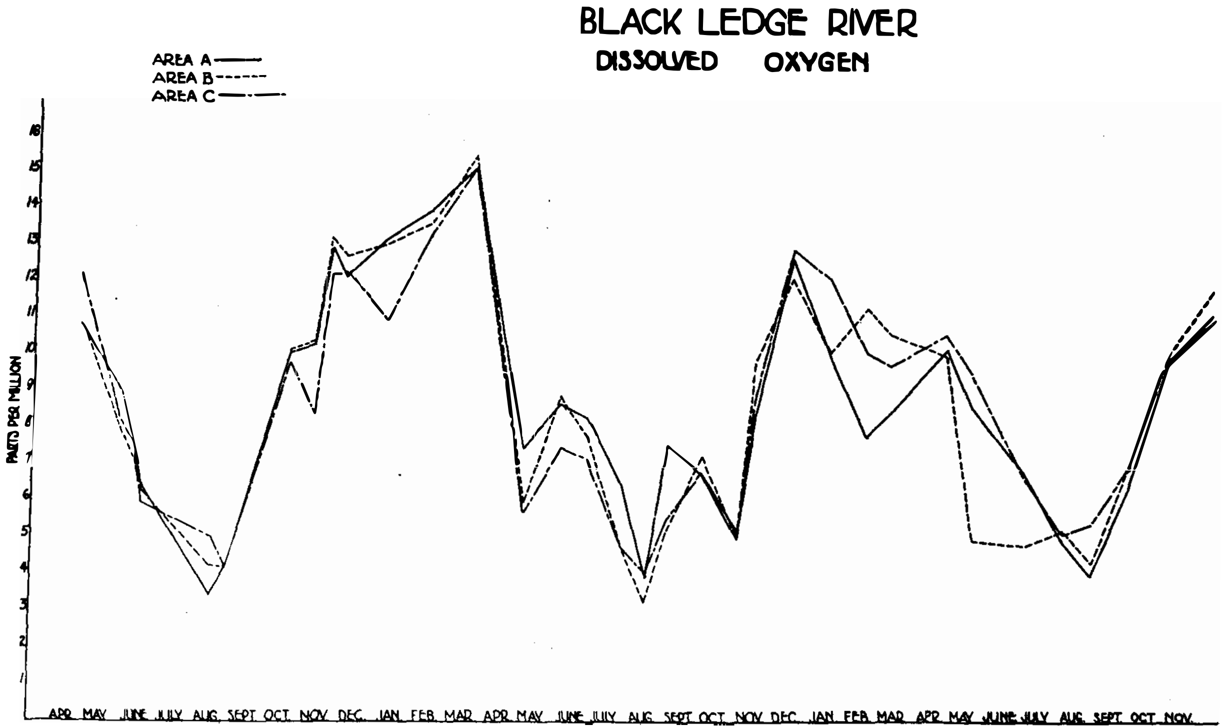

Figure 2. Dissolved oxygen expressed in parts per million in the three areas of the Blackledge River from April 1937 to November 1939. The x-axis represents time, the y-axis, ppts per million of D. O.

trout to be 1.0 to 2.5 cubic centimeters per liter which is the equivalent of 1.5 and 3.5 parts per million. While there is known to be some variation in the tolerance of aquatic organisms, especially fish, these figures do, nevertheless, represent an important approximation. Furthermore, it is well to keep in mind that a rise in temperature causes an increase in oxygen consumption by the fish. This is to be expected since the metabolic rate of cold-blooded organisms is largely controlled by the temperature of their environment.

It should be kept in mind that after the construction of the "V" dam the three areas offered marked environmental contrasts. The control area lay just below a region characterized by riffles which presumably meant that the water was well aerated. Area B, being a quiet water pool, might be expected to be somewhat warmer during the summer months, although its greater depth and surface might offset the lack of flow. Area C, lying below the dam, had the advantage of greater depth and aeration as the water poured over the apron of the dam.

A total of thirty-seven dissolved oxygen samples were taken during the two and one-half years of this experiment. These samples were secured about every three weeks during the summer and somewhat less frequently during the winter. A study of Figure 2 reveals no significant differences in dissolved oxygen during the cooler seasons of the year. However, when the flow of the stream is reduced, as it is during the summer months, there is only a few inches or less passing over and through the rubble of the control area and therefore the water rapidly warms up. Under such conditions the dissolved oxygen in the quiet water pool, Area B, is not materially improved. Area C, however, reveals at such times the value of these stream improvement structures as the temperature differences range up to 3° F. and the amount of dissolved oxygen is usually higher than in other areas.

Bottom Fauna.—Food of the right sort is essential if the carrying capacity of a trout stream is to be increased. In recent years a number of stream surveys have been carried on in various states. Most of these studies have attempted to classify streams as to food production on the basis of a brief survey made during the summer. These data are used as a cornerstone of a "sound stocking policy". Some surveys, or workers, have employed quadrats as their yardsticks, as outlined by Davis (1938), while others have resorted to a cursory examination of a bit of the trout stream. This latter method has been employed by the New York State's Biological Survey. Obviously the success of such a system depends upon the experience of the persons making such observations, as pointed out by Mottley, Rayner and Rainwater (1939).

The bottom fauna of the Blackledge River was measured by means of square foot quadrats, following Davis (1938). It is quite possible that the data so obtained are an inadequate measure of the actual productivity of this stream for stocking purposes, but it is felt that the comparisons of these three areas, A, B and C, are *relative* and fall within the limits of accuracy necessary to determine whether or not the bottom food has been increased as a result of the installation of this type of stream improvement device. As seen in Figure 1, ten samples were usually taken in each area; *all* specimens in *each* sample were counted and weighed.

As indicated previously, several workers in this country, notably Embody (1928) and Needham (1928), have studied the productivity of trout streams and reported their findings. Surber (1937) attempted to determine whether a certain grade of stream actually represents a definite "capacity of the stream to produce a certain amount of fish". Mottley, Rayner and Rainwater (1939) complain over the failure of most authors to utilize a standard statistical treatment. To us the problem seems to center around a lack of an adequate control. An attempt has been made to eliminate this by:

(1) Not attempting to formulate a stocking recommendation on these data.

(2) Recognizing that certain errors in sampling are bound to occur but assuming these to be fairly constant as the samples were taken by the same group of persons from the same localities upon ten different occasions in a period of two and one-half years.

(3) Maintaining a constant control area for comparison in the *same* stream. This control area is composed of the *same* type of bottom that Areas B and C originally possessed as far as could be determined by visual examination and a collection of bottom fauna, etc.

(4) Counting and weighing *all* specimens in *all* samples. Therefore, it is believed that a basis for comparison exists that is more valid than that reached by many other workers who at the best have been forced to utilize two similar streams (Tarzwell, 1938) and not all the samples.

During the two and a half years that the Blackledge was under observation ten series of bottom samples were taken. The selected area

TABLE 1. A LIST OF DATES WHEN BOTTOM SAMPLES WERE TAKEN

Sample No.	Date	Comments
I	2/IV/37	before construction of dam; stream moderate
II	4/V/37	after construction of dam; stream moderate
III	19/XI/37	stream moderate
IV	19/IV/38	stream high
V	11/VI/38	stream moderate
VI	7/VII/38	stream moderate
VII	1/VIII/38	stream low
VIII	18/VIII/38	stream low
IX	15/X/38	after the flood and hurricane; stream moderate
X	19/VI/39	stream moderate

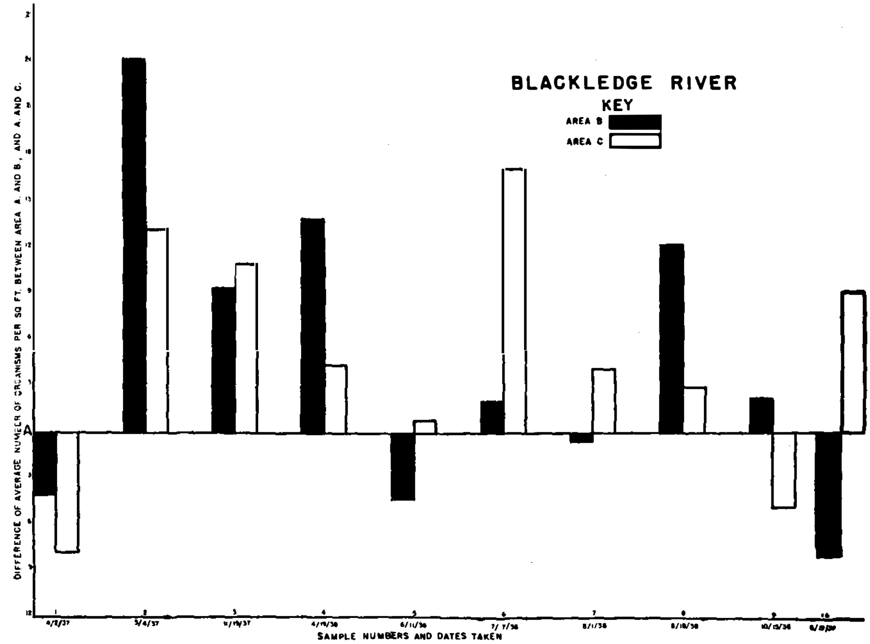

Figure 3. Average number of organisms per square foot quadrat as compared with Area A; the control is represented by the straight line, A. Increases are indicated above and decreases below the line, A, and represent changes in relation to average per quadrat for Area A. The first series were taken before the dam was built. The ninth approximately three weeks "after the hurricane."

was studied intensively before the experimental "V" dam was constructed and periodically thereafter. The dates of these examinations follow (see Table 1). It will be seen by glancing at the table that a series of six sets of bottom samples were taken during 1938.

These collections clearly indicated that certain qualitative and quantitative changes had taken place (Figure 3). In the first place it is apparent that while the control Area A produced a few more organisms per square foot quadrat before the dam was constructed, the productivity of the quadrats in the improved areas jumped markedly shortly *after* the construction of the barrier and that this improvement was, on the whole, maintained. The most striking change followed the installation of the dam for on May 4, 1937, a series of samples indicated that Area B was producing over twenty-four more organisms per quadrat than the control area while Area C yielded about 13.5 more. By November of that year Area B was producing nearly ten more organisms per square foot, and Area C over eleven more organisms per square foot than the control (Figure 3). By spring Area B was the most productive area having an average of fourteen more per quadrat than A, and C was 4.5 organisms per square foot better than the control. During the months of June, July and early August, Area C yielded more favorable results than B. This was also true of June, 1939. However, towards the middle of August, Area B was yielding 12.2 more organisms than the control. Figure 3 summarizes these comparisons diagrammatically.

A rather striking corollary of the increase in the numbers of organisms per quadrat in Areas B and C is the average difference in weight between the samples of Areas B and C when contrasted with A. Before the experimental "V" dam was built, the samples from the Area B quadrats weighed on an average 0.16 grams more than A; Area C, upon the other hand, was only 0.04 grams better per sample than the control. As soon as the dam was constructed conditions improved and the average weight of the samples was definitely in favor of the improved areas (Figure 4). It should be noted in passing, however, that during the flood of the fall of 1938 and the subsequent hurricane, the control area fared better than the two experimentally improved sections. The June, 1939, samples indicated an improvement in Areas B and C compared with A, suggesting that a certain amount of recovery was taking place.

The mere increase in numbers and weights of organisms is of little

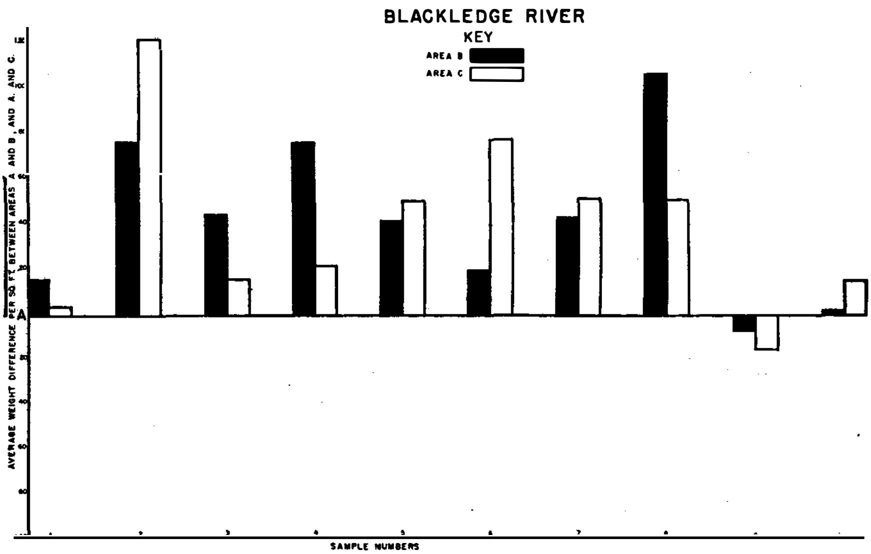

Figure 4. Average weight of organisms per square foot quadrat as compared with Area A; the control is represented by the straight line, A. Increases are indicated above and decreases below the line, A, and represent changes in relation to the average per quadrat for Area A. The first series was taken before the dam was built, the ninth three weeks "post hurricane."

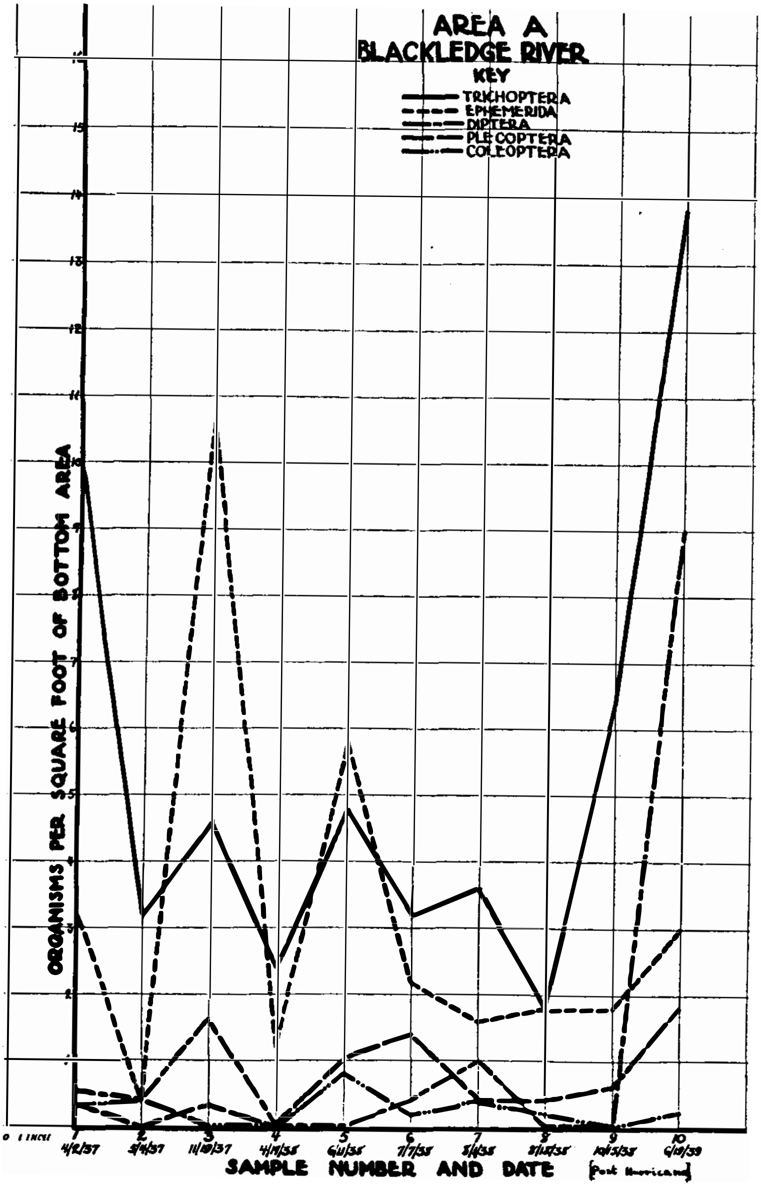

Figure 5. Average numbers of organisms in Area A per square foot quadrat, arranged by orders of insects; other groups not included.

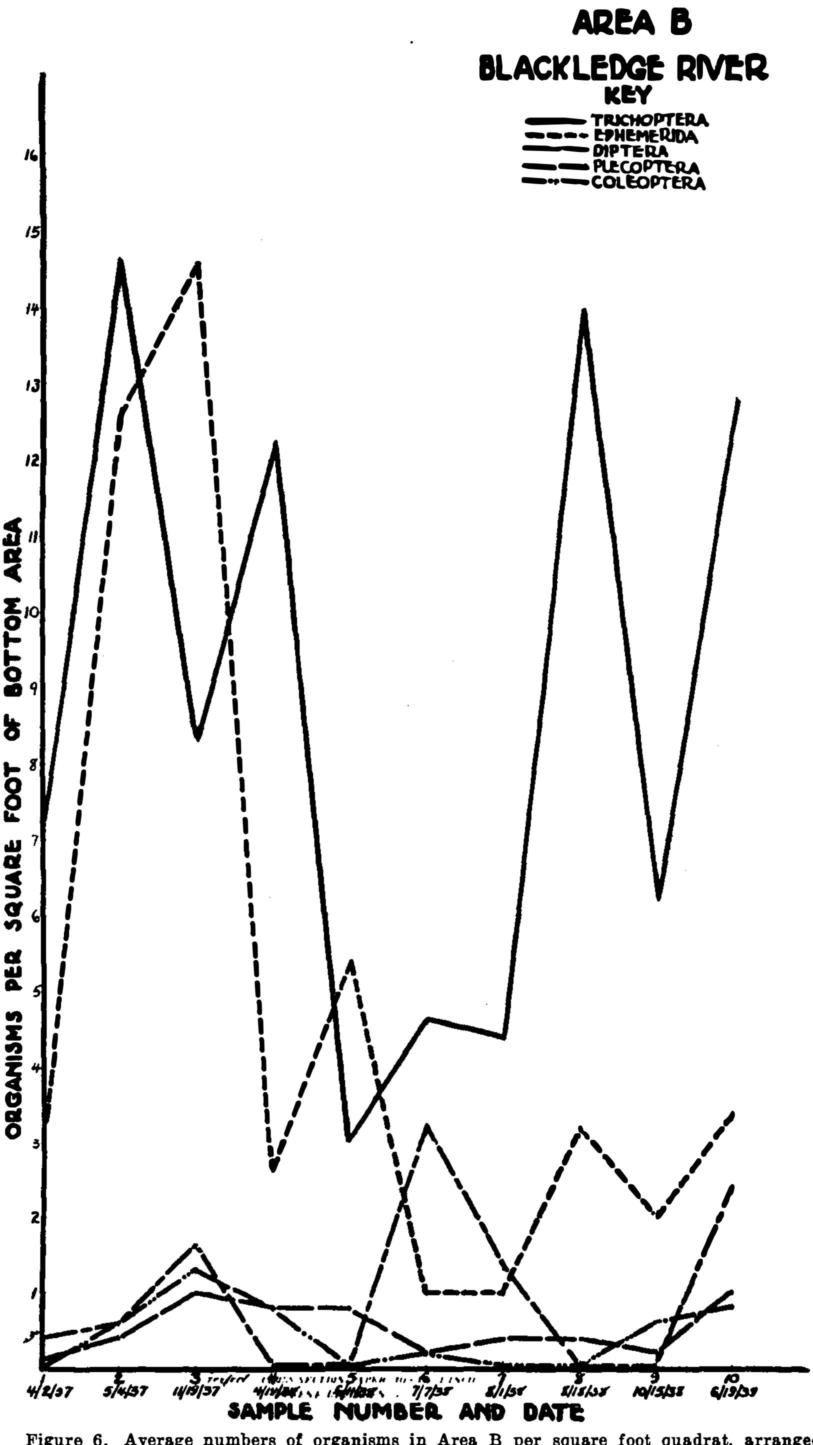

Figure 6. Average numbers of organisms in Area B per square foot quadrat, arranged by orders of insects; other groups not included.

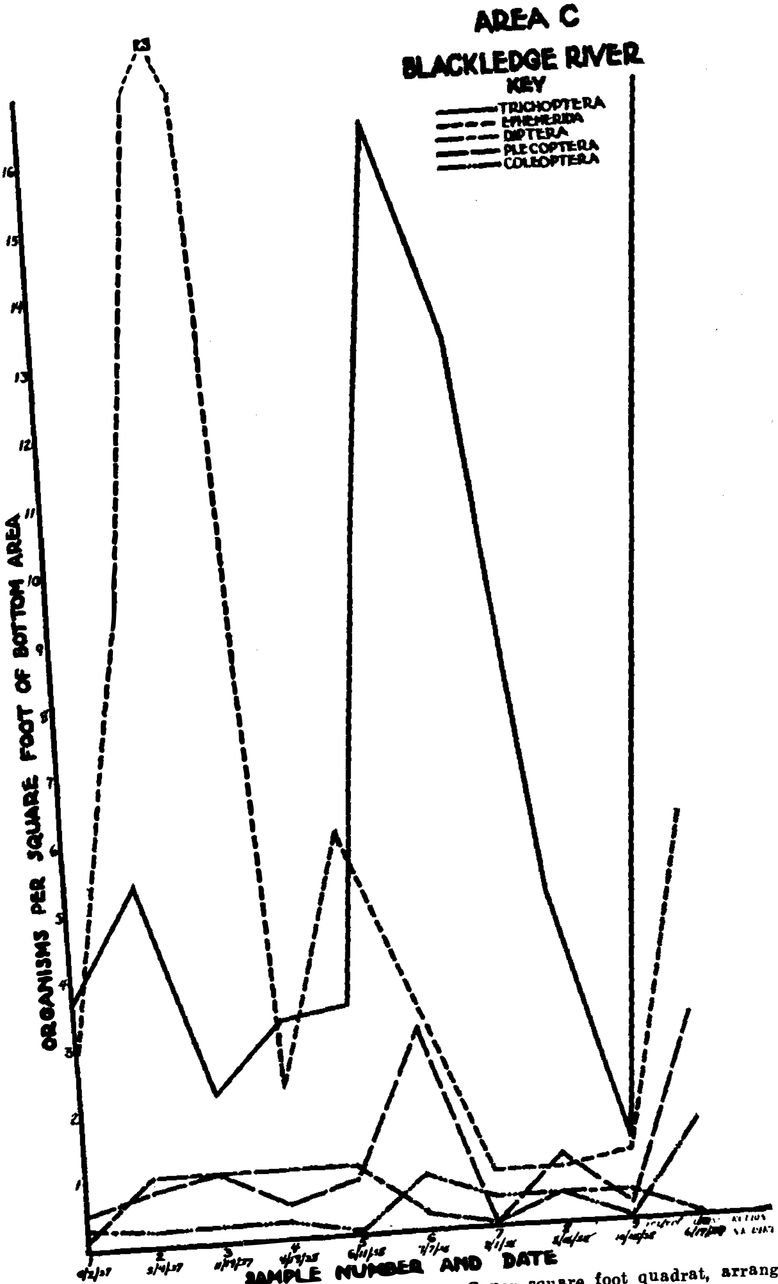

Figure 7. Average numbers of organisms in Area C per square foot quadrat, arranged by orders of insects; other groups not included.

significance unless the items which are produced are organisms that are on the "preferred diet list" of trout. Figures 5-7 indicate that the increases occur largely in three orders of insects, the caddis flies (Trichoptera), the mayflies (Ephemerida) and the true flies (Diptera).

Interestingly enough, the literature indicates that members of these three orders play an important rôle in the diet of trout. Ricker (1931) found that aquatic insects contribute the bulk of trout food, except for trout 1 inch long and that Trichoptera constitute the most important single item. Rimsky-Korsakoff (1930), in examining trout stomachs taken from the Champlain watershed in New York, found that Chironimidae, mayflies and stoneflies provide the greater number of food items. Surber (1937) found mayflies, midges, beetles, and caddis flies to be the most numerous food organisms of rainbow trout taken in West Virginia. Townes (1938), as a result of his work in New York State, came to the conclusion that invertebrate organisms are eaten in accordance with their abundance; however, Pate (1933, 1934) believes that Ephemerida, Trichoptera and Diptera are eaten more than other bottom fauna whether other forms are more accessible or not.

According to Metzelaar (1929, 1930) stomach analysis of rainbow trout showed that one-third to one-half (average of 28.3 per cent) of the food was aquatic insects and that young fish live almost exclusively on insects. Needham (1935, 1935a) found that over 85 per cent of stream bottom organisms belong to five groups, Trichoptera, Ephemerida, Diptera, Plecoptera, and Neuroptera and that the Trichoptera was the most important single group, trout eating them cases and all. According to weight, caddis flies and mayflies are also the most important (Needham, 1935). Needham (1931) reported that during any month caddis flies and mayflies constituted the principal food of brook trout and that land forms of insects outnumbered the aquatic forms in May, August, September and October only. Clemens (1929) found that as a rule Chironimidae, mayflies, caddis flies and stoneflies constituted the most important food organisms of trout. Lord (1934) on studying the stomach contents of wild trout, reported that the dominant aquatic organisms were Trichoptera, Diptera, Ephemerida and Plecoptera.

The above paragraphs attempt to summarize some of the more recent findings of various workers on the food of trout. All the authors agree on the importance of mayflies and five of the six on caddis flies while four of the six found stoneflies and diptera important. On the Blackledge caddis flies, mayflies and diptera showed the greatest numerical increase. Assuming the findings of our colleagues to be sound, it appears that the introduction of the "V" dam on the Blackledge was responsible for the increase in potential trout food of the most desirable types.

Carry over of trout.—In November, 1938, thirty trout marked with the Nesbit coelomic tag were liberated in the test area. Half were freed in the quiet water pool above the dam and half below. Tags of five of these fish liberated below the dam were recovered after the opening of the trout season on April 15, 1939. This suggests that such a structure is effective in helping fish to winter over. Unfortunately, at the time of writing similar data are not available for the summer months. It may be of interest, however, to point out that a similar structure on the Salmon River held trout during all of the summer months. These Salmon River trout were planted in April and May and were recovered the following November.

SUMMARY AND CONCLUSIONS

From the above discussion we have tried to show that this "V" dam in the Blackledge River did improve the stream in so far as its ability to support trout was concerned. This was based upon the following points:

1. A significant change in temperature resulted only during the critical summer months. At this time Area C showed a maximum of 3° F. below the control area (Area A).
2. Dissolved oxygen content varied little during the cooler months but during the critical period Area C showed improvement.
3. Bottom fauna has been markedly improved in both Area B and Area C as to (a) average number of organisms per square foot, (b) average weight of organisms per square foot, (3) qualitative increase in desirable items of trout food.
4. Recovery of tagged trout showed that trout will at least remain in the improved areas during winter months and through the spring break-up.
5. According to all criteria Areas B and C now provide improved cover for trout.

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CONTROL OF GAR FISH IN LOUISIANA

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Louisiana Department of Conservation

All four species of North American gars, the Mississippi alligator gar, *Atractosteus spatula* (Lacepede), the longnosed gar, *Lepisosteus osseus* (Linnaeus), the spotted gar, *Lepisosteus productus* (Cope), and the shortnosed gar, *Lepisosteus platostomus* Rafinesque, inhabit the waters of the Gulf States. One of them, the alligator gar, moves freely from fresh into brackish and sea water. Gars are highly predacious animals, stealthy and persistent destroyers of a vast quantity of aquatic life. The speaker for two years has conducted investigations concerned with the control of gars. The results include certain new data regarding the habits and life history of these animals.

Gars spawn in Louisiana during the month of March, at which time they ascend the typical slow streams (bayous) until they reach water so shallow that often the backs of the fish are exposed. Spawning occurs with great rapidity. Gars are prolific. One 49½-inch individual contained mature ovaries weighing 8 1/3 ponds. Ten 1-gram samples of these ovaries were taken and an exact count of the eggs made to provide a basis for the estimate of total eggs present. The number thus arrived at was 340,000. The eggs are spawned out at once so that the ovaries become virtually thin, empty, flaccid sacs. The ova are highly poisonous, injection of the extracts causing convulsions, heart disturbance and death in guinea pigs and rabbits. The precise character of this poison is being presently investigated by Dr. Greene of the University of Missouri at Leland Stanford Junior University. Numerous instances were noted wherein fishermen fed the eggs to chickens, invariably causing their death. The similarity in appearance of gar ova to caviar is dangerous, since a physician friend of the speaker's attempted to make caviar from the ova and critically poisoned himself by eating only one half-teaspoonful of the salted gar eggs.

Gars are unusually rapid in their digestive processes. Captured individuals containing fish identifiable because of the fact that they had broken and still carried known fishing lines revealed an unusual speed of digestion. This accounts for the fact that stomach examinations of hundreds of gars included an exceptionally high number of individuals containing no food. Food examinations revealed that the gars subsisted chiefly on game and food fish and when in brackish or salt water considerable quantities of the blue crab.

The flesh of gars is not only edible but highly palatable when properly prepared. It compares favorably with the flesh of highly regarded game and food species. This is in sharp disagreement with the general opinion that gar flesh is coarse and tasteless. Although not sold under the name of gar, gar flesh is widely marketed, and the available supply fails to meet the demand. Fishermen in New Orleans receive for dressed gar meat \$0.03 a pound. It is retailed as steaked fish for \$.12½ a pound. One fault in marketing gars is that the autolysis occurs with more than usual rapidity. Experiments revealed that gars can be retained for at least three months in live cars only several inches longer than the fish even though these live cars were lightly constructed and gars are extremely powerful. Instead of losing weight under these conditions the gars gained weight through their capture of minnows and other prey entering the live cars.

Gars play an important role in modifying the character of fish populations. The legal gear for seines in the fresh waters in the State of Louisiana is a 3-inch mesh. Through such gear gars can force their way, while game and commercial fish are captured. The result is that in the course of time a sharp contrast develops between the fished and the unfished lake. The unfished lake shows a population of gars and game and food fish representing a wide range in age classes. The food fish concerned are chiefly the three species of buffalo which do not compete with the gar since they graze on the bottom. The fished lake on the other hand develops a progressive preponderance of large-sized gar which escape the 3-inch mesh seine and since the larger age classes of the buffalofish are captured by the seine and since the productivity per acre of the buffalofish is limited a tendency continues toward a population of large gar and small game and commercial fish. These large predacious gar so successfully prey upon the growing game and food fish that a population picture of larger gar and smaller game and food fish is attained. The game and food fish cannot succeed in reaching full size.

It was desirable to devise some method of eliminating gar. A commercial fisherman, Bert Oldham, who at the time was engaged in construction work on one of the large fish preserves found a simple and successful method which he patented. This is a gar-trap-game-fish-escape, based upon the extremely simple fact that gars because of their ganoid scales and more rigid bodies are less able to turn a corner than are game and commercial fish. The fish are simply presented with an obstacle to one side of which they must turn. Gar fish 12 inches and over cannot flex themselves sufficiently to make that turn, whereas game fish of 20 inches in length can easily accomplish it.

It was necessary in the experimental work to carry out carefully controlled studies of the conditions under which gars could be caught and not only the numbers, sizes and species of gars caught, but also the numbers, sizes and species of fishes and other aquatic life that passed the gar-trap-game-fish-escape. This was accomplished by inserting the gar trap device in the middle of an 18-foot, two-chambered hoop net, 4½ feet in diameter. Nets exactly similar were so equipped and were comparatively tested. The nets in some experiments were placed facing up and down stream. In other experiments they were placed facing in the same direction, one baited, the other not baited. A wide variety of such investigations was carried out. The end results can be simply stated. Baiting proved not to be necessary. No appreciable difference appeared in effectiveness of baited and unbaited nets. The nets became naturally baited by the ingress of game and food fish. Gars followed them and the game and food fish escaped through the gar trap into the second chamber where they were held until counted. Two typical counts follow:

Set twelve hours:

First chamber:
- 10 gars, ranging from 21½ to 42 inches
- 6 shortnosed gars
- 4 alligator gars

Second chamber:
- 25 lake perch, *Eupomotis holbrookii* (Cuvier & Valenciennes)
- 6 morone interrupta
- 11 purple perch, *Chaenobryttus gulosus* (Cuvier & Valenciennes)

Set twelve hours:

First chamber:
- 9 alligator gars, totalling 131 pounds
- 1 turtle

Second chamber:
- 12 goggle-eyes perch, *Ambloplites rupestris* (Rafinesque)
- 10 lake perch, *Eupomotis holbrookii* (Cuvier & Valenciennes)

Experiments disclosed that contrary to previous opinion gars rove considerably and it was possible by barring the mouth of a bayou to clear such a half-mile stream completely of gars in one setting of a trap. Forty-nine gars were caught in a single twelve-hour set of a single trap. One area of several ponds was trapped for six days, during which time 295 pounds of gars were caught. No game fish could be taken previously in these ponds which were connected through estuaries with the Gulf of Mexico. One year later these same ponds in a period of only several weeks yielded to sportsmen over 300 pounds of largemouth black bass (*Huro*).

Blue crabs (*Callinectes sapidus*) entered these traps in great numbers. In one instance 320 were counted in the second chamber, having escaped from the gar, which were in the first chamber of the net. In another instance, 431 catfish passed through the gar-trap-game-fish-escape into the second chamber, during a period of only twelve hours.

It is not possible to eliminate gars but, by means of this device applied to pound nets, hoop nets and seines, it is possible to control gars to such an extent that the fish population changes in a direction desirable both for the sportsman and the commercial fisherman. The device itself is extremely simple. Its cost is less than \$.30. It can be applied by anyone to any standard fishing gear. The only difference involved is that to make its use effective in a seine, the seine should be constructed of 1- or 1½-inch mesh instead of 3-inch mesh, although the wings of the seine may be of 3-inch mesh.

The considered opinion of the speaker is based upon two years of experimental and practical application of this method of gar control and is that in those areas where gars are important predators no single factor can accomplish more in destroying a desirable fish population. The matter has passed beyond the experimental stage and is now being applied practically in large lakes and large rivers.

There is exhibited here a fish trap provided with the gar-trap-game-fish-escape and also a separate gar-trap-game-fish-escape of the exact dimensions used in the experiments upon which this discussion is based.

FOURTH TECHNICAL SESSION

Tuesday Afternoon—March 19

Chairman: JOHN D. CHALK

Commissioner of Game and Inland Fisheries, North Carolina

WILDLIFE MANAGEMENT ON AGRICULTURAL LANDS

WILDLIFE MANAGEMENT ON LAND DITCHED FOR AGRICULTURE

WARREN S. BOURN
U. S. Bureau of Biological Survey

A major problem confronting those interested in the conservation of natural resources is the maintenance on lands ditched for agriculture of desirable wildlife in numbers sufficient to meet an ever-growing national demand. The magnitude of the problem becomes evident when the extent of agricultural drainage and its effects upon the wildlife of the country are realized.

According to the 1930 census, there were in the United States 84,408,093 acres of land included in organized drainage enterprises. This acreage is approximately 4.4 per cent of the total area of the United States, or the equivalent of the combined areas of Illinois, Indiana, and Ohio. About 60 per cent of this acreage was drained during the period 1905 to 1919. In the same census, private drainage was reported on 650,172 farms, totaling 44,523,685 acres, but these figures were considered too low. For periods since 1930 accurate estimates of the acreage drained are difficult to formulate. The establishment of relief agencies early in the last decade gave fresh impetus to drainage activities because of the eligibility of such projects as a desirable means of employing relief labor. The National Resources Committee in its Drainage Basin Problems and Programs, 1937 Revision, states (p. 132):

The Civilian Conservation Corps has had forty-six camps engaged primarily in drainage work. The Works Progress Administration has authorized drainage undertakings to cost more than $145,000,000, of which approximately a quarter have been undertaken.

At the present time the Civilian Conservation Corps has thirty-nine camps engaged in agricultural drainage, and relief appropriations for such work have been continued.

Although the current census may be depended upon to supply a record of the approximate acreage of land drained for agriculture during the past decade that will enable us to form a more accurate idea of the situation, it is known that drainage throughout this period has been practiced on a tremendous scale with disastrous effects on the wildlife involved. Much of the drainage, of course, has been concerned with the more fertile lands and may be considered a worthy undertaking, but a considerable part of it has been ill-advised and has resulted in the unwarranted destruction of important wildlife values. That such an activity, especially when unbridled and aided generously with public funds, would soon cause a conflict between drainage and wildlife interests was inevitable.

Approximately one-twelfth of the land in organized drainage enterprises is in districts that have become inactive or have been abandoned for agricultural purposes. Good examples of this are lands in the Florida Everglades and in northern Minnesota. In the former section 4,100,000 acres and in the latter 2,043,000 acres of ditched lands have been abandoned as unproductive for agriculture. In both cases attempts had been made to drain land practically worthless for crop production but very valuable as natural wildlife habitat. These well known examples serve to illustrate the colossal waste of natural resources and the appalling destruction of wildlife values resulting from purely speculative agricultural enterprise practiced on an extensive scale. Perhaps much less known but just as real are the thousands of smaller drainage projects that have been operated throughout the country, which in the aggregate total an almost incredible acreage. These lesser enterprises had become so common and extensive a few years ago as to cause the development of considerable concern among various agencies and individuals interested in wildlife conservation. The situation became particularly alarming in certain states of the Middle West in which drainage activities were so general as to threaten the elimination of practically all lowland wildlife habitat over entire counties or even districts of several counties.

Drainage methods as ordinarily employed are drastic, and their detrimental effect on wildlife is a matter of degree, depending chiefly upon the size, importance, and ecological relations of the habitat concerned. Their purpose is generally the removal of water, usually both surface and underground, through the action of gravity, in order to obtain additional land for tillage, although sometimes it is for procurement of more pasture land. In some instances drainage has been associated with flood control, and the value of good marsh or swamp land, highly productive from the standpoint of fur and wildlife values, has been sacrificed to protect less valuable acreages under cultivation from periodic inundation. Frequently, enterprises have been under taken that drained principally sand, gravel, peat, or other unproductive soils. These were mistakes that could have been avoided and wildlife habitat preserved by careful soil investigations made before drainage was begun.

Agricultural drainage nevertheless is more often concerned with the reclamation of fertile marsh and swamp lands for the purpose of increasing crop production. Such lands may constitute the last retreat in the community for wet-land wildlife, including game species, fur bearers, and song or insectivorous birds. Ordinarily, such habitats are completely eliminated by drainage. The customary procedure for transforming land of this nature into agricultural use is to dry it out by a system of main and lateral ditches. These remove not only the water but in time eliminate also all life, plant and animal, that depends upon it for existence. The natural ecological balance is thereby disturbed, and the new conditions may be particularly fatal to nonmotile forms that normally play an essential role in the biotic community. Scrub pine has been known to take over a drained cypress swamp and corresponding changes to occur in the particular fauna associated with those species within the space of a few years. Not the least of the danger to wildlife is the fire hazard produced wherever peat soils are drained, but the ravages of peat fires are probably too familiarly known to warrant discussion here.

All swamp drainage involves at least a certain amount of clearing land of tree growths as well as lowering of water levels. This results in the reduction of both food and cover for wildlife. Even when a ditch is constructed through a swamp to serve merely as an outlet to facilitate the drainage of adjacent lands, it seems difficult indeed for drainage engineers to refrain from cutting a right-of-way of excessive width that serves to impair seriously the normal wildlife value of the area. In many cases a strip 60 feet wide has been cleared for the excavation of a ditch 3 feet wide, although the tree stumps may be left to impede the flow of water just the same as would the standing trees.

As already stated, drainage activities had progressed to such an extent in this country a few years ago and the methods appeared so unnecessarily destructive to the limited lowland wildlife habitat, especially in those sections where such habitat is definitely restricted, that conservation interests initiated a movement in protest. This ultimately resulted, in 1937, in the Bureau of Biological Survey, the federal agency specifically charged with the guardianship of the Nation's wildlife, being afforded the opportunity to review all drainage projects before federal funds are allotted for their prosecution. The purpose of this action is to enable the Biological Survey to make appropriate recommendations for the conservation of wildlife before the projects are released for operation. Since accorded the right of such review, the Bureau from 1937 to the end of the fiscal year 1939 investigated 364 state-wide or area-wide drainage projects, involving 3,294 separate units, of which 1,812 were concerned with agricultural drainage. As a result of the investigations more than 100 of the units were disapproved by the proper federal agency and 303 were conditionally approved, provided the work was done according to the specifications outlined or the restrictions imposed by the Biological Survey to conserve wildlife values on the areas. Of 1,079 units that involved no wildlife values, no objection was interposed against their operation. The projects are reviewed solely from the standpoint of wildlife conservation, and every effort is made to cooperate with the project sponsor so that his purpose may be accomplished without appreciable interference to wildlife. Sometimes compromises have been effected whereby the sponsor's aim has been attained through methods of water control rather than drainage. This is accomplished through the installation of suitable structures that permit the discharge of flood waters but serve to retain sufficient residual water during dry seasons for the protection of wildlife and the prevention of undesirable ecological successions. In all cases where the construction of outlet ditches through swamps or other wooded areas is necessary, the clearing of trees and brush invariably is restricted to ditch cross sections, and spoil is deposited on one bank only. The preservation of a climax growth of trees or shrubs along the banks supplies shade to prevent the appearance of troublesome weed growths in the ditches, retards bank erosion, preserves wildlife values, and reduces the cost of ditch maintenance. From the standpoint of wildlife conservation, approval has never been recommended for projects proposed primarily for the drainage of natural habitat for wildlife for the purpose of putting the land into agricultural production. These restrictions have resulted not only in a marked preservation of wildlife areas from unnecessary destruction but also in the submission of a less objectionable type of projects. The importance of imposing such restrictions may be better appreciated when it is realized that in many communities highly developed for agriculture little or no wildlife habitat is found. Consider Wood County, Ohio, for example, with its large population of ringneck pheasants that are largely dependent for cover upon the vegetation in and along the drainage ditches. In areas so highly developed for agriculture, the few scattered woodlots are too clean to supply either food or cover for most forms of wildlife, and in such communities only specialized forms of wildlife can exist unless artificial habitat is provided.

No matter how important land may be considered for the production of agricultural crops, it should be recognized that conservation of wildlife is one of the essentials of a good land-use program. Sufficient acreages of marsh and swamp land should be devoted to that purpose. It is certainly not in accordance with good land-use to drain the last acre of such land in any section. The extensive drainage program practiced in this country during recent years, however, leads us to believe that many owners or developers of agricultural lands still fail to recognize the value of preserving a habitat even for insectivorous birds that may serve them well in time of need. They continue to remain unconvinced that wildlife management pays dividends. This fact is well shown by their reluctance to exert any effort in behalf of wildlife conservation on new lands continually being ditched for agriculture. In spite of the continuance of extensive drainage projects that are highly destructive to wildlife, it is felt that rigid reviews, together with a constructive educational program, as now being carried out by the Biological Survey and other public agencies are having beneficial effects and will ultimately correct a deplorable condition.

THE LIFE EQUATION OF THE RINGNECK PHEASANT IN PENNSYLVANIA

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Although a comparatively recent addition to the avifauna of Pennsylvania, the ringneck pheasant (*Phasianus colchicus torquatus*) is now one of the important game birds of the Commonwealth. For the purposes of securing information that will aid in shaping management policies for this species, a study of the ecology and management of the pheasant is being conducted by the Pennsylvania Cooperative Wildlife Research Unit.

The pheasant study is being carried on under the supervision of Dr. Logan J. Bennett, Biologist, U. S. Bureau of Biological Survey, and Dr. P. F. English, Associate Professor of Wildlife Management, Department of Zoology and Entomology, The Pennsylvania State College.

Leopold (1933) terms the collective action of the environmental factors on a given species in a given locality through a typical year the

TABLE 1. LAND-USE, SUMMER OF 1939

Crop	Acreage	Per cent of total area
Wheat	489	29.2
Corn	326	19.5
Potatoes	300	18.0
Alfalfa and clover	206	12.2
Barley	123	7.3
Oats	104	6.2
Wasteland	50	3.0
Pasture	19	1.1
Soybeans	12	0.7
Orchards	7	0.4
Sweet clover	5	0.3
Conifer plantations	3	0.2
Farmyards, etc.	31	1.9
	1,675	100.0

"life equation" of the species. This paper presents the available information on the life equation of the ringneck pheasant in southeastern Pennsylvania. These data result from an investigation conducted between July 1, 1938, and October 31, 1939.

This intensive study of pheasant populations was made on a 1,675-acre sample tract in Lehigh County. The area is considered typical of the first-class pheasant range and is in one of the most productive agricultural sections of the State.

On many farms a four-crop rotation—consisting of alfalfa or clover, followed by corn, then potatoes, and finally wheat—is practiced. At times the rotation is varied to include winter barley, oats, or soybeans. With a few exceptions, no large dairies are kept; and the percentage of the land area in pasture is small. Table 1 presents the acreage and the percentage of the total land area on the study tract occupied by each cover type during the summer of 1939.

The pheasant population of the Lehigh County study area on October 15, 1938, was estimated to be about 950 birds, or 1 bird to 1.8 acres. This figure was obtained by a roadside-census method in September and October (Randall and Bennett, 1939), supplemented by daily observations and censusing with a well trained pointer. During September pollen in the air interfered with the dog's scenting birds except very early in the morning, but by October only a few species of plants retained pollen and the dog was used very successfully.

The 1938 pheasant season extended from October 31 through November 26. The number of hunters using the study area and their daily kill were recorded. In isolated portions of the study tract, cooperating farmers aided the writer by listing the number of birds taken by sportsmen on their property. From all sources the kill of legal cock birds was estimated to be 266 (Table 2). Fifty-six per cent of these birds were killed on the opening day, and about 85 per cent were killed during the first week of the season.

Crippling losses were high. Data secured from cooperating sportsmen revealed a loss of about 33 per cent of the birds shot in eastern Pennsylvania (Randall, 1939b). Interviews with hunters and observations on the study area indicated a similar crippling loss. In addition to the reported kill, 133 birds were believed to have died in consequence of the shooting season (Table 2).

TABLE 2. LIFE EQUATION FOR PHEASANTS

Date	Item and computation	Gain	Loss	Current population
On Oct. 30, 1938	Fall population			950
Oct. 31 to Nov. 26, 1938	Legal kill		266	
	Crippling loss		133	
	Illegal kill		35	
	Fall mortality		15	
	Driven from study area by hunting		201	
By Dec. 2, 1938	Total hunting season losses		650	300
	Early winter mortality		13	
	Strayed from area		78	
By Feb. 1, 1939	Total early winter losses		91	209
	Late winter and early spring mortality		30	
	Strayed on area from surrounding territory	25		
By Apr. 12, 1939	Net late winter losses		5	204
	Sex ratio = 27 cocks and 177 hens			
By July 15, 1939	Late spring and early summer mortality		24	180
May to August, 1939	80 clutches successful at 9.7 birds per clutch	776		956
May to Sept., 1939	Juvenile mortality		96	860
By Sept. 20, 1939	Late summer adult mortality		10	850
Sept. 20, 1939	Current population			850

A few hen pheasants were killed by hunters, either by mistake or intentionally. These birds were often left where they fell. The dog used by the writer near the end of the season found several dead females. Farmers also reported hens illegally killed. About thirty-five hen pheasants were believed to have been shot during the gunning season.

During the fall a few birds were killed by accidents or predators. On the study area five pheasants lost their lives in November by flying into the sides of buildings. Fall mortality from all sources except hunting comprised only fifteen pheasants.

The large fields of standing corn on the study area provided the only suitable escape cover from gunners. These fields were extensively utilized as havens, but many harassed birds were driven from the area to more adequate escape cover nearby. A wood of several hundred acres was about a mile from the study tract. Pheasants flocked to this wood for safety during the open season. The number of pheasants that left the study area for better escape cover had to be determined by an indirect method. After the mortality from all fall decimating factors was totaled and the post-hunting-season census was completed, the difference between these figures was regarded as the number of birds driven from the area by hunting. This movement apparently involved 201 pheasants (Table 2). Few of these ever returned to the study tract, for excellent winter habitats were available near their refuges.

During the winter all censusing was done while the ground was covered with several inches of snow. The pheasants were concentrated at such times in standing cornfields, fencerows, thickets, conifer plantations, and other good cover; and the task of censusing was simplified. A hound was used to aid in flushing the birds. The post-hunting-season census, completed on December 2, revealed that 300 pheasants were still on the study area.

By February 1 the pheasant population had dropped to 209 birds, a loss of 91. Three of these birds were killed in accidents. Ten birds, or 3 per cent of the population, were victims of various predators.

During the early winter seventy-eight pheasants moved off the area. Forty of these birds left immediately after an 11-acre standing cornfield in which they had fed and loafed was machine-picked in late December. Several other flocks moved from the area when their food supplies were cut off by snow. These birds had been feeding in cornfields harvested with a mechanical corn-picker. Although this machine missed from 3 to 5 per cent of the grain. It broke the stalks less than a foot above the ground. A light snowfall covered this food supply and forced the pheasants to other habitats.

On half of the study tract, known as the Spring Creek Unit, 14.1 per cent of the total land area was occupied by hand-picked standing cornfields. On the other half of the study tract, designated as the Brooksides Unit, only 1.5 per cent of the land area supported standing corn. Plenty of winter cover was available on both units. A realignment of the pheasant population resident on the study tract began about the time of the first major snowfall. By February 1, 184 birds were living on the Spring Creek Unit, a population of 1 bird to 4.5 acres; only twenty-five pheasants remained on the Brooksides Unit, a population of 1 bird to 34 acres (Randall, 1939a). The amount of standing corn apparently determines to a large extent the number of pheasants that an area in southeastern Pennsylvania will winter.

Late winter mortality among the study-area pheasants reduced the population by thirty birds. It was believed that twenty-seven of these were taken by predators. Although many kills were evidently the work of raptors, the predators responsible for most of the kills could not be identified. Cooper's hawks (*Accipiter cooperi*) were flushed from two kills and were suspected of others. Pheasants were very much afraid of Cooper's hawks. A hen pheasant was killed by a Cooper's hawk in a standing cornfield during the afternoon of January 20. Previously thirty birds had eaten there daily, but for four days thereafter no pheasants fed in this cornfield. Ten days later the pheasants still did not loiter in this cornfield as they had before: they sought brushy cover as soon as they had finished feeding.

Much of the winter and early spring predation occurred during late March and early April. Fourteen birds, or 7 per cent of the study area population, were taken by predators between March 15 and April 10. Errington (1937) stated that there seemed to be a temporary increase in vulnerability of pheasants to general predation about the time the birds began their mating and nesting activities. As mating activities began in late March this might account for the increased pressure from predators. At this period the pheasants began to expose themselves much more freely than they did earlier in the winter, probably owing to mating and nesting impulses.

The pheasant study revealed the need of greater proximity of food and cover. All too often, dense fencerows and other good winter cover were on an area but no permanent food supply was available. On a few areas, cornshocks or other foods were available but cover was lacking. Both food and cover must be present, close to each other and preferably adjoining. Studies in Iowa during the severe winter of 1935-36 revealed that pheasants in the open may choke or freeze to death in sub-zero weather accompanied by strong winds (Green and Beed, 1936). Green (1938) found that during this severe winter survival was high in those flocks that needed to range only a short distance from good cover for food, and was poor in those flocks that were forced to travel a considerable distance from cover for food. The ideal winter pheasant habitat is probably a hand-picked standing cornfield surrounded by thick fencerows or other brushy cover.

The spring census, completed with the aid of the pointer on April 12, revealed that 204 birds were resident on the study area. This was a population of about 1 bird to 8 acres.

The spring movement during late March and early April had distributed the population evenly over the area. In midwinter only 25 pheasants had remained on the Brooksides Unit, while the Spring Creek Unit had harbored 184 birds. By April 12 the populations of the two areas were approximately equal.

The spring or breeding-season population consisted of 27 cock pheasants and 177 hens, a sex ratio of 1 cock to 7 hens. Spring and early summer mortality from accidents and predation reduced the adult population to 154 hens and 26 cocks by July 15. This was a sex ratio of 1 male to 6 females.

The ringneck pheasant is a polygamous animal, evincing a territorial type of polygamy. A cock bird appropriates a territory in which the females of his harem may nest and which he defends against

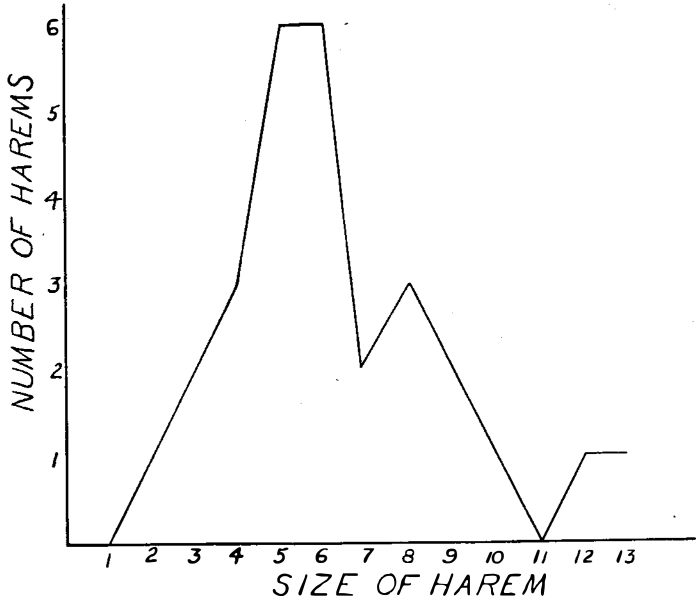

Figure 1.—Number of hens in harems.

all other males. This territory was called a "crowing area" by Wight (1930). The cocks on the study area were observed to have from two to thirteen hens in their harems, although five or six was the usual number (Figure 1). Leopold (1936) reported that central European gamekeepers preferred a sex ratio of 1 cock to 5 or 6 hens.

During the nesting season of 1939 complete observations were obtained on 310 pheasant nests. Of these nests, 181 were on the pheasant study area and the remainder were scattered in other parts of Lehigh and Northampton Counties. Farmers reported the presence of 35 nests; the remaining 275 were located by the writer by means of direct search.

The nesting season extended from early April until late August. The earliest recorded laying date was April 6. The peak for the

TABLE 3. SUCCESS OF NESTS BY DATES, STUDY AREA

Date of first egg	Total nests	No. nests successful	Per cent successful	Per cent of all successful nests
April 1 -15	4	1	25.0	2.3
April 16-30	14	3	21.4	6.8
May 1-15	23	11	47.8	25.0
May 16-31	51	22	43.1	50.0
June 1-15	30	5	16.7	11.3
June 16-30	17	1	5.9	2.3
July 1-15	8	1	12.5	2.3
July 16-31	3	0	0.0	0.0
Totals	150	44	29.5	100.0

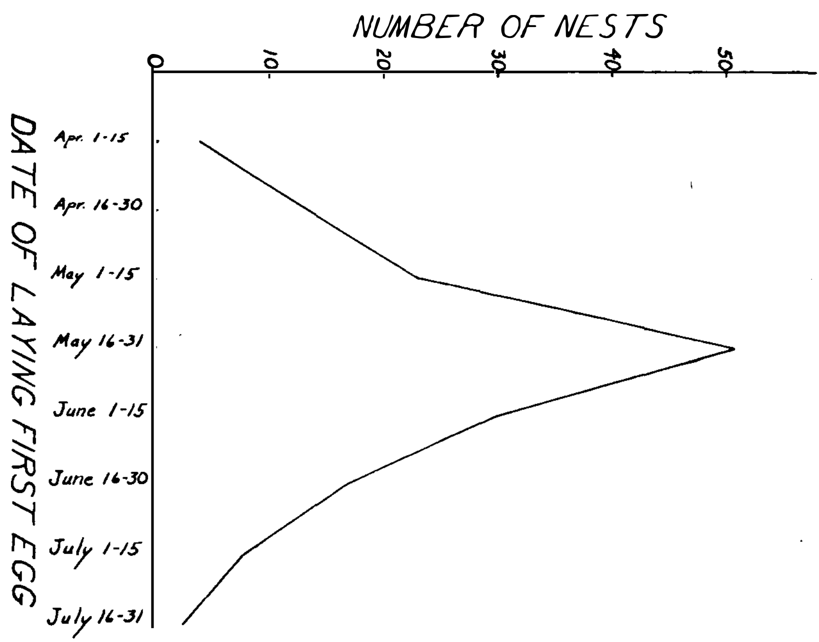

Figure 2.—Dates of beginning of clutch.

establishment of nests came in May and early June (Figure 2). Nests instituted in May had the best chance of hatching successfully. In 75 per cent of the successful nests, laying began in May (Table 3).

In April the only cover available for nesting purposes was the vegetation of the previous year. This consisted largely of the old stalks of such plants as bluegrass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), broomsedge (*Andropogon furcatus*), lesser ragweed (*Ambrosia artemisiifolia*), greater ragweed (*Ambrosia trifida*), sweet clover (*Melilotus alba*), goldenrod (*Solidago* sp.), chicory (*Cichorium Intybus*), and aster (*Aster* sp.). Most of the April nests were in fencerows, wasteland, or along roadsides (Table 4).

TABLE 4. DISTRIBUTION OF NESTS BY DATES AND COVER TYPES

Date of first egg	Roadside	Fence-row	Waste land	Alfalfa, clover	Small grain	Pasture	Potatoes	Misc.	Total
April 1-15	1	2	2	1	0	1	0	0	7
April 16-30	4	3	5	8	1	0	0	5	26
May 1-15	4	6	6	33	5	3	0	4	61
May 16-31	1	1	6	63	10	1	0	3	85
June 1-15	2	0	5	32	8	0	0	0	47
June 16-30	2	0	2	14	1	0	0	0	19
July 1-15	2	0	3	2	0	0	2	0	9
July 16-31	0	1	1	0	1	0	0	0	3
Totals	16	13	30	153	26	5	2	12	257

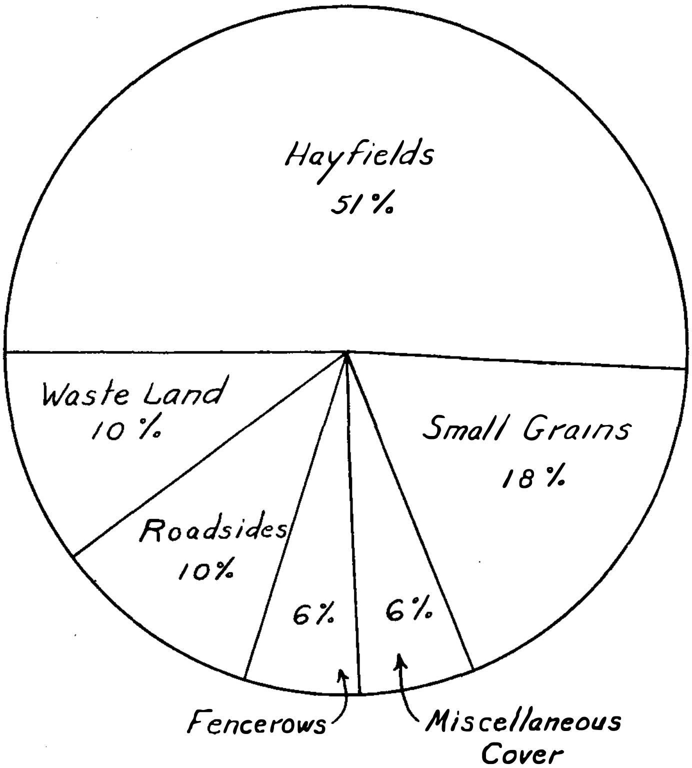

Figure 3.—Location of nests, pheasant study area.

During May the vegetation grew rapidly and soon supplied abundant nesting cover. Alfalfa, clover, small grains, pastures, and grassy waste areas became available for nesting. These cover types were used most in May and June. No nests were established in pastures after mid-May, probably because of grazing. More than half of the nests on the study tract were in fields of alfalfa or clover (Figure 3). Wheatfields were also important nesting sites.

The cover types in an agricultural region vary considerably in value as pheasant nesting cover. The service rendered by a type is determined to a large extent by the amount of the type available for nesting. In order to have a factor for comparing the value of various cover types to a species, Williams and Marshall (1938) worked out per cent acreage-use ratios for each type. They devised the formula:

$$\frac{\text{(Per cent of nests in a cover)}}{\text{(Per cent acreage of a cover)}} = \text{Per cent acreage-use ratio}$$

TABLE 5. PER CENT ACREAGE-USE VALUES, STUDY AREA

Cover type	Value	Cover type	Value
Roadsides	19.8	Pasture	1.5
Fencerows	18.7	Wheat	0.6
Conifer plantations	5.5	Barley	0.2
Wasteland	5.0	Oats	0.2
Alfalfa and clover	4.4	Potatoes	0.2

This formula was used to determine the ratios for the nesting cover types on the pheasant study area. The values obtained are listed in Table 5.

Pheasant nesting densities differed widely from field to field. Numerous 11- to 30-acre hayfields contained a nest to an acre. A 3-acre field of mixed alfalfa and clover contained nine nests, or 1 nest to 0.33 acre. The greatest density encountered was on a measured acre in a 30-acre alfalfa field, where ten nests—simultaneously occupied—were discovered on June 5. Two of these nests were side by side, less than 6 inches apart. The hens were flushed from the nests at the time of their discovery. When found, both nests had been incubated about 10 days. On two other occasions nests were observed side by side, less than a foot apart.

The fencerows on the study area contained about 1 nest to 0.4 acre. Considering the density of the nests and the per cent acreage-use ratios presented in Table 5, the writer is inclined to agree with Leopold (1937) that pheasants prefer nesting in fencerows to nesting in alfalfa or clover. Fewer nests in hay or grain were found on the Spring Creek Unit—which has numerous fencerows—than on areas where fencerows were scarce. This seemed to indicate a preference for fencerows as nesting cover. Because of the minor success of fencerow nests, however, the encouragement of fencerows does not appear to be the solution to the pheasant nesting problem.

No other cover types showed such densities as did hayfields and fencerows. The average nesting density for wasteland was one nest to 1.4 acres. The maximum nesting recorded for a wheatfield of any size was one nest to 4 acres. Two 20-acre fields contained five pheasant nests each, or one nest to 4 acres.

The placement of nests in regard to homogeneous blocks of cover has been the subject of much controversy in the past. Wight (unpublished) found that most of the nests were within 30 feet of the edges of fields or other peripheries, such as ravines or ditches. English (1933) reported that 53.7 per cent of the nests were within 50 feet of the peripheries. Hamerstrom (1936) stated that a preference for nesting in the edge zone seemed to be exhibited. He felt that this edge zone might be proportional to the depth of the block, rather than consisting of a strip of absolute depth regardless of the size of the field.

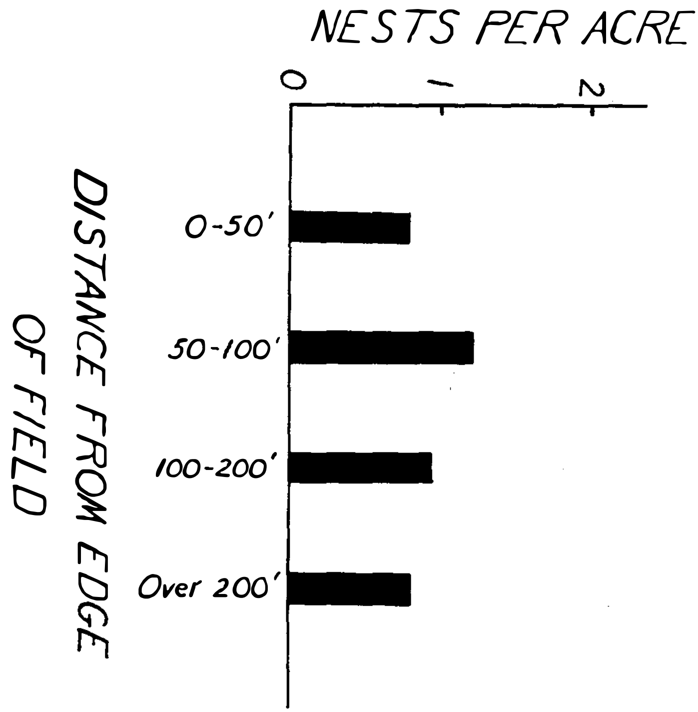

Figure 4.—Distribution of nests in relation to the edges in a 17.4-acre clover field.

On the other hand, neither Leopold (1937) nor Leedy (1938) noted any preference for the peripheries in the placement of nests.

In the present study it was noted that there was a definite tendency for the nests to be grouped in several small areas in a field. In several hayfields where the density of nests approached one nest to an acre, the locations of the nests were carefully plotted to scale on a map of the field. The field was then divided into units, such as the outer 50-foot strip and the next 50-foot strip. The area of each strip and the percentage of the total area were determined. The percentage of the nests in each strip was then worked out. A study of these two sets of figures for several fields revealed conflicting data. In some fields the

TABLE 6. NEST LOCATIONS IN 17.4-ACRE CLOVERFIELD ON BASIS OF AREA

Distance from edge in feet	Area of strip in acres	No. nests in strip	Nests per acre
0- 50	3.8	3	.79
50-100	3.3	4	1.21
100-200	5.3	5	.94
Over 200	5.0	4	.80
Totals	**17.4**	**16**	**.92**

TABLE 7. NEST LOCATIONS IN 30-ACRE ALFALFA FIELD ON BASIS OF AREA

Distance from edge in feet	Area of strip in acres	No. nests in strip	Nests per acre
0- 50	7.5	4	.53
50-100	7.0	10	1.43
100-150	6.5	7	1.08
150-200	6.1	4	.66
Over 200	2.9	3	1.03
Totals	30.0	28	.93

nests were evenly distributed in the strips on the basis of area; in other fields the largest proportion of the nests were in strips 50 to 100 feet or 100 to 150 feet from the edge. Tables 6 and 7 and Figure 4 present the distribution of nests in typical hayfields on the basis of area.

The grouping of nests in certain parts of a field was believed to be correlated with the location of crowing areas. The hens belonging to a harem tended to nest within the crowing area of the cock. If fencerows or wasteland providing suitable cover for crowing areas adjoined a field, the nests were usually in that part of the field nearest the cover. On the other hand, if the cocks were forced to establish crowing areas in alfalfa or wheat and some distance from the edge, the nests were

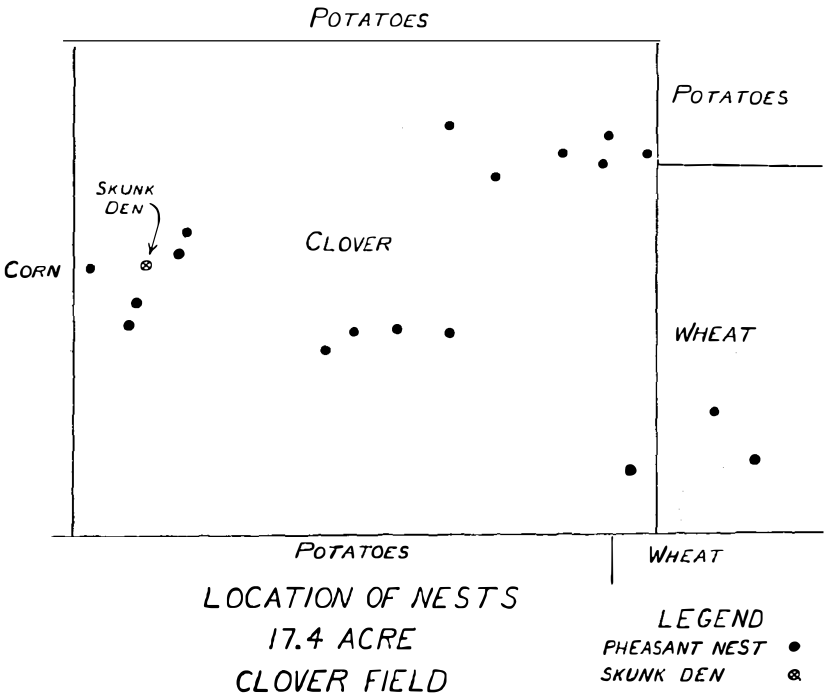

Figure 5.—An example of the placement of nests in groups in a large field.

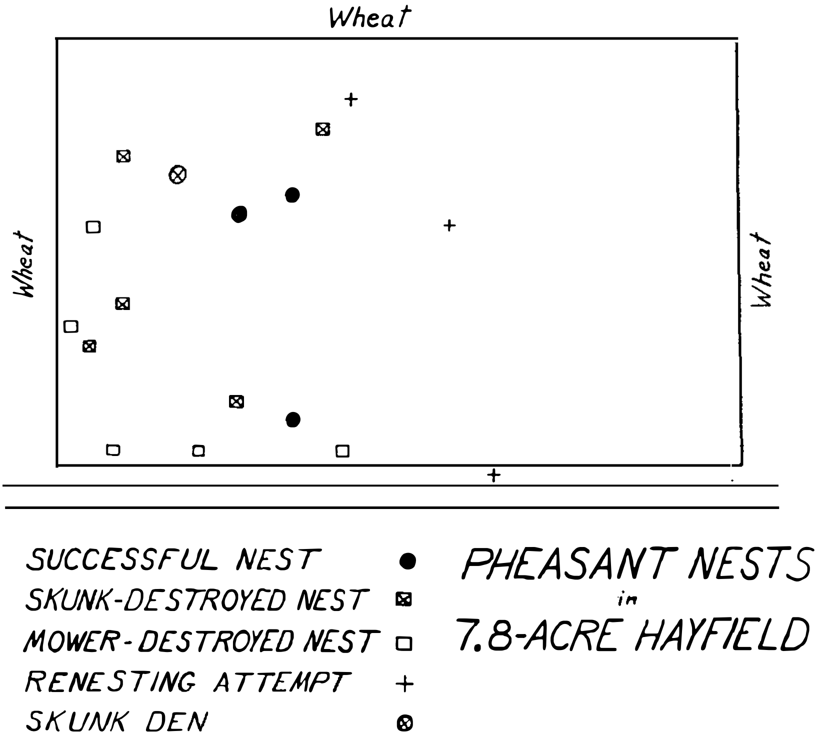

Figure 6.—The history of a concentration of nests in one end of a hayfield.

usually far from the borders of the field. For example, a group of five nests was found almost in the center of a 62-acre field of alfalfa. The nearest periphery was 720 to 800 feet from the nests. In Figures 5, 6, and 7 are shown typical arrangements of nests in fields.

The density of pheasants also affected the placement of nests. In general, the percentage of the nests placed away from the peripheries increased as the population density increased.

The clutches ranged in size from four to twenty-three eggs (Figure 8), averaging 10.8 eggs. The clutches became smaller as the season

TABLE 8. DECLINE IN SIZE OF CLUTCHES

Date laying first egg	Number clutches	Average number eggs in clutch
First half of April	6	15.0
Last half of April	19	14.2
First half of May	37	11.6
Last half of May	48	9.6
First half of June	17	9.4
Last half of June	8	8.0
First half of July	6	7.7
Total	141	Average 10.8

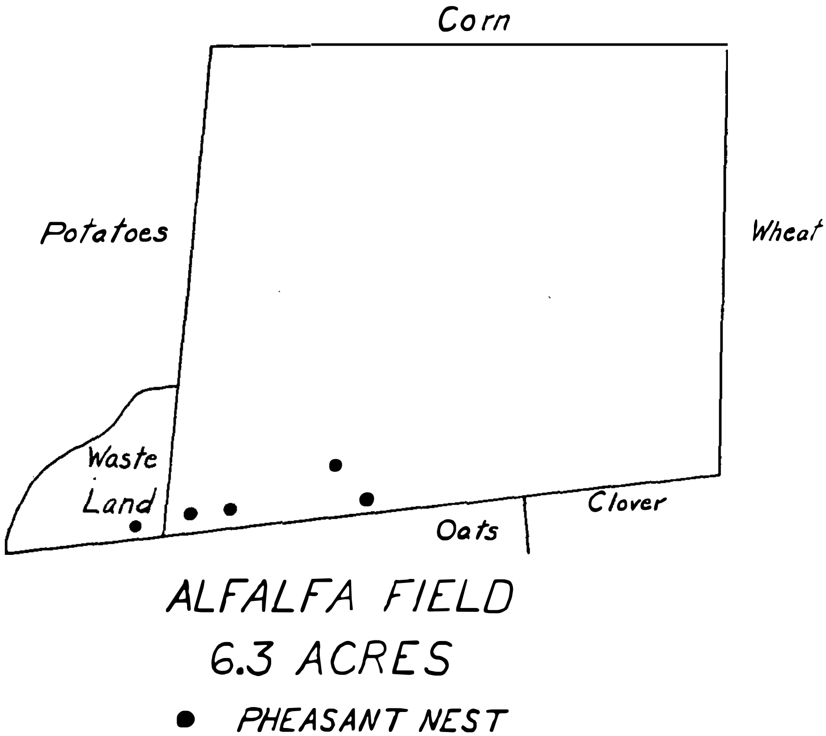

Figure 7.—Nests concentrated in one corner of a field near a crowing area.

advanced (Table 8). Two factors probably contributed to the progressive decline in the size of clutches. First, more than one hen often laid in the same nest early in the season when suitable nesting cover was scarce. Second, later nests included many renesting attempts by hens whose first nests were failures. These second clutches were usually smaller than the first ventures.

TABLE 9. SUCCESS OF NESTING ATTEMPTS, ALL NESTS

Cover type	Number nests	Number successful	Per cent successful
Roadside	22	2	9.1
Fencerow	16	1	6.3
Wasteland	35	9	25.7
Hayfields	182	35	19.2
Small grains	37	11	29.7
Pasture	6	3	50.0
Potatoes	2	1	50.0
Plantations	4	1	25.0
Orchards	2	0	0.0
Brush	2	0	0.0
Woods	1	0	0.0
Grain stubble	1	0	0.0
Totals	310	63	Average 20.3

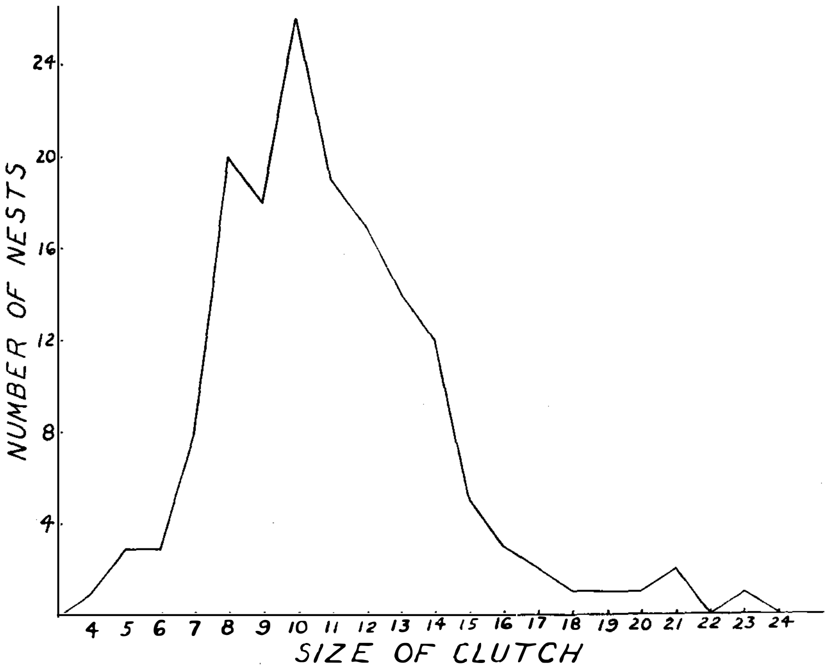

Figure 8.—Clutch size frequencies.

Forty-four hatched clutches upon which complete information was obtained indicated that 94.1 per cent of the eggs were fertile. As 4.1 per cent of the chicks failed to get out of the shell, 90 per cent of the eggs actually hatched. The percentage of infertile eggs was higher in late clutches than in early ones.

Of the 310 nests under observation, 63—or 20.3 per cent—were successful (Table 9). Of the 181 nests under observation on the study area, 46—or 25.4 per cent—were successful (Table 10). Other nesting

TABLE 10. SUCCESS OF NESTING ATTEMPTS, STUDY AREA

Cover type	Number nests	Number successful	Per cent successful
Roadside	18	2	11.1
Fencerow	10	1	10.0
Wasteland	18	5	27.2
Hayfields	92	25	27.2
Small grains	33	10	30.8
Pasture	3	1	33.3
Potatoes	2	1	50.0
Plantations	2	1	50.0
Orchard	1	0	0.0
Woods	1	0	0.0
Grain stubble	1	0	0.0
Totals	181	46	Average 25.4

studies have revealed a high mortality among pheasant nests. English (1933) found that 34.8 per cent of 193 nests studied in Michigan were successful. Only 23.1 per cent of the 445 nests studied by Hamerstrom (1936) in Iowa hatched. Girard reported the hatching of 49 per cent of the 6,977 pheasant eggs observed by him on the Nine-Pipe and Pablo Migratory Bird Refuges in Montana (Kalmbach, 1939).

Only two of the twenty-two roadside nests under observation hatched. The poor outcome of roadside nests was due to abandonment by the hens and to destruction by mowing weeds along the highways. Disturbance by man was probably a factor contributing to the failure of roadside nests.

Fencerow nests also fared poorly: only one of ten on the study area succeeded. Fencerows were travel lanes for such nest-destroying animals as skunks and opossums, and many nests in this cover were destroyed by predators.

Of the thirty-five nests observed in wasteland, 25.7 per cent hatched. As soon as cultivation of farmland ceased, the population of skunks and weasels increased; the abandoned areas afforded excellent sites for dens. The various predators combined to wreak havoc among pheasants nesting in waste areas; they destroyed 54.3 per cent of the nests in this type. Skunks accounted for 31.4 per cent of the wasteland nests.

In the hayfields of the study area, ninety-two nests were studied. Of these, twenty-five nests—or 27.2 per cent—were successful. Two hens returned and completed incubation in the open after mowing had exposed their nests.

The success of hayfield nesting attempts depended largely upon whether the hay was harvested early or late in the season. In alfalfa and clover cut during the early part of June, few nests had hatched; by late June or early July, a much larger number of nests had hatched. Even in July some nests were destroyed by mowing, as the hayfields contained renesting efforts of hens whose first nests were failures. During the past nesting season a large number of hayfield nests hatched about June 20. The data in Table 11 show this "critical" date in hayfield nesting.

Thirty-seven clutches were discovered in fields of small grains. All but six of these clutches were in wheat. Eleven of these nests—29.7

TABLE 11. SUCCESS OF HAYFIELD NESTING BY DATES

Date of mowing	Total nests	Number hatched	Per cent hatched
June 1-5	33	3	9.1
June 6-10	38	4	10.5
June 11-15	20	2	10.0
June 16-20	10	1	10.0
June 21-25	30	9	30.0
June 26-30	27	10	37.0

TABLE 12. CAUSES OF NEST FAILURES

Cause of failure	Number	Per cent of losses	Per cent of all nests
Man			
Mowing	123	49.8	39.7
Harvesting	9	3.6	2.9
Cutting weeds	5	2.0	1.6
Miscellaneous	3	1.2	0.9
Predators			
Crow	16	6.5	5.2
Grackle	2	0.8	0.6
Bluejay	1	0.4	0.3
Dog	5	2.0	1.6
Cat	1	0.4	0.3
Skunk	29	11.7	9.4
Weasel	3	1.2	1.0
Unknown predators	19	7.7	6.2
Pheasants			
Abandoned	13	5.3	4.2
Dump nest	2	0.8	0.6
Observer	3	1.2	1.0
Flooding	4	1.6	1.3
Unexplained	9	3.6	2.9
Total	247	99.8	79.7
Hatched	63		20.3
Grand total	310		100.0

per cent—succeeded. Because of the extensive acreage of wheat in the Pennsylvania pheasant range, this grain is an important site of pheasant nests. A large part of the pheasant crop is produced in this cover type.

The number of nests found in other cover types is too small to justify any conclusions as to the value of these covers for nesting.

The activities of men destroyed 45 per cent of the nests (Table 12). This was 56.6 per cent of the nesting losses. Mowing destroyed 39.7 per cent of the nests under observation. Eight per cent of the incubating hens were killed and 15 per cent were maimed by the mower on the study area. Harvesting grain, cutting weeds along railroad right of ways, plowing, and pilfering were other activities that caused nest failures.

Crows (*Corvus b. brachyrhynchos*) destroyed sixteen nests, or 6.5 per cent of the total. Crows also ate eggs from many nests exposed by farming operations but were not the primary causes of failure in such cases. Crow damage was recognized by a large hole picked in the shell and a crack or small hole on the opposite side where the bird's beak had broken through.

Purple Grackles (*Quiscalus quiscula quiscula*) destroyed pheasant eggs occasionally. They picked holes large enough to insert their beaks in the shells and then devoured the contents of the eggs. The holes picked in eggs by grackles were usually too small to admit the bill of a crow. (When the grackles picked a large hole in an eggshell, no differentiation between crow and grackle damage was made.)

A bluejay (*Cyanocitta c. cristata*) was observed eating eggs from nest No. 44 in a white pine plantation. This bird had eaten two eggs from a clutch of six. As the hen deserted the nest after this, failure of the nest was attributed to the jay. Eggs destroyed by bluejays were ordinarily not distinguishable from those taken by crows or grackles.

A cat killed the female on a nest in a wheatfield. Of the more than 300 nests under observation in this study, this was the only one where a predator killed a hen on the nest.

The common skunk (*Mephitis nigra*) was the most serious predator of pheasant nests. These mammals destroyed twenty-nine nests, or 9.4 per cent of the total. Skunk damage was identified by the large hole chewed in the shell, the frayed membrane, and the eggs scattered close to the nest. Toothmarks were sometimes visible on the shells.

Individual skunks seemed to form the egg-eating habit. A clutch hatched within 50 feet of an occupied skunk den, but later in the season these skunks destroyed four nests in the same field (Figure 6). Although an active skunk den was almost in the center of a group of five nests in the field shown in Figure 5, no nests were harmed by the skunk. Both Stoddard (1931) and Wight (1938) state that skunks do not inherit the egg-eating habit but must acquire it.

Weasels (probably *Mustela noveboracensis*) destroyed three, or 1.2 per cent of the nests. Eggshells left by weasels were very similar in appearance to those left by skunks, but the weasels usually carried the eggs under cover before consuming the contents.

Pheasants occasionally deserted nests. Human intrusion probably contributed to the abandonment of some nests, but unsuitable sites may have led to the abandonment of others. Hen mortality may also have been responsible for some desertions. Thirteen nests were abandoned during the course of this study.

The agencies responsible for the failure of twently-eight nests were not determined. The cause of the destruction of these nests was classified as either unexplained or unknown predator.

Observations during the late summer revealed that about eighty broods of young pheasants were produced on the study area in the 1939 breeding season. As 154 adult hens were resident on the study area at the close of the nesting season, about 52 per cent produced young. To check these figures, all hens seen—either with or without broods—and all broods without hens were recorded. A tabulation of these series indicated that about 55 per cent of the hens had produced young, so that the estimate of the number of broods hatched on the area seemed nearly correct.

Although the clutches averaged 10.8 eggs (Table 8), only 90 per cent of the eggs actually produced young. Thus 9.7 chicks to a clutch were hatched. The number of broods, multiplied by the average number of young in a brood, gave the number of young pheasants produced on the study area—$80 \times 9.7 = 776$.

Brood counts were taken throughout the summer. They indicated a shrinkage from 9.7 at hatching to 8.5 at ten weeks of age. During the first three weeks the broods diminished rapidly in size, but thereafter the shrinkage was gradual (Figure 9). The number of broods on the study area, multiplied by the average size at ten weeks, gave the number of young surviving in the fall—$80 \times 8.5 = 680$.

The juvenile mortality was the difference between the number of pheasants hatched on the area and the number reaching maturity: $776 - 680 = 96$. The loss, ninety-six birds, represented 12.4 per cent of the young produced on the study area.

About 66 per cent of the juvenile mortality among study-area birds was explained. This mortality was caused by a variety of factors, including mowing, harvesting, falling into depressions from which the young could not extricate themselves, weather, and predators—such as Cooper's hawks, marsh hawks, and stray dogs. The losses due to predators were not extensive. Contemporaneous food habits studies of

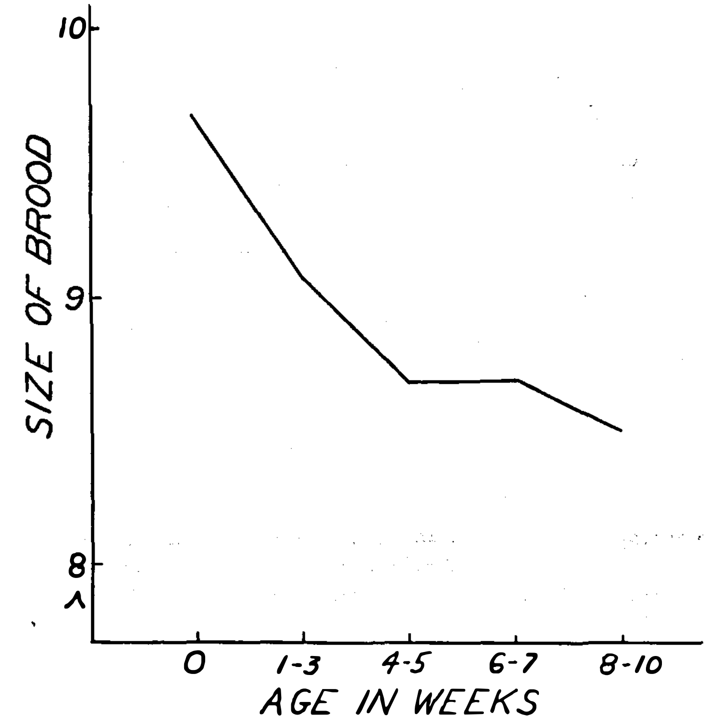

Figure 9.—Seasonal decline in size of broods.

marsh hawks, which were common on the study tract, indicated that these harriers were not serious enemies of pheasants.

Productivity was defined by Leopold (1933) as "the rate at which mature breeding stock produces other mature stock." The population of the pheasant study area in the fall of 1939 was about 850 birds. The breeding population consisted of 204 pheasants. The actual productivity of the 1,675-acre study tract in 1939, therefore, was 646 birds, or about 317 per cent.

The population of the study area in the fall of 1939 was 100 birds less than in the fall of 1938 (Table 2). Other regions censused by the roadside-count method (Randall and Bennett, 1939) indicated that this reduction in pheasant density was not limited to the study area.

Observations in the nesting season indicated that the exceptionally dry weather during June, 1939, was primarily responsible for the reduction in the pheasant population. Because of the dry weather, most of the hay was cut in June. Only 27.2 per cent of the study area's hayfield nests were successful (Table 10), whereas Leopold (1937) reported the hatching of 41 per cent of the hayfield nests examined by him. Half of the study area nests were in hayfields, and an increase of 15 per cent in successful hayfield nests would have returned the population of the study tract to its 1938 level. Many nests in hay were destroyed within a few days of hatching. The nesting study indicated that had all the mowing on the study area been deferred for one week, the number of successful nests would have been increased by 20 per cent. Ideal late June weather—from the standpoint of the pheasant—would probably consist of light showers and threatening weather, sufficient to postpone mowing but unharmful to young pheasants.

SUMMARY

The pheasant population of the 1,675-acre study tract in the fall of 1938 was 950 birds, or 1 bird to 1.8 acres. Hunting and associated losses reduced the population to 300 pheasants in early December.

Although the approach of the breeding season in late March apparently increased the vulnerability of the pheasants to predation, winter mortality was low. The study-area population dropped to 204 birds before spring. Many pheasants left the area during the winter when hand-picked standing cornfields were destroyed. The availability of standing cornfields and the winter carrying capacity of a Pennsylvania area for pheasants seemed to be closely correlated.

A breeding population of about 1 bird to 8 acres and a sex ratio of 1 cock to 7 hens occurred on the study area. In spite of the unbalanced sex ratio, 94.1 per cent of the eggs were fertile.

During this study 310 nests were under observation. The nesting

season extended from April through August, reaching its peak in May and June. About half of the nests on the study area were in hayfields. Other important nesting cover included wheat, roadsides, and waste-land.

In many hayfields a density of 1 nest to an acre was observed. The maximum density recorded was on a measured acre where ten nests were simultaneously occupied. When the density of nests approached or exceeded 1 to an acre, there seemed to be no tendency to seek a peripheral zone. The grouping of nests in certain parts of a field was often dependent upon the location of crowing areas.

The number of eggs in a clutch decreased as the season advanced. This indicated that wildlife managers should encourage farming practices that would enable the first clutch to succeed.

On the study area 25.4 per cent of the nests were successful. Nest mortality was large in all the important nesting covers, and no "best" type for nesting was discovered. Mowing was the most serious cause of nest destruction, accounting for 49.8 per cent of the nesting losses. Predators were responsible for 30.7 per cent of the nest failures. Skunks and crows were the most serious nest-destroying species.

Through renesting efforts, between 52 and 55 per cent of the hens on the study area raised broods. Juvenile mortality was comparatively low, as only 12.4 per cent of the hatch failed to reach maturity.

The population of the study area in the fall of 1939 was about 850 birds. This was an increase of 317 per cent from the breeding population, but it represented a reduction of 100 birds from the population in the fall of 1938. This decline in population was general throughout the pheasant range. The early summer drouth was believed responsible, as the mowing was done unusually early. The haying operations destroyed many nests that were within a few days of hatching. Delay of the mowing for one week on the entire study area would have increased the number of successful nests by 20 per cent.

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COTTONTAIL NESTING-STUDY IN PENNSYLVANIA[1]

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Although management of cottontail rabbits (*Sylvilagus* spp.) has advanced rapidly in recent years, the fundamental reproductive and nesting activities of these animals have to a great extent remained obscure. The difficulty with which cottontail nests have been found has generally limited previous studies to nests found accidentally. A study of the nesting habits and juvenile mortality of cottontails has been carried on by the writer as part of a management investigation of these animals in Pennsylvania since July 1, 1938. This paper is a preliminary report on the nesting habits of the Mearns cottontail (*Sylvilagus floridanus mearnsi*). All specimens collected and examined were identified as *Sylvilagus floridanus mearnsi,* but it is possible that some of the nests and young were those of *S. f. mallurus* and *S. transitionalis.*

The study was carried on in Centre and Lehigh Counties, Pennsyl-

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vania, under the direction of Dr. Logan J. Bennett, Biologist, U. S. Bureau of Biological Survey, and Dr. P. F. English, Associate Professor of Wildlife Management, Department of Zoology and Entomology, The Pennsylvania State College. Pierce E. Randall, Russell T. Norris, Tracy M. Kuhn, and Allan T. Studholme, graduate assistants at The Pennsylvania State College, helped materially in locating nests for study.

From April 1, 1939, to September 15, 1939, twenty-five active nests and sixty-six old nests were found by systematic search. This method, however, was of little value until indicators that revealed the presence of the well concealed nests were discovered. After a number of active nests had been observed, the arrangement of dried grasses covering the nests became a useful indicator. Portions of the excavated dirt and the fur lining were sometimes visible and were clues to the presence of nests. Cottontails dug many nesting cavities that were never used as nests. The investigation revealed an approximate 1 to 1 ratio between these cavities and the completed nests. Eighty per cent of the eighty-six unused nesting cavities examined contained materials for the outer grass lining, but none contained the fur lining.

The first active nest was found on April 6, 1939, and nesting activities continued through September 14, 1939, when a litter left the last occupied nest. Trippensee (1936) and Allen (1938) reported pregnant females in January and February, respectively, in southern Michigan. Similar early records may be expected for Pennsylvania.

The importance of the nesting period before April 1 is not known, as field work began on that date. Young cottontails, however, were seen in March, 1939. Nesting activities were under way in Pennsylvania on the 1st of April, and the peak of nesting activities was reached late in May and early in June. From May through September the number of nests found was progressively smaller when figured by months (Table 1). During August few nesting data were obtained because the writer was absent from the study areas. A number of young cottontails that were caught in box traps during September showed that nesting activities continued throughout August.

When choosing a nesting site, cottontails often left their favorite haunts of dense shrubs for the adjoining open meadows and fields.

TABLE 1. NESTS AND LITTER COUNTS OBTAINED BY MONTHS

Month	Nests found	Litters examined	Average in litter
April	2	2	6.0
May	44	8	6.1
June	22	8	5.8
July	17	4	4.5
August	2	2	3.5
September	4	2	4.5
Totals	91	26	Average 5.42

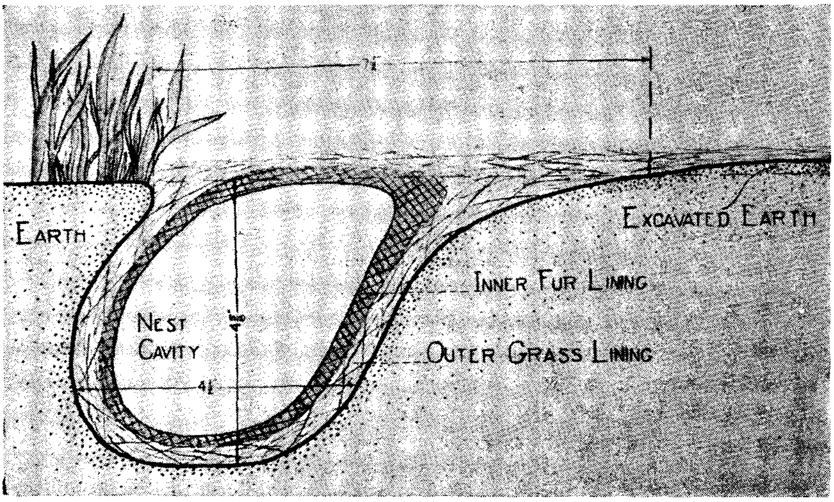

Figure 1. Diagram of section of typical cottontail nest.

Perhaps the nests were placed where mammalian predators would be least apt to travel. The study thus far has not revealed any avian predator as a destroyer of cottontail nests. The location of nests with reference to cover types is presented in Table 2.

The nest of the cottontail was arranged in a cavity in the ground, presumably dug by the female in most cases. An outer lining of vegetation and an inner lining of fur were placed in the shallow hole. Nesting cavities were surprisingly uniform in size and shape although several exceptions were observed. The nest shown in Figure 1 was drawn from the average measurements of forty-nine nests. That no incomplete nesting cavities were found indicated that they were dug in a single operation.

In April and May (when green vegetation was not available) dried leaves, mosses, fine roots, and straw were used for the outer grass lining. Later in the season bluegrass and timothy were most commonly used for the outer lining although nests located in barley, oats, and wheatfields contained the basal leaves of those plants. With the exception of early nests, the materials for the grass lining were cut when green and were loosely placed in the cavity, where they dried in a few days. The nest was left in this condition from four to fourteen days, after which the grass lining was rearranged and fur from the abdomen of the female was added. The young were born shortly after the fur was placed in the nest. After the birth of the young, more fur was added to the lining and arranged to surround them. Green vegetation was then cut and put over the conspicuous fur lining and excavated

TABLE 2. LOCATION OF COTTONTAIL NESTS

Location of nests	Number of nests
Wastelands	32
Alfalfa	13
Orchards	8
Hayfields (containing timothy)	7
Barleyfields	5
Wheatfields	5
Oatfields	4
Red clover	4
Roadsides	3
Woods (mixed oak and pine)	3
Pastures	3
Strawberry patch	1
Pine plantation	1
Scrub oak	1
Manure pile	1
Total	91

dirt. Two nesting cavities were dug six and seventeen days, respectively, before the birth of the young.

Twenty-five litters of nestling cottontails were examined during this study, and one litter count was obtained from a pregnant rabbit that had been hit by a car. Seton (1929) gave the number of young to a litter as four to six or seven and very rarely as many as eight or as few as three. In Pennsylvania the number in a litter ranged from three to eight and averaged 5.42 for the twenty-six litters examined. Large litters of six to eight were frequently found during the early nesting months, but litters found after July 15, 1939, were comparatively smaller and ranged from three to five (Table 1). Dalke (1937) found a larger number of embryos to the female during the early breeding months in Connecticut, but a table compiled by Trippensee (1936) showed no appreciable difference in the number to a litter throughout the entire breeding season in Michigan.

On one of the experimental areas a half-grown cottontail was caught and tagged in August, 1938. On June 28, 1939, this rabbit was caught again. The condition of the genitals and the secondary sex characteristics showed that she had given birth to young about the first week in June. This was considered the animal's first litter, for Trippensee (1934) determined the breeding age of cottontails to be about forty weeks. This cottontail was again trapped in July, August, September, and October and revealed no further nesting activities; she therefore had only one litter in her first breeding year.

Fifty young cottontails, trapped repeatedly throughout the summer and early fall, gave no indication of breeding during the first year.

Ordinarily the female returned to the nest only to feed the young, although she spent much time in a nearby form. Feeding hours were determined by the use of an apparatus that stopped an alarm clock at each visit of the female to the nest. One feeding period was determined to be about dusk, and a second was indicated to be about dawn. At the conclusion of each visit the female rearranged the nest and often added more fur and grasses to conceal the nest.

Trippensee (1934) cited examples of female cottontails responding to the squeals of the young and offering protection when the latter were in danger. Once while nestling cottontails were being tagged, a squeal from one of the young caused the female to come within 3 yards of the writer, who was standing over the nest. She departed, however, when the observer moved.

No tendencies toward desertion were recorded, although the young of many nests were handled daily. On one occasion there were indications that the female had moved her young to another site after the writer had made initial observations.

Mammalian predators, insect larvae, and man were responsible for the destruction of nine of the twenty-five active nests under observation. In one locality skunks (*Mephitis nigra*) destroyed three nests and were partly responsible for the destruction of a fourth (Table 3).

TABLE 3. CAUSES OF NESTLING MORTALITY

Mortality factor	Number of nests destroyed
Skunks	3
Man	3
Wohlfahrtia vigil	2
Skunk and *W. vigil*	1
Weasel	1
Mice or shrews	1
Total	11

These mammals, however, in other localities did not disturb nests; apparently skunks had to learn to search for nests before they became a menace. Nestling mortality attributable to skunks was difficult to determine when an entire litter was eaten at one time. Fortunately a few nests containing large litters were destroyed and the remains of several of the young were left at the nest. The predator was then caught in a steel trap the following night, when it returned for the remaining young.

The larvae of the flesh fly (*Wohlfahrtia vigil*) caused myiasis in nestling cottontails and resulted in the destruction of two nests. The nestlings of a third litter were infested but were taken by a skunk. Larval specimens from the young of all infested litters were identified by Dr. J. E. Shillinger, Division of Wildlife Research, U. S. Bureau of Biological Survey, and Dr. Charles T. Green, U. S. National Museum, Washington, D. C. Johannsen (1926) reported taking Wohlfahrtia larvae from young cottontails that were reared under seminatural conditions at Ithaca, New York. Kingscote (1935), working in Ontario, Canada, found a similar infestation in 149 mink, 20 dogs, 4 cats, 4 ferrets, 2 rabbits, and 1 fox.

The manner in which nestling cottontails were thus parasitized is unknown. Under experimental conditions the larvae (which are born alive) were deposited on the host by the female fly. They immediately entered the body of the host and reached maximum larval development in four to nine days (Ford, 1936). Nestling cottontails of all infested litters died just as their eyes were beginning to open, showing that all litters were parasitized at the same time in their development. The presence of second- and third-instar larvae in dead and dying cottontails indicated that the young were probably infested at birth. It is doubtful that the female flies could have entered the matted fur lining to larviposit on the nestlings. Wohlfahrtia larvae entered the nestlings from any part of the body, but the abdominal and anal areas were especially vulnerable (Figure 2).

In Ontario, Wohlfahrtias were associated with railroad tracks and water. The association with railroad tracks has been explained in the laboratory by the insects' attraction to heat. In nature the warmth of the tracks after sundown attracted these insects. Exposed rocks or metal buildings were also suggested as possible attractors of Wohlfahrtias. The association with water is yet unexplained (Ford, 1932, 1936). The Ontario investigations also revealed that *Wohlfahrtia vigil*—unlike most of the related flesh-flies—were flower feeders. These insects were noted feeding on wild carrot (*Daucus carota*), wild caraway (*Carum carvi*), white sweet clover (*Melilotus alba*), goldenrod (*Solidago juncea*), and milkweed (*Asclepias* sp.).

All infested nests were found on or bordering a rocky experimental area in Centre County, Pennsylvania. With the exception of wild caraway, the plants listed above were abundant in this region. Numerous exposed rocks on the area may also have influenced the presence and abundance of Wohlfahrtias.

In Ontario these insects were found from the last week in May to the last week in September. They may, therefore, be a potential mortality factor for nestling cottontails throughout the greater portion of the nesting season. The dates of parasitization in Pennsylvania were May 31, July 12, and July 22, 1939.

The remaining three nests were destroyed by man. Sportsmen removed two litters from supposedly deserted nests, and all the young died. The third nest—located in a badminton court—was trampled, and the three nestlings were killed.

In addition to the nests under observation, two examples of nesting mortality were reported. Pierce E. Randall found a nest in which three of the four young were dead from open wounds on their sides and flanks. The fourth nestling was untouched and alive on the bot-

Figure 2. Nestling cottontail parasitized by *Wohlfahrtia vigil* and showing entrance of larvae through anal and abdominal regions.

tom of the nest. Mice or shrews appear to have been the predators. O. R. Snyder, of Allentown, Pennsylvania, watched a large weasel (*Mustela* sp.) carry young rabbits, one by one, from a nest into a den between two rocks.

Of the twenty-five active nests under observation, sixteen, or 64 per cent, were successful. To determine the success or failure of the numerous old nests presented a more complex problem. After the small pellets of the young had been found at several old nests, they were believed to indicate successful nests. An investigation revealed that pellets were always present at known successful nests, but no pellets were ever found at a nest known to have been destroyed. Nestling cottontails do not drop pellets until they have fed upon solid foods. Several days prior to their final departure, the young venture short distances from the nest to feed, and after this the first pellets are dropped. The nesting materials and the peripheries of the nest must be searched thoroughly if pellets are to be found, and one or two pellets are enough to indicate the success of a nest. Twenty-two of the thirty-four old nests examined contained pellets of the young cottontails: this indicated the success of 64.7 per cent.

SUMMARY

1. Twenty-five active nests and sixty-six old nests were found by systematic search from April 1, 1939, to September 15, 1939. Eighty-six nesting cavities that were never completed as nests were also found by this method.

2. Nests were located in a variety of habitats, but the majority were found in wastelands, alfalfa, orchards, and hayfields.

3. The peak of nesting activities was recorded late in May and early in June, and progressively fewer nests were found throughout the remainder of the nesting season.

4. Twenty-six litter counts ranged from three to eight young and averaged 5.42 in a litter. Larger litters were found early in the season.

5. One female, known to be in her first breeding season, had only one litter for the year.

6. Ordinarily the female rabbit returned to the nest only to feed the nestlings. A timing apparatus recorded one feeding period about dusk and indicated a second feeding period about dawn. Young rabbits could call the female in time of danger by squealing.

7. Skunks, the larvae of the flesh-fly (*Wohlfhrtia vigil*), and man destroyed nine of the twenty-five active nests under observation. Reliable cooperators noted the destruction of one nest by a weasel and of another by shrews or mice.

8. The presence of the pellets of the young in or about the peripheries of a nest seemed to indicate success for that nest. Twenty-two of the thirty-four old nests examined contained pellets and indicated the success of 64.7 per cent, as compared with the known success of 64 per cent of twenty-five active nests.

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NESTING COVER USED BY MEARNS COTTONTAIL[1]

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Mearns cottontail, *Sylvilagus floridanus mearnsii* (Allen), may place its nest in a variety of cover varying from bare soil without plant cover to forested land. Because only fragmentary information is available about preferred types of nesting cover and the placement of nests in relation to protective and other types of cover, it was considered advisable to investigate the nesting and related cover uses by the cottontail in a detailed manner during the spring and summer, 1939, on three tracts of agricultural land in central and southern Iowa.

In the course of general observations in our cottontail investigations during the past five years April 13 was the earliest date of an observed nest, and it contained five young with their eyes open. The latest nest was reported from a cultivated raspberry (*Rubus*) patch September 17, with four young and their eyes closed. Therefore, it was decided to conduct an intensive search for nests on farm lands April 1-September 1.

The first tract chosen has an area of about 80 acres, college property. About 30 acres are in bearing orchard with chiefly bluegrass (*Poa*) as ground cover, mowed several times each summer, on one-half, and the other half is quite bare of plant cover, as it is disced periodically in summer. Approximately 10 acres are in small fruit and vegetable garden, a new herbaceous garden with relatively little tall cover as yet, and a small horse pasture quite closely grazed. The remaining 40 acres are a central part of the arboretum with several acres of tall and low evergreens (*Pinaceae*), chiefly massed at the east central side and at two corners. Several square plots of 0.5-1 acre of young deciduous trees such as catalpa (*Catalpa*), black locust (*Robinia*) and sycamore (*Platanus*) are at the north and west sides. As yet few trees and shrubs have been planted in the inner part of the arboretum. The ground cover of the arboretum portion is largely bluegrass and alfalfa (*Medicago*), with some weeds, and kept trimmed under 1 foot during

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most of the summer. A narrow creek, normally with running water, enters at the southwest corner and leaves at the northeast corner of the 80-acre tract, and a gravelled highway runs north and south midway through the tract. Woven wire fence bounds the sides of the road nearly all its length, most of the north and west sides of the tract, the pasture, and the north side of one-half of the orchard.

In this investigation the writer was assisted by Cecil Haight, Emmett Polderboer and Harry Harrison, wildlife management students.

Watching adult cottontails for some hours yielded no clues as to nest locations. Also observers walked through the tract at intervals of about 6 feet and looked closely to each side for hair and plant debris, the characteristic nest materials, and the small, bare areas of earth such as were found in front of nests previously seen in other years. The small bare areas, platforms, of soil are excavated from the nest burrows and tread down to an elliptical form about 0.5 foot in area.

Although much time was spent during April in the search no nest was found until May, when thirteen nests were found on the 80 acres. In those thirteen nests the nesting materials averaged 39 per cent hair and 61 per cent plant debris, with a minimum of 2 per cent hair in a nest found late in May and a maximum of 75 per cent hair in a nest under a vacant beehive early in May. Of the twelve nests in the open, ten were in bluegrass or brome grass (*Bromus*) estimated to have been 4-6 inches tall when the nests were used, one in growing sweet clover (*Melilotus*) 14 inches tall and one in dead sweet clover 2 feet tall. The ten nests in shorter cover were an average of 34 feet from the nearest protective hazard such as woven wire fence, shrubbery or closely planted trees, with a minimum of 0.5 foot and a maximum of 125 feet. The two nests in taller cover were 15 and 38 feet from similar hazards. Three nests had a total of eleven live young and one nest contained two dead.

The same 80-acre tract was combed again late in July and in August for cottontail nests. Although it is not known whether or not the fifteen later nests were used earlier than June or July, at least none of the nests is recorded twice. In the fifteen nests the nesting materials averaged 38 per cent hair and 62 per cent plant debris, with a minimum of 5 per cent in each of five nests and a maximum of 90 per cent hair in one. Six nests were in bluegrass or foxtail (*Setaria*) estimated as under 6 inches tall when the nests were in use, and nine were in foxtail, cultivated beans (*Phaseolus*) or tomatoes (*Lycopersicon*) 8-36 inches tall when in use. The six nests in shorter cover averaged 77 feet from protective hazards such as woven wire fence, shrubbery, or closely planted trees, with a minimum of 12 feet and a maximum of 205 feet. The nine nests in taller cover were an average of 49 feet from hazards such as woven wire fence, tall bean and tomato plants, shrubbery or closely planted trees varying from 0 to 163 feet. Two nests together contained five live young, and three had a total of eight dead.

Early in June the rabbits on the 80 acres were estimated at twenty-two adults and twenty-eight young. In October, fifty-two cottontails were found on the same tract.

A second investigational tract was selected 2.5 miles north of Bloomfield, Davis County, southern Iowa. This 17-acre tract is composed partly of about 10 acres of low bluegrass pasture, moderately grazed, and with about one-eighth of the area taken up by scattered clumps of Indian currant (*Symphoricarpos*), and partly of about 7 acres of eroding clay hillside with a thin stand of weedy Japanese lespedeza (*Lespedeza*) and sweet clover, and a few scattered briar (*Rubus*) patches. A 4-acre cornfield is wedged into the clay hillside which comes around the corn to meet the pasture at each side. A narrow creek, normally with running water, traverses the length of the pasture. The nesting materials in the ten nests of this second tract contained an average of 12 per cent hair and 88 per cent plant debris, with a minimum of 2 per cent and a maximum of 50 per cent hair. Nine nests were in bluegrass, ragweed (*Ambrosia*), or poverty grass (*Aristida*) estimated as under 6 inches tall when the nests were in use, and one nest was in bluegrass 8 inches tall. The nine nests in shorter cover averaged 7 feet from a hazard such as woven wire fence, briars, or an Indian currant patch, with a minimum of 0.2 foot and a maximum of 15 feet. The nest in taller cover was 3 feet from woven wire fence. No young were found in the nests.

The third observational tract is 4 miles west of Corydon, Wayne County, and 54 miles west of Bloomfield. On this tract an L-shaped field of 8 acres is in timothy (*Phleum*) with an occasional patch of red clover (*Trifolium*) mixed in. An Osage orange (*Maclura*) hedge runs along about 40 rods of the west and north sides, and at the east side are 20 rods of thicket, mostly wild plum (*Prunus*), and after a break another approximately 10 rods of trees and shrubs in a healed gully. South of the gully and the timothy field lies the remainder of the tract, 13 acres of oat (*Avena*) stubble.

On this tract the farmer in April reported three nests with a total of eleven living young in a straw pile 40 feet from the Osage orange hedge. In August, eight nests were found in mown timothy and red clover estimated to have been 8 inches or more tall when the nests were in use, one in oats over 12 inches tall when used, and one in construction in foxtail and timothy 8 inches tall. The nests in growing cover averaged 89 feet from fenceline thickets, gully thickets or osage orange hedge, varying from 22 to 210 feet. No young were in the nests found in August.

The populations of cottontails were estimated at 2 an acre on both the Bloomfield and Corydon tracts early in April, and 4 an acre in August. Tularemia began to take its toll then, and by December the estimates were 1 rabbit to 3 acres.

SUMMARY

From April-September, 1939, fifty-one cottontail nests were found on 118 acres of three Iowa agricultural tracts in attempts to discover all nests. The soil varied from clay to sandy loam and loess. Spring populations were estimated at 0.3-2 cottontails an acre and fall populations at 0.6-4 cottontails an acre. The ground cover was chiefly bluegrass, timothy, oats, and alfalfa, partly in open fields and partly in orchard and arboretum. One nest was under a vacant beehive. In herbaceous cover, 8 inches or taller and dense enough to conceal an adult cottontail at the time a nest was used, twenty-two nests were 0-210 feet (average 63 feet) from the nearest woody or other cover of protective value. In short herbaceous cover and strawpile twenty-eight nests were 0-205 feet (average 24 feet) from the nearest woody or protective cover. Of the nesting materials 32 per cent was hair and 68 per cent plant debris such as was readily available. In the search for nests the elliptical bare spot of earth about 0.5 foot in area usually found in front of a nest was the most helpful sign. The average dimensions of the burrows containing nests were 3.9 inches deep, 5.1 inches wide, and 6.3 inches long. Seven nests contained an average of 3.4 living young and four nests averaged 2.5 dead young. Over a 4-year period reports of other observers of seventeen nests found at random showed an average of 6.4 young, including a maximum of 12 young of two sizes or age classes.

THE EFFECT OF LAND-USE ADJUSTMENTS ON WILDLIFE POPULATIONS IN THE OHIO VALLEY REGION

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The definitive relation of land-use to wildlife populations has been recognized by economic biologists. Moss (1939) found that in Connecticut, as the area in cultivation was reduced, population of bobwhite quail, pheasants, and cottontail rabbits dropped off rapidly. For instance, during the 50-year period from 1880 to 1930 quail declined in abundance and disappeared over much of its range. During approximately the same period, crop acreage decreased from 1,600,000 to 550,000 acres.

Through the activities of state agencies and the various bureaus of the Federal Government millions of acres of land subject to erosion, when cultivated, are being protected by permanent cover of grass, trees, or shrubs or so farmed that erosion is reduced to the barest minimum. It has been estimated (U. S. D. A., 1938) that only about 39 per cent of the present cropland of the United States can be safely cultivated under prevailing practices, while under good conservation practices an additional 43 per cent can be cultivated safely. The remaining 18 per cent of the present cropland should be retired from cultivation to permanent vegetative cover. Should such retirement actually take place it would place an additional seventy-six million acres under permanent vegetative cover. This suggests the magnitude of the land-use adjustments needed for conservation of soil and moisture resources. It follows logically that biologists should consider the effect of such adjustments on wildlife populations. This paper presents some of the effects of changing land-use and land-use practices on wildlife populations influenced by the Soil Conservation Service in the Ohio Valley region.

This region embraces the States of Ohio, Michigan, Indiana, Kentucky, and Tennessee. Readjustments in land-use and in farming methods are being demonstrated through several types of programs, including watershed demonstration projects, Soil Conservation CCC Camps, and Soil Conservation Districts, the latter organized by landowners to facilitate erosion control planning on their farms. In these programs, trained technicians study the physical, economic, and biologic problems of the land and, together with the farmers, work out a plan of conservation operations. The plan is a formal written agreement between the farmer and the cooperating agency for a five-year period or longer, during which, working together, a permanent soil-conserving program is established in keeping with the abilities of the man and the land.

Through cooperative plans, about 8,000 farms, comprising over 1,100,000 acres in this region, have been replanned for soil conservation. The significance of these figures lies not so much in the acres actually affected as in their demonstrational value in encouraging similar changes on other farms with comparable erosion problems.

The effect of the various land-use adjustments and soil conservation practices on farm wildlife populations are so closely interrelated that to discuss all of them would lead to confusion. For the sake of clarity, only certain outstanding changes in land-use and farming practices will be considered with reference to their influence on farm wildlife populations.

As has already been pointed out by Moss, changes in crop acreage materially affect populations of certain game species. This is equally true of non-game birds. Studies made in southwestern Ohio, for instance (Dambach and Good, 1940), indicate that meadows average about 50 pairs of breeding birds per 100 acres compared to an average of ten pairs per 100 acres in small grains (wheat, rye, oats). In corn, populations were found to average slightly over 3 pairs per 100 acres. In this area, meadow populations were found to be 4.5 times as great as those in small grain and fifteen times as great as those in corn. Any material shift in acreage from corn and small grain to meadow thus makes for potential conditions that may result in a material increase in the population of farm breeding birds.

Leedy (Leedy, 1938) found in northwestern Ohio that pheasants nested in different crops in the ratio of 1 nest per 22.7 acres of oats, 1 per 6.9 acres of wheat, and 1 per 1.6 acres of alfalfa meadow. Approximately 75 per cent of all nests found were located in meadows. Decrease in meadow would thus obviously decrease the acreage of preferred nesting territory of pheasants in this area. Decrease of corn or small grain, on the other hand, would change the food supply on which pheasants in this area are largely dependent.

Rearrangement of farm layout to permit introduction of conservation practices such as strip-cropping, contour cultivation, and crop acreage changes also affects farm wildlife populations. On the Indian Creek Project Area of the Soil Conservation Service in Butler County, Ohio, contour strip-cropping resulted in an increase of breeding birds on meadow and small grain crops of approximately twice the populations on large fields of the same crops. Cornfields in strips showed no significant difference over non-stripped fields. These differences are believed due primarily to decreasing the size of acceptable territories for the birds which commonly nest in these crops (Dambach and Good, 1940).

On the negative side of the picture, however, is the fact that establishment of strip-cropping often reduces the total length of permanent border on a farm. On one farm studied in Butler County, Ohio, the introduction of strip-cropping resulted in a decrease of permanent border from 19,075 feet to 15,750 feet, or a loss of about 17 per cent (Dambach and Good, 1940). From the standpoint of travel lanes this is not a material loss. Actually it is a gain, since most field borders in this intensively farmed section are clean (bluegrass) and provide less effective cover than the greatly increased margin of meadow and small grain stubble which intersperses rowcrop fields.

Reduction of populations due to loss of field border varies with the quality of vegetation in the border. Studies made on field borders in southwestern Ohio in 1939 indicate that populations of breeding birds per mile of border increase as the amount of woody cover increases (Table 1).

TABLE 1. THE RELATION OF WOODY COVER IN FIELD BORDERS TO BREEDING BIRD POPULATIONS, PERRY TOWNSHIP, MONTGOMERY COUNTY, OHIO, MAY-SEPTEMBER, 1939

Type of border	Pairs, birds per mile	Number of species
Bluegrass—no woody cover	2.07	4
Bluegrass—occasional vines	5.2	2
Bluegrass—occasional shrubs	8.7	9
Unclipped osage orange hedge	19.2	8
Dense shrubby growth	23.3	5

In the replanning of farms for soil conservation, reduction of cropland usually is offset by increased acreages of permanent meadow, pasture, protected woodland, and wildlife areas. Pasture acreage not only is increased, but also pasture land is so managed that each acre has a greater carrying capacity of domestic livestock. Under this type of management brushy cover is eliminated or greatly reduced. Such pastures provide little food and cover for common farm game species. They do, however, support larger populations of breeding birds than are ordinarily found on cropland. Pasture populations of breeding birds per 100 acres in southwestern Ohio, for instance, averaged 61.9 pairs per 100 acres for three years, as compared to an average for the same area on all types of crops of 20.46 pairs per 100 acres.

Areas retired to woodland or for permanent wildlife cover rapidly become havens for many game and non-game species. Concentration of cottontail rabbits in such areas frequently is so great during the early stage of development that serious injury to plantations results. One badly eroded area near Dry Ridge, Ky., which was planted to black locust in the spring of 1937 illustrates clearly how quickly an area becomes revegetated and reinhabited by wildlife after protection. On this area of 3 acres there were found, during the summer of 1939, fifteen occupied nests of six different species of birds. Later in the season an additional eight nests were located which evidently had been occupied by fledglings during the summer. In addition, two rabbits were observed in the area consistently throughout the summer.

Merely protecting many eroding areas from fire and grazing has permitted rapid development of native vegetation and increase in wildlife populations as illustrated in the example given. Similar observations have been made in other localities. The number of such areas per farm planned varies with the type of farming and physical land conditions. In general, however, one or more forest plantings and wildlife areas are provided for on each demonstration farm in soil conservation work areas. In addition, farmers are encouraged to maintain, insofar as practical, all areas which provide suitable wildlife habitats.

Existing woodland on farms planned, with few exceptions, are protected from fire and grazing. In the Ohio Valley region, this practice

TABLE 2. BREEDING BIRD POPULATIONS IN GRAZED AND PROTECTED WOODS

Location and observer	Reported	Type of woods	Pairs birds per 100 acres		Number of species	
			Protected	Grazed	Protected	Grazed
Toronto, Canada D. A. Ross and R. D. Ussher Reported by K. M. Mayall	1937	Hardwood bush	110.5	84.9	15	15
		Mixed bush	95.3	87.0	21	21
		Second growth hardwood	118.4	64.8	13	11
Quaker Run Valley, Pennsylvania Aretas A. Saunders	1936	Maple, beech and hemlock	182.1	62.8	27	11
Butler Co., Ohio E. E. Good and C. A. Dambach	1940	Beech and maple	225.36	111.11	24	11
Geauga Co., Ohio C. A. Dambach	1938	Nearly pure stand of sugar maple	189.8	45.0	15	3
	1939	Nearly pure stand of sugar maple	126.0	24.0	7	2
		Average	149.6	68.5	17.4	10.5

has resulted in a desirable increase in population of breeding birds. Leedy (1939) has pointed out, also, that protected woods supporting an abundance of thicket cover provide much more acceptable pheasant roosts than do clean grazed woods. Presumably, a similar relation may exist for other game species, particularly those which are dependent upon woodland edge. Breeding bird populations in grazed and protected woods reported from four widely separated areas and by as many workers are notably higher in protected woods (Table 2).

From an examination of the species composition of bird populations in grazed versus protected woods, the most conspicuous difference apparent is the almost complete absence in grazed woods of ground and shrub nesting species.

Other conservation practices affecting farm wildlife populations, such as sod waterways in cultivated fields, meadow and shrub buffer strips, woodland borders, windbreak plantings, reservoir plantings, live shrub dams, vegetated terrace outlets, and so on, might be cited. Those discussed, however, represent the most significant changes in land-use and farming practices being applied in the Ohio Valley region which affect farm wildlife populations. That their application is affecting land-use and wildlife populations locally is apparent from studies of developments on some of the projects which have nearly completed their work. That their application is becoming widespread is evident from the spread of these practices to farms outside of work units and the interests of farmers in organizing districts to facilitate soil conservation planning on their farms.

On the Indian Creek Project in Butler County, Ohio, breeding bird

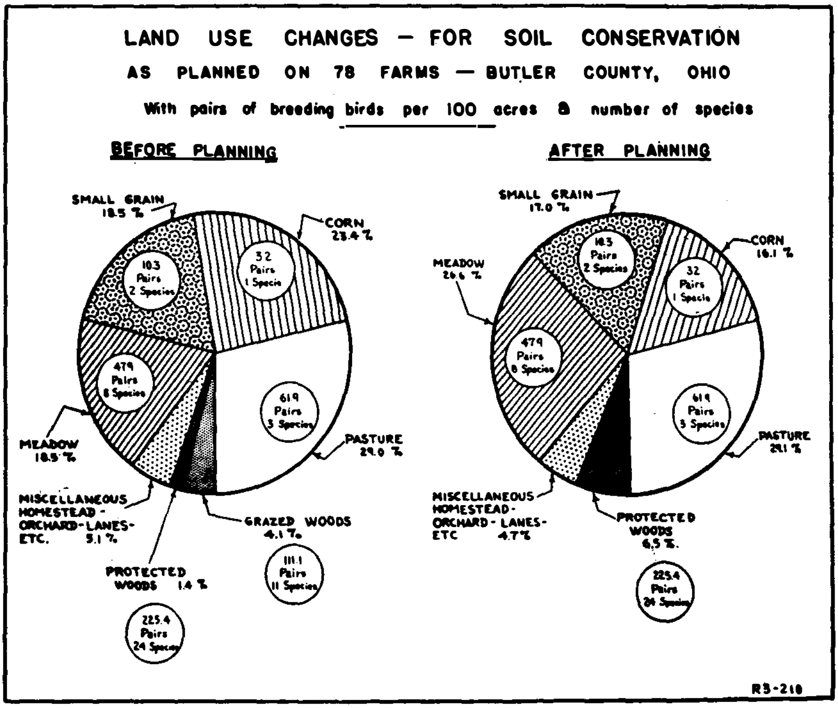

Figure 1.

censuses conducted for three years indicate that major land-use changes on farms planned result in increased populations per farm of a little over 38 per cent. This change is due mainly to a decided increase in protected woods, new woodland plantings, meadow and pasture, and a corresponding reduction in cropland (Figure 1).

Land-use adjustments affecting a large percentage of the cropland of the United States are needed to maintain soil and moisture resources. These adjustments materially affect wildlife populations which are a part of the agricultural pattern. Although much more information is needed to ascertain their effects on various farm wildlife species, it is apparent from the limited studies referred to that they are of considerable magnitude.

Biologists should be aware of the influence land-use changes have on farm wildlife populations and the land-use changes being planned for the future. To meet new problems introduced by necessary agricultural adjustments, compensatory or complementary practices beneficial to wildlife use may be needed. On the whole, however, it appears that these changes point to improved farm biotic conditions. In those instances where clashes in objectives do occur the burden of adjustment falls largely to the biologist. Where they do not occur biologists should be ready to complement them to the end that maximum wildlife benefits result. This calls for much needed study in the field of land-use-wildlife relationships which only recently have held the attention of biologists.

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A STUDY OF BOBWHITE FOODS IN RELATION TO FARM PROBLEMS IN NORTHERN MISSISSIPPI

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This three-year study of bobwhite (*Colinus virginianus*) foods in relation to farm problems in northern Mississippi was initiated as a method of approach to a specific problem. The objective was to determine foods commonly available on farms on which various agricultural crops are raised, how certain crop rotations, woodland management practices, and pasture improvements might affect food supplies, and then to decide which supplemental foods should be produced as by-products of planting for erosion control on such wildlife areas as field borders, woodland margins, odd corners, fence and hedgerows, isolated gullies, pond banks, and small unproductive fields that have been abandoned.

[1]Grateful acknowledgment is made to Verne E. Davison, U. S. Soil Conservation Service, for instruction in food analysis methods and in making summaries, for assistance with individual crop analyses, and for criticism of the textual material; to Anderson M. Gray, U. S. Soil Conservation Service, for analyzing a portion of the crops and for compiling the 1938-39 summaries; and to sportsmen, farmers, and SCS personnel for collecting the crops, particularly W. G. Beatty, U. S. Soil Conservation Service.

It is felt that plants used on these wildlife areas should supplement rather than duplicate the available foods in fields, woodlands, and pastures. More, however, is required of such plants. On the field borders, for example, they must also withstand the rough usage given them by work stock and implements during cultivation and harvest. The plants or seed must be easy to obtain, and the farmer should experience no great difficulty in establishing and maintaining them. Also, they must survive and thrive under adverse conditions and must not shade or sap adjacent crops.

Determining dependable and staple food plants for quail, that also offer outstanding erosion control possibilities, does not detract from the pure scientific value of the study but contributes rather to its scope of application.

The material used in this study was not gathered as a special collection. Sportsmen, farmers, Soil Conservation Service personnel, and others were asked to save crops from quail taken while hunting during the months of November, December, January, and February. The crop material was saved by drying, after which it was placed in envelopes on which pertinent data were recorded. Upon receipt from the field, the contents of each crop were analyzed and tabulated in accordance with a method developed by Davison.[2]

The tabular results for all crops from a single county were then summarized and recorded in a suitable table. County summaries were grouped into larger summaries when the results compared favorably and in cases of counties having similar agricultural conditions. This paper is based upon such combinations of the following eleven counties. (See Figure 1 and Table 1.)

TABLE 1. SHOWING THE NUMBER OF BOBWHITE CROPS ANALYZED FROM EACH COUNTY BY YEARS AND THE TOTALS FOR THE 3-YEAR PERIOD

County	Year			Totals
	1937-38	1938-39	1939-40	
Benton	66	12		78
Calhoun	44			44
Chickasaw	9	5		14
Grenada	19	7		26
Lafayette	23	17	5	45
Marshall		13		13
Pontotoc		15	93	108
Tippah		5	31	36
Union		43	9	52
Webster		13		13
Yalobusha	462	472	472	1,406
Totals	623	602	610	1,835

Small collections for a single county, as previously explained, were combined with those of the same season from adjoining counties having similar agricultural conditions. The compilation of these yearly

[2]Davison, Verne E. 1940. A field method of analyzing game bird foods. Jour. of Wildlife Management, April, 1940.

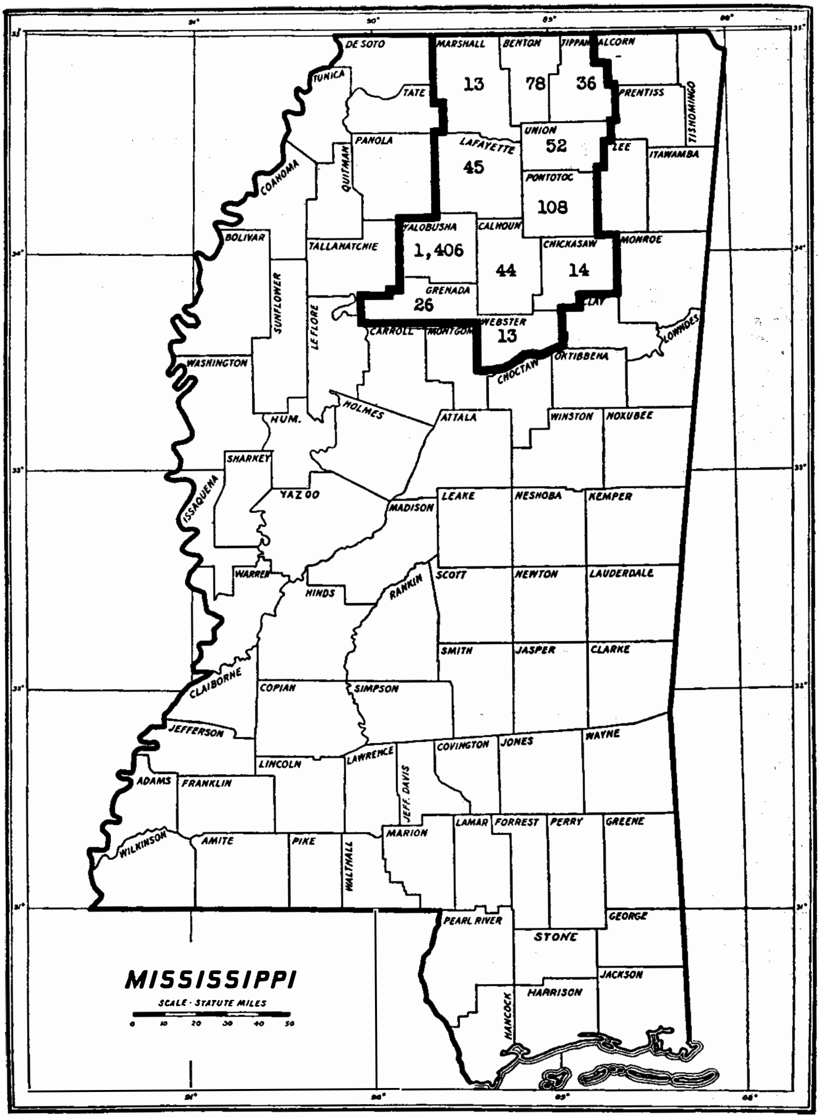

Figure 1. Location of counties from which crops were collected with totals from each taken seasons 1937-1939.

combinations bore out Davison's statement that from 100 to 200 crops must be analyzed from a locality for any one season in order to obtain an adequate representation of the foods quail are utilizing. They are also in accord with his assertion that such a number should be obtained each year for at least three years in order to reveal variations in food production due to climatic changes. The combinations for each of the three seasons are presented in Table 2.

TABLE 2. SHOWING BY PERCENTAGE THE AVERAGE UTILIZATION OF ITEMS FOUND EACH YEAR IN BOBWHITE CROP ANALYSES

Food items	Average percentage		
	1937-38	1938-39	1939-40
Lespedeza striata and *L. stipulacea* (annuals)	39.3	23.6	36.2
Quercus spp. (oaks)	20.7	21.7	19.8
Soja max (soybeans)		16.4	3.4
Vigna sinensis (cowpeas)	11.4	10.0	2.5
Glycine apios (ground nut)		4.3	.3
Ambrosia elatior (ragweed)	.2	3.7	2.0
Zea mays (corn)	.6	2.1	.4
Desmodium spp. (beggarweeds)	3.6	1.9	1.0
Sorghum vulgare (sorghum)	.1	1.8	T
Chamaecrista spp. (partridge peas)	1.6	1.7	2.8
Paspalum boscianum (bullgrass)		1.5	7.2
Cornus florida (dogwood)	3.5	1.3	.5
Strophostyles helvola (wild bean)	T	1.2	.3
Robinia pseudoacacia (black locust)		1.0	1.1
Nyssa sylvatica (black gum)	1.0		T
Lespedeza spp. (perennials)	4.2	.9	.9
Sassafras sassafras (sassafras)		.9	
Insects (several species)	.7	.9	2.1
Falcata comosa (hog peanut)	T	.6	T
Sesban macrocarpa (Sesbane)			.6
Galactia volubilis (milk pea)	.2	.5	T
Croton capitatus (wooly croton)	2.8	.4	.7
Ostrya virginiana (Ironwood)	.4		
Catalpa sp. (catalpa)		.4	
Fagus grandifolia (Beech mast)	.4		
Impatiens biflora (jewel weed)	.2	.3	T
Bradburya virginiana (butterfly pea)	T	.3	TT
Rhus glabra (smooth sumac)	.1	.3	T
Liquidambar styraciflua (sweet gum)	.7	.3	5.7
Prunus serotina (black cherry)	.9	.2	.4
Green leaves (several species)	1.5	.2	1.8
Pinus spp. (pines)	.2	.2	2.9
Digitaria filiformis (crabgrass)		.2	.1
Smilax sp. (Greenbrier)	.1		
Sorghum halepense (Johnson grass)		.1	T
Rhus radicans (poison ivy)		.1	T
Rhus copallina (dwarf sumac)	.1	.1	
Hicoria spp. (hickory and pecan)	1.7	.1	2.4
Digitaria sanguinalis (crabgrass)	T	.1	.7
Vicia sp. (vetch)		.1	
Juniperus virginiana (red cedar)		.1	TT
Cracca sp. (hoary pea)		.1	T
Vaccinium arboreum (sparkleberry)	.6	.1	T
Diodia teres (poverty weed)	.1	.1	.2
Symphoricarpos orbiculatus (coralberry)		.1	
Unidentified, Misc. and Traces	1.9	.1	T
Paspalum ciliatifolium (ciliate-leaved paspalum)		T	T
Strophostyles umbellata (wild bean)	T	T	T
Physalis sp. (ground cherry)		T	
Panicum sp. (panic grass)	T	T	T
Bidens sp. (Spanish needle)	T		TT
Paspalum laeve (paspalum)	T	T	TT
Crotalaria sp. (rattlebox)	T		TT
Galls	T	T	T
Phaethusa virginica (frost weed)		T	TT
Passiflora incarnata (passion flower)	T		TT
Lonicera japonica (honeysuckle)	T	T	.2
Fraxinus americana (white ash)	.4	T	2.6
Persicaria pennsylvanica (smartweed)	T	T	TT
Rosa sp. (rose)			T
Strophostyles pauciflora (wild bean)	T	T	.9
Strophostyles sp. (wild bean)		T	
Tecoma radicans (trumpet creeper)			T
Citrullus citrullus (watermelon)		T	
Vitis sp. (grape)	.2	T	TT

Food items	Average percentage 1937-38	1938-39	1939-40
Helianthus sp. (sunflower)		T	
Liliaceae (lily)		T	
Uniola sp. (spangle grass)		T	T
Ceanothus americanus (N. J. tea)		T	TT
Rhynchosia sp. (Rhynchosia)	T		
Snails	T	T	TT
Paspalum sp. (paspalum)	.4	T	T
Sida spinosa (Indian mallow)	T	T	T
Psoralea pedunculata (Congo root)	T	T	.2
Parthenocissus quinquefolia (Va. Creeper)		T	T
Scleria sp. *oligantha* (?) (nut rush)	T		T
Scleria ciliata (nut rush)	T	T	T
Callicarpa americana (beautyberry)	T		
Polygonum sp. (knotweed)	T	T	TT
Acer spp. (maple)	T	TT	.1
Andropogon virginicus (broomsedge)		TT	TT
Aristida sp. (wire grasses)			TT
Ascyrum hypericoides (St. Andrew's cross)		TT	
Carduus sp.			TT
Cephalanthus occidentalis (button bush)		TT	
Cyperaceae spp. (sedges)		TT	TT
Ilex sp. (holly)			TT
Iva sp. (marsh elder)		TT	
Lamium amplexicaule (dead nettles)		TT	
Lathyrus spp. (vetchlings)		TT	
Carpinus caroliniana (blue beech)			TT
Totals	100.0%	100.0%	100.0%

T = trace of less than 0.1 per cent in summary but indicates that the item was 1.0 per cent or more of one or more crops.
TT = trace of less than 1.0 per cent in all crops analyzed.

A study of Table 2 reveals that foods consumed during the three seasons fall into five groups according to importance as determined by volume eaten. The group of first importance consists of four foods. These foods appeared each season and comprised 71.4 per cent of all the material analyzed the first year, 71.7 per cent the second year, and 61.9 per cent the third year. They are, in order of consumption: annual lespedezas (*Lespedeza striata* and *L. stipulacea*), acorns (*Quercus* spp.), soybeans (*Soja max*), and cowpeas (*Vigna sinensis*). The group of second importance is made up of only two genera: beggarweeds (*Desmodium* spp.) and partridge peas (*Chamaecrista fasciculata* and *C. nictitans*). These two were utilized by quail to the extent of 1 per cent or more each season. The group of third importance embraces a total of sixteen items, exclusive of insects, all of which were eaten to the extent of 1 per cent or more of the total during only one or two years out of the three studied. They are ground nut (*Glycine apios*), ragweed (*Ambrosia elatior*), corn (*Zea mays*), sorghum (*Sorghum vulgare*), bullgrass (*Paspalum boscianum*), dogwood (*Cornus florida*), wild bean (*Strophostyles helvola*), black locust (*Robinia pseudoacacia*), black gum (*Nyssa sylvatica*), perennial lespedeza (*Lespedeza virginica* and others), woolly croton (*Croton capitatus*), sweet gum (*Liquidambar styraciflua*), pines (*Pinus* spp.), hickory and pecan (*Hicoria* spp.), white ash (*Fraxinus americana*), and green leaves. Twenty-nine foods are placed in the group of fourth importance, because they accounted for less than 1 per cent but more than 0.1 per cent during one or more years. An additional thirty-eight foods, the group of fifth importance, occurred only as traces because they never accounted for as much as 0.1 per cent. These two last groups, totaling sixty-seven items, were found to be of minor importance in the aggregate diet of the quail studied. They will, therefore, be given no further consideration.

From a study of the summaries for the three seasons, it would appear that the twenty-two food items included in the groups of first, second, and third importance should be given major consideration in providing wildlife foods on farms having agricultural conditions similar to the section from which crops were collected. They may be grouped according to (1) cropland species, which are: annual lespedezas, soybeans, cowpeas, corn, sorghum, and green leaves; (2) wild herbaceous species, which are: beggarweeds, partridge peas, ground nut, ragweed, bullgrass, wild bean, native perennial lespedezas, and woolly croton; and (3) woodland species, which are: oaks, dogwood, black locust, black gum, sweet gum, pines, hickory and pecans, and white ash.

Soil Conservation Service technicians must consider individual farms as complete units in developing farm plans which encourage permanent agriculture through good land-use and erosion control. On each farm dependable practices must be adapted to the slope, soil characteristics or other physical features of fields, pastures, woodlands, roads, ponds, and hedges. As a part of these practices some or all of the twenty-two important food items must be established and maintained, if they are to contribute to better farm management.

This is not so difficult as it first appeared. Annual lespedezas, soybeans, cowpeas, corn, sorghum and green leaves are produced extensively in crop rotations. For example, corn or cotton followed by small grain or winter cover crops, small grain followed by lespedeza, and lespedeza followed by corn interplanted with soybeans or cowpeas are planted in alternate contour bands or strips of uniform acreage on sloping fields. These bands are moved up or down the slope every few years, but good farm management demands that the amounts of each crop remain constant. Sorghum is sometimes planted on one or more units where it is necessary to supplement or increase livestock feeds. Annual lespedezas are included in seeding mixtures for pasture development. Permanent cover on the edges of fields and on streams through pastures makes the waste from such crops available to quail year after year.

Eroding field borders, which are used as turn rows, and isolated gully areas are permanently protected by seedings of a perennial lespedeza. *Lespedeza sericea* has been used with remarkable success in re-employing these sites, so to speak, in the interest of wildlife. Field borders parallel to cultivation are seeded with an annual lespedeza.

Where these improved farming practices do not provide foods in the quantities or locations desired, they may be produced in wildlife food patches. Such food patches of annual plants are usually undesirable because of their poor erosion control value and the cost involved.

The ground nut, woolly croton, the native perennial lespedezas, partridge peas, wild bean, and bullgrass respond well to disking rotations on idle areas. These plants are ordinarily found most abundantly in lands which are idle because of misuse, but this is a land condition which will no longer exist on well-planned farms.

The oaks, dogwood, black locust, hickory, pecan, black gum, sweet gum, pines, and ash are available from the woodlands, and they are made more useful by considering their wildlife values in connection with forest plantings and management. Plantings of black locust, usually limited to 2 or 3 acres, designed primarily for fence-post production, extend availability of black locust as food and nesting cover. Foods produced by dogwood and other small trees or shrubs can be increased by planting and protecting them on woodland borders, in fencerows, hedges, and for the control of certain gullies. Other shrubs, such as blackberries, which provide summer foods, can be increased in the same places.

SUMMARY

1. A total of 1,835 quail crops was saved by hunters from eleven contiguous counties in northern Mississippi during the hunting seasons of 1937-38, 1938-39, and 1939-40.
2. Contents of the crops were analyzed and the data combined into county summaries by years.
3. The county summaries were combined each year because all had similar agricultural conditions.
4. A total of twenty-two items was found to constitute the bulk of foods during the three years; sixty-seven additional foods, exclusive of insects, were found in small quantities only.
5. The twenty-two species are given special consideration in connection with their adaptability to practices of crop production, pasture improvement, field border and gully control, wildlife areas, and woodland management which are needed for soil conservation on individual farms.

IS WILDLIFE MANAGEMENT PRACTICAL NEAR POPULATION CENTERS?

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Ohio is divided into seven wildlife districts. The various districts of the State offer problems peculiar to each section. One of the most difficult problems presented was that of producing a wildlife crop in the heavily populated district of northeastern Ohio. This section of the State is industrial and includes in a small radius such cities as Cleveland, Akron, Youngstown and Canton. The hunting pressure is heavy; hunting territory is limited and the game crop is insufficient to meet the demand.

The rural population is extremely dense and the farms are small. High land values, high taxes and high operating expenses on small farms result in an attempt to utilize every acre. This paper attempts to show that changes in land-use, favorable to wildlife, are practical under such conditions.

The material for this paper was secured on the 1,576-acre Stewart Lake Game Management Area in Portage County in northeastern Ohio. This area, located between Cleveland and Akron, was established in June, 1937, as a demonstration area in wildlife management with twenty-three landowners cooperating. It is located in the glaciated Appalachian plateau and is dotted with morainic swamps and potholes. Farms average 68 acres in size and the soils are silty clay loam and sandy loam derived from glacial sandstone and shale. Some muck land is present.

Farming practices are greatly influenced by the soils and climate in this region. Soils are very acid and require heavy applications of lime to grow legumes. A growing season of less than 150 days limits the profitable production of some crops important to wildlife, particularly corn grown for grain. Thus corn and legumes which are associated with large wildlife populations in other sections of the State, occur in limited quantities in northeastern Ohio. Other crops grown are wheat, oats, soy beans, buckwheat and native grasses for hay. As dairying is the predominant type of agriculture, all crops are harvested cleanly and all land not cultivated is heavily grazed.

Summary of Wildlife Management Practices — General wildlife management practices were followed. Those mentioned herein were found to be most successful and produced the greatest returns for a given amount of effort.

Management efforts were concentrated on the numerous swamps and potholes which, when undisturbed, are invaluable as winter, nesting and roosting cover. Cover development consisted primarily of restriction of grazing in swamps. Small earthen dams were constructed to maintain the water level of these swamps. The improved growth of swamp vegetation which resulted provided nesting cover for large numbers of ducks and muskrats. It provided ideal winter cover where ringneck pheasants, rabbits and other wildlife sought shelter.

To provide a constant supply of food for critical periods numerous food patches were planted throughout the area. Food patches adjacent to swamps were most productive and supported large populations of wildlife species, including pheasants, quail, ducks, rabbits, fox squirrels, raccoons, muskrats, woodchucks and numerous small rodents and song birds. Corn was the preferred food and after the first year was the only grain planted. Several thousand trees and shrubs of value as food and cover to wildlife were planted along fence rows and in waste areas.

Five wildlife safety zones were established to provide an area of escape from hunters. Swamps were usually utilized as safety zones because of the cover and the natural boundary which lessened the possibility of violation by hunters.

To encourage natural propagation farmer vigilance in locating and saving game bird nests from destructive farming operations was urged. In 1938 this vigilance was rewarded with the saving of thirteen pheasant nests and of these ten were successfully hatched. A brood census taken in August, 1938, resulted in the observation of 30 broods with a total of 198 pheasant chicks (6.6 chicks per brood). As pheasants had never been well established in this section of the State 143 artificially propagated birds were stocked to provide initial brood stock.

Landowners in northeastern Ohio are greatly harassed by trespassing and suffer considerable property damage from careless and reckless hunters. The farmers of this area were quite willing to follow wildlife management practices in return for the protection which this plan afforded them. Once the plan was in effect many other advantages were recognized which helped to convince them further of the value of such a program.

Method of Harvesting—The Ohio plan of operating controlled hunting was reported at the Conference by Benjamin in 1939. This area was divided into five districts of approximately 300 acres each by means of easily recognized boundaries. This method facilitates placing and checking of hunters and makes possible securing accurate records of the harvest in each district. A record of all wildlife killed, crippled and observed was obtained by means of a questionnaire on the hunting permit tag. A record of all fur bearers trapped was secured from the landowners or persons who had trapping permits.

Some regulations which influence the wildlife harvest should be mentioned. The quail is a song bird in Ohio. Squirrel and ruffed grouse were protected on this area and night hunting for raccoon, skunk and opossum was prohibited. Woodchucks were protected until 1939 to increase the number of burrows for other wildlife and are not included in the kill. A season limit of one cock pheasant per hunter was enforced on this area. The wildlife harvest represents only the harvestable surplus at best and in some cases (fur bearers) the surplus was not taken.

Harvest Results—In 1938, 988 pieces of fur and game were harvested from this area. No hunting had been permitted the previous year and this year was exceptionally wet. In 1939, a total of 614 pieces of fur and game was harvested. This was an unusually dry year and many of the smaller swamps dried up, particularly where no effort had been made to conserve the water. Consequently the take of muskrats and waterfowl was greatly reduced.

Recreation — As stated before, the privilege of hunting is highly prized in this section of the State near population centers, especially by the hunter in the low income bracket who can not afford a trip to the better game country. Consequently this area was very popular despite a lack of publicity and many hunters were turned away. A limit of one man per 40 acres per day was adhered to throughout the season. In 1938, 336 hunter days were permitted, 147 for waterfowl and 189 during the 9-day season on upland game. In 1939, 250 hunter days were permitted, 60 during the waterfowl season and 190 during the 10-day season on upland game (6 days for pheasants). The average hunting day lasted three hours in 1938 and 4.3 hours in 1939. The average daily bag per hunter was 1.65 pieces of game in 1938 and 1.6 in 1939.

Economics of Wildlife Harvest—A common criticism of many conservation practices is the cost involved. Figures from the Stewart Lake Area indicate that wildlife management practices on this area are self-sustaining if not actually profitable and meet the criteria of economic feasibility.

In 1938, managed swamps yielded 444 pelts with a value of more than $350.00. In 1939, 242 pelts were taken with a value of $275.00. The trapping program was not as extensive as it could have been. No effort was made to trap the upland fur bearers (skunk and opossum) due to the relative ease with which muskrats could be taken and because of the low price. A few small and isolated swamps were not trapped.

Seventy acres of swamp land yielded $350.00 worth of fur or $5.00 per acre in 1938. In 1939 the same area yielded $275.00 from fur or $4.00 per acre. Fees from hunting permits at fifty cents per day totaled $125.00 in 1938 and $100.00 in 1939. This income averaged

$5.50 per farm in 1938 and $4.35 in 1939.

Landowners on the area expressed the opinion that the hunting fee repaid them for their investment in wildlife management and that the income from the fur crop which was produced concurrently with the game crop represented a profit from the submarginal land on their farms. The average annual gross cash income is $868.00 per farm in Portage County or approximately $12.50 per acre. Hence the fur income from the submarginal land compared favorably with the net income from cultivated land.

SUMMARY

The data from this area represent only two years and do not justify conclusions. They are summarized to indicate possibilities and trends in northeastern Ohio.

1. Wildlife management as practiced on this area is compatible with good farming and is acceptable to farmers.
2. The optimum of wildlife management was achieved on this area by managing swamps, planting food patches adjacent to swamps and saving game bird nests. A more intensive program might evoke the law of diminishing returns.
3. These practices produced a harvestable surplus of wildlife great enough to satisfy farmer and sportsman. The yield per square mile was 406 pieces of fur and game harvested in 1938 and 249 pieces in 1939.
4. The proximity of population centers created a demand for this surplus and provided a ready market which repaid farmers for their efforts.
5. The income from the fur crop represented profit to the farmers.
6. This income was great enough to justify the necessary changes in land-use.
7. The net income per acre from submarginal land compared favorably with that of farmed land.

TABLE 1. HARVEST STATISTICS FOR STEWART LAKE GAME MANAGEMENT AREA FOR 1938 AND 1939

Year	Number of hunter days	Rabbits	Pheasants	Ducks	Other waterfowl	Muskrat	Mink	Opossum	Raccoon	Skunk	Other furbearers	Total number of pieces of fur and game	Acreage of S. L. area	Acres per piece of fur and game
1938	336	412	57	55	20	431	1	5	1	2	4	988	1,576	1.57
1939	250	320	29	22	1	237	1	0	0	2	2	614	1.576	2.56

WILDLIFE MANAGEMENT ON COAL STRIPPED LAND[1]

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Worked-over strip mines constitute a recently created biological habitat. More than 90 per cent of the present area of about 150,000 acres has been stripped, chiefly for coal, since 1920.[2] This acreage does not include the open-pit iron mines of Minnesota or the thousands of excavations made for clay or other materials throughout the country. The strip-mine habitat lies for the most part in Illinois, Indiana, Kansas, Missouri, North Dakota, and Ohio, but at least twelve other states have coal stripping operations of some importance.

This newly created land type has never been considered in any comprehensive land-use program.

Strip land offers both terrestrial and aquatic habitats, usually about 80 per cent land and 20 per cent water. These areas, during the last decade, have been found useful for forest, game, fish, and fur production; for recreational uses such as camping, picnicking, boating, swimming, and skating; and for grazing. In that recreational land is scarce on the central prairies, Indiana, Illinois, Kansas, and other states have met this problem in part by utilizing stripped land for state-owned public parks.

The physical features of the stripped habitat are especially characteristic. In the mining process, the top soil is usually buried deeply under great, parallel ridges of raw subsoil, shale, and rock. As laid down by the gigantic steam shovels, the ''spoil-bank'' peaks may be 60 feet above the valleys, but ordinarily this distance is only 20 or 30 feet. The horizontal distance between peaks averages 30 to 50 feet, but may be 100 feet or more. Slopes of 60 per cent are common. Settling is most pronounced the first year or two after mining, during which time the compactment may be a vertical distance of 2 to 3 to several feet (Figure 1).

The revegetational aspects of stripped land have been ably studied in Illinois by McDougall (1918, 1925) and Croxton (1928). McDougall, interested in plant succession on artificially bared areas, reported on both herbaceous and woody plant invasion. Croxton, on a representative area, determined that excessive acidity caused very probably by the disintegration of iron pyrites (FeS_2) exposed in stripping was a principal factor in retarding revegetation. The pres-

[1]The writer is indebted to Dr. D. H. Thompson and Dr. R. E. Yeatter of the Illinois Natural History Survey for suggestions and certain original data use in this paper.

[2]Compiled from information supplied by various state geological survey reports and by correspondence with authorities. Dr. L. C. McCabe of the Illinois Geological Survey and James W. Bristow, Secretary, Illinois Coal Strippers' Association, were very helpful in this respect.

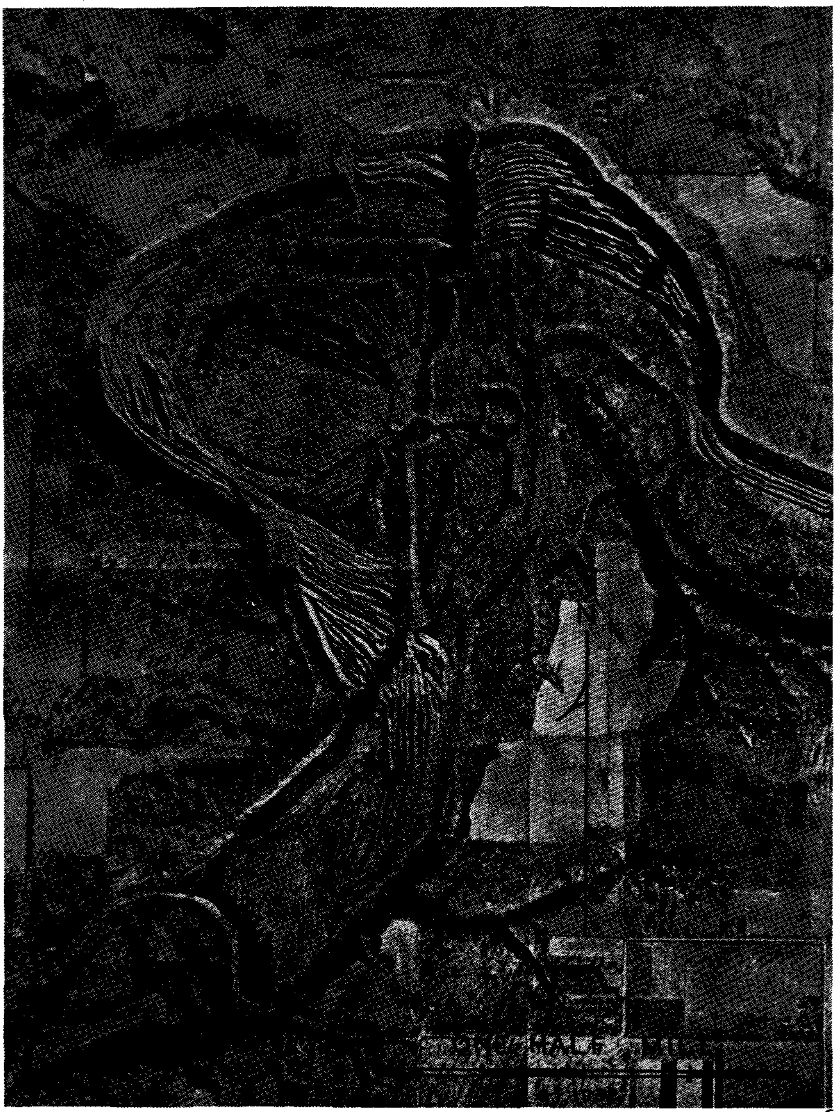

Figure 1. Air view of a typical stripped area, Vermilion County, Illinois. Worked-over lands from top to right center range from one to more than fifty years old. Photo by U. S. Army Engineers.

ent writer has observed that erosion, due both to high-velocity runoff down the steep slopes and to spring landslides, is important in retarding the invasion of plants or even in destroying a limited amount of established cover.

Tree species first invading the mine habitat are cottonwood, willows, maples, elms, and sycamore, undoubtedly because these seeds are abundant and largely wind disseminated. Others commonly seen in the early stages of succession are ash and box elder. Persimmon and sassafras, probably seeded by animals, are common in the more southern latitudes. Common shrubs include elderberry, sumac, roses, hawthorns, and dogwoods. The common vines are trumpet creeper, wild grape, smilax, and moonseed. Blackberries and other brambles are often common around the mine borders and on the more fertile slopes and valleys.

In Illinois and other central states the first important upland herb invader is white sweet clover. This species seems to grow everywhere except on the more acid peaks, and reaches a height of 6 feet or more on favorable valley sites. It serves to control erosion, build up the soil, and provide food and cover for birds, rabbits, and muskrats. Other early invading herbs include certain smartweeds, wild lettuce, foxtail grasses, ragweeds, mustard, and various mints, composites, and other grasses.

Aquatic plants invade the habitat more slowly than land plants. Cattails are the first important species to appear, again probably because the seed are abundant and easily spread. Quite extensive cattail stands may occur within two or three years after mining. Other species appearing within a few years are musk grasses (Characeae) and waterweed (Elodea). In most Illinois mine waters it has been found that a wide variety of aquatics grow when planted, the list including white and yellow water lilies, duck potato, reed grass, bulrushes, bur reed, wild millet, sago pondweed, and several other *Potamogetons*. Strip-mine lakes, especially at first, are singularly free of plant debris and animal wastes or remains, and probably for this reason seldom support duckweeds or other species requiring rich concentrations of organic materials in solution.

There is ample reason to believe that most strip-mine habitats will support plant and animal life as they become biologically mature.

The wildlife species known to live on or to use the habitat include all native forms, although squirrels occur only on the older mines where forest cover has been well re-established. In Illinois, the list of game and fur animals includes quails, pheasants, shorebirds, waterfowl, rabbits, muskrats, minks, opossums, weasels, skunks, foxes, and raccoons. Raccoons seldom den on the areas but range freely over the marsh lands. In numerous instances heavy *Microtus* populations occur on sites having herbaceous cover, a condition adding greatly to the suitability of the range for predatory species. Woodchucks, on older mines, are often abundant, and serve usefully in providing ground dens. Rabbits make wide use of these holes during severe weather. A variety of passerine birds are found; herons frequent the older water areas; and raptors both forage and nest on appropriate parts of the habitat. The waters have been found chemically suitable to large-mouth black bass, crappies, bluegills, and bullheads, but during the first years, growth may be slow because of low water fertility and resultant food deficiency.

Populations, including game birds, rabbits, fur animals, and other wildlife, as well as vegetation, are generally thin during the first years after the completion of mining. As time passes, strip mines become progressively revegetated except on highly acid or adverse sites, support more wildlife, and in gradual stages approach a normal condition. The poor quality of the initial mine habitat is reflected, as stated, by sparse plant and animal populations, and the difference in the rate of improvement on given mine sites is probably due chiefly to the difference in soil fertility. Naturally the more fertile areas, whether due to the liberation of plant nutrients unavailable previous to mining or to the retention of a part of the top soil, show the most rapid rate of biological recovery, which, in all cases, is more or less influenced by slope, exposure, and other factors.

On the black prairie region of Illinois limited sampling indicates that the older mines (15 to 30 years or more) may hold larger game populations than the adjacent farmland. The following table is illustrative:

TABLE 1. COMPARISON OF GAME POPULATIONS ON "OLD" COAL-STRIPPED LAND AND FARMLAND

Area	Acres	Man Hours	No. of Game Flushed			No. of Game Flushed per man-hr.		
			Rabbits	Quails	Pheasants	Rabbits	Quails	Pheasants
Strip mines	467	59	101	58	17	1.7	1.0	.3
Farmland	1,580	92	91	74	27	1.0	.8	.3

Although the trend indicated in the table seems to characterize the comparative density of game populations on the prairies, the opposite is believed to be true in southern Illinois. Here, the river breaks and scattered agricultural lands undoubtedly hold quails and rabbits in numbers exceeding local strip mine densities.

The problems of management on mine lands appear to be the acceleration of plant successions so as to produce suitable habitats in a shorter time than nature can do it alone, and to maintain such areas in a productive state. Of the common management practices, reforestation is the only one having what may be called a background of experience. In Indiana, Illinois, and other states there are now a number of forest plantations, up to perhaps fifteen years old, on worked-over mine land. A good many of these plantations are thrifty. The chief species used to date are black locust, white ash, hackberry, black and white oaks, yellow poplar, and Scotch, red, white, and shortleaf pines. Black locust grows well the first few years, but older plantations may be badly damaged by the locust borer. Wild plum has been planted extensively and this shrub seems to thrive on the mine site.

Just what these plantations will ultimately amount to is not known. The average mine is a low-quality planting site, at least for most of the more valuable commercial species. It would seem, therefore, that commercial timber growth would not be especially good, and that the wood produced would not be of especially high quality. Considerable time is likely to be required to build the site into high producing capacity. It is apparent, however, that woody cover can be re-established, and that this step in converting stripped lands into suitable wildlife areas can be practically achieved. Over a very considerable part of the mine habitat at least moderate game bird, rabbit, and certain fur animal crops can be produced during the pre-forest successions. After the reestablishment of forest cover game birds, at least, will finally give way to timber-inhabiting species, such as squirrels and raccoons. The water areas, in general, should show steady improvement as waterfowl, aquatic fur animal, and fish habitats. And edaphic conditions would approach the normal forest site in time.

Another management practice that seems to be needed is the provision of dens or nests, for strip mines are barren of logs, stumps, and hollow trees. Mines adjacent to timber tracts probably do not feel the shortage of dens so acutely, but many are on the open prairie where no natural tree cavity dens are available. Squirrels, raccoons, opossums, and certain owls especially would make use of properly placed nest boxes and den logs; and it is probable that wood ducks could be attracted to some of the strip-mine lakes if nesting places were provided.

Uncontrolled burning and grazing have been found to have the same injurious effect on strip-mine wildlife as on wildlife in other habitats. Both of these bad practices have been studied in Illinois, and it is known that unburned, ungrazed areas supported quails, pheasants, rabbits, muskrats, minks, and other fur animals, while the grazed and burned areas held little game or fur, and almost no forest reproduction. It is believed that very light grazing may be allowed, especially if most of the water areas were fenced.

Mining practices designed to leave stripped lands in better physical condition is a subject which cannot be discussed adequately here. For wildlife, the shortage of water is probably the major shortcoming of the mine habitat. The loss of most of the top soil, abnormal terrain, and excessive acidity are factors which profoundly affect revegetation and therefore biological recovery. The latter can hardly be avoided since it would require literally a sifting of the entire mining debris to remove the chief source of the acid, iron pyrites. It would seem that water areas could be increased by building dams at strategic points, which, with the heavy machinery used, would be a small operation. Many such dams could be made during the mining process by choosing the proper points for redepositing the soil.

Leveling and recovery of the top soil are controversial subjects. It is known that even partial leveling, by a separate operation, costs $12.00 to $20.00 per acre, being therefore too expensive for practicality. The development of mining techniques that will result in a less broken topography, and insure the recovery of a larger percentage of the top soil, are believed worthy of consideration.

Stripped lands are obviously difficult to hunt, both because of their rough terrain and because of the frequent impossibility of shots from the valley position. Tall vegetation at times adds to shooting difficulties. Hunting stripped land calls for great physical exertion on the part of man and dog. The latter often cannot be seen for long distances or from many positions. Such upland shooting as may be afforded requires more than average shooting skill. Fishing, duck hunting, fur production, timber production, and various forms of recreation are likely to be the major uses made of the mine habitat.

It has been demonstrated repeatedly that pheasants and quails fly into stripped lands when hunted on adjacent farmed or wooded areas. It is therefore apparent that the sanctuary value of strip land, especially in heavily hunted districts, is considerable. Over a limited part of the more intensively farmed prairie these mine lands may offer a ready made system of refuge areas.

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REGULATED PRIVATE SHOOTING PRESERVES IN CONNECTICUT

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In 1933 the Connecticut Board of Fisheries and Game inaugurated a program for the establishment, under regulations, of areas known as private shooting preserves. The application of the principle of private shooting preserves to meet Connecticut conditions and the regulations for management were planned under the direction of Arthur L. Clark while Superintendent of the Department. The drafting of regulations for the management of these preserves was governed by the desire, first, to protect the public interest; second, to benefit open shooting; third, to encourage the propagation and liberation of more game birds in Connecticut; and fourth, to provide a method by which individuals or clubs could obtain good pheasant shooting on highly developed private areas with a reasonable chance of a fair return in relation to the time and money expended.

REGULATIONS

1. The area must be suitable for the purpose and shall not conflict with a reasonable prior public interest.
2. Regulations apply to pheasant shooting only.
3. *Acreage requirements*—A minimum of 500 contiguous acres is required with a maximum of 1,000 acres per area and not more than 5,000 acres per county.
4. *Boundaries and posting*—The boundaries in so far as possible shall extend to natural boundaries such as roads, railroads, streams, etc. To avoid unintentional trespass the area shall be adequately posted with signs of standard size and wording.
5. *Required liberation and length of season*—The shooting season is confined to the regular open season for pheasants (October 20 to and including Thanksgiving Day) if the liberation is carried out at the rate of 1 bird for each 4 acres in the preserve. If, however, pheasants are liberated at the rate of one bird per acre, shooting is permitted from October 1 to February 28, inclusive. The total yearly liberation shall be made in the ratio of not less than 1 cock to 5 hens.
6. *Bird-credits for game management*—Allowances in lieu of liberating birds are given, after inspection, for game management practices carried out on the preserves. Information obtained on the results of these game management practices can be applied by the Department to the management of public shooting areas.

7. *Kill restrictions*—The birds which may be killed is limited to 70 per cent of the number liberated. The bird-credit allowances given are considered as birds liberated in figuring the number that may be killed. There is no restriction on the sex of birds to be killed or the daily bag limits.
8. *Time of liberation*—Birds must be liberated one day in advance of a day when shooting is being done on the preserve. This regulation prohibits the liberation of birds as "live-targets." An exception is made for duly authorized field trials.
9. *Identification of kill*—All pheasants shot on the preserve must be tagged, not later than one hour after sunset on the day killed, with sealed, numbered tags which cannot be duplicated or used more than once. These tags must be purchased from the Department for which a charge of ten cents per tag is made.
10. *License fee*—In lieu of a license fee for the permit to operate, an annual rental fee of ten dollars ($10.00) is made for a tag sealing device.

    All monies collected as rental of tag sealing devices and the sale of tags used to identify birds killed on the preserve is received by the State Board to be used for the protection, preservation and propagation of game. Since the preserves were established, $890 has been realized from the rental of tag sealing devices and $1,785.10 from the sale of tags, making a total of $2,675.10 in revenue received from the preserves.
11. *Permit and license requirements*—The permit to operate and shoot on the Preserve must be secured from the Board each year in advance of the shooting season. Reasonable proof is required that all requirements have been satisfied. A game breeder's license is required in addition to the permit to operate. A hunting license is required of all who shoot on the preserve. Permits are subject to revocation at any time for violation of the game laws or of the regulations.
12. *Records and reports*—Accurate records of the number of birds raised or purchased and liberated together with the dates of liberation, the number of hunters and the number of birds killed each day are required. These records are open to any duly authorized agent of the Board at any reasonable time. Within thirty days after the close of the season a copy of these records, together with any other information requested, is filed with the Board by the permit holder.
13. *Revision of regulations*—Regulations are subject to reasonable revision at the option of the Board and such revision may be effective ten days after written notice has been sent to each person holding a permit.

The private shooting preserves have carried on operations under widely different methods and with varying degrees of success. Most of the preserves employ a game keeper. Seven of the twenty areas, that have been in operation, have propagated the birds used. In some cases surplus birds raised have been sold to help defray the cost of operating. Thirteen areas have used birds purchased from commercial game breeders. All of the areas have carried on some form of game management practices and bird-credits allowed for these practices have ranged from a low of 15 to as many as 400 birds. Many of the preserve owners have never asked for bird-credit allowances and have been willing to liberate the full quota of birds required. In many instances more birds were liberated than is required. The methods of operating vary from year to year to meet changing conditions, correct mistakes that have been made in the past or to try out some new theory in an attempt to obtain more efficient results. It would be impractical to enter into a lengthy discussion at this time on how each individual preserve has operated from year to year. Regardless of the different methods of operation, the number of birds killed in relation to the number of birds liberated, compiled over a 6-year period does provide some valuable information.

The private shooting preserves in Connecticut fall into three general classifications:

1. Those operated by one person or a few individuals for their own enjoyment and that of a limited number of guests.
2. Those operated as a club with limited membership.
3. Those operated on a purely commercial basis.

Of the twenty different areas established since 1933, seven have been operated by individuals, nine by clubs, and four commercially. Two new preserves were started during the 1939-40 season, one operated by an individual and the other on a commercial basis. Only five areas have discontinued operation, of which one was operated by an individual, two as clubs and two commercially.

TABLE 1. SUMMARY OF REGULATED SHOOTING PRESERVE RECORDS

Season	Number of Preserves Operating	Total Acreage	Number Operating During Regular Season	Number Operating During Extended Season	Total Liberation	Total Kill	Per Cent of Kill
1934-35	9	4,522	1	8	3,918	1,252	31.9
1935-36	13	6,770	1	12	6,779	2,506	36.9
1936-37	14[1]	8,046	3	11	7,576	2,868	37.9
1937-38	17[2]	9,986	2	15	8,034	3,433	42.7
1938-39	15[3]	9,040	4	11	7,491	3,086	41.2
		38,364			33,798	13,145	38.9

[1]One preserve discontinued operations the following season.
[2]One preserve discontinued operations the following season.
[3]Three preserves discontinued operations the following season.

Since the preserves were established in 1933 up to and including the 1938-39 season, a reported total of 34,566 pheasants have been liberated. The total reported kill was 13,314 birds or 38.5 per cent. The preserves established in 1933 were started too late in the season to make their first year's records comparable with the following years so they have been omitted from all tabulations. Liberation figures refer only to those birds actually liberated and do not include the bird-credits that were given for game management practices.

Table 1 summarizes the regulated shooting preserve records for the past five years.

Table 2 shows the total reported liberation and kill of the seven preserves operated by one person or a few individuals. Taken as a whole these preserves carried on the most extensive game management practices. The low percentage of kill shown by preserves 1, 4 and 7 is believed due to the relatively small hunting pressure.

TABLE 2. TOTAL LIBERATION AND KILL RECORDS FOR PRESERVES OPERATED BY INDIVIDUALS

	Number of Years Operating	Total Liberation	Total Kill	Per Cent of Kill
1.	4	2,263	343	15.1
2.	4	4,204	1,431	34.0
3.	3	895	367	41.0
4.	3	1,260	239	19.0
5.	2	1,523	775	50.8
6.	2	633	166	26.2
7.[1]	1[1]	510	78	15.3
	19	11,288	3,399	30.1

[1]Discontinued operation.

TABLE 3. TOTAL LIBERATION AND KILL RECORDS FOR CLUB OPERATED PRESERVES

	Number of Years Operating	Total Liberation	Total Kill	Per Cent of Kill
1.	5	2,777	1,014	36.5
2.	5	1,843	866	46.9
3.	5	3,061	1,509	49.3
4.	5	864	225	26.0
5.	4	2,159	1,079	49.9
6.	4	1,859	747	40.1
7.	2	793	338	45.1
8.[1]	2	919	187	20.3
9.[1]	1	175	34	19.4
	33	14,450	5,999	41.5

[1]Discontinued operation.

TABLE 4. TOTAL LIBERATION AND KILL RECORDS FOR COMMERCIALLY OPERATED PRESERVES

	Number of Years Operating	Total Liberation	Total Kill	Per Cent of Kill
1.	5	4,192	2,700	64.4
2.[1]	4	1,998	533	26.7
3.[1]	3	1,258	265	21.1
4.	1	612	249	40.7
	13	8,060	3,747	46.5

[1]Discontinued operations.

Table 3 shows the total reported liberation and kill of the nine preserves operated by clubs.

Table 4 shows the total liberation and kill of the four preserves operated commercially.

Table 5 presents a comparison of the total liberation and kill of the three different classes of operations.

TABLE 5. COMPARISON OF THE TOTAL LIBERATION AND KILL OF THE THREE DIFFERENT CLASSES OF OPERATIONS

	Total Number of Years in Operation	Total Liberation	Total Kill	Per Cent of Kill
Individual	19	11,288	3,399	30.1
Club	33	14,450	5,999	41.5
Commercial	13	8,060	3,747	46.5
	65	33,798	13,145	38.9
Birds liberated and killed during the 1933 season		768	169	22.0
		34,566	13,314	38.5

On these preserves which are operated under as favorable conditions as is possible and with no restriction as to the sex of the birds that could be taken, the highest percentage of reported kill was 64.4 per cent of the total number of birds liberated during a 5-year period. The lowest percentage of kill was 15.1 per cent of the total number of birds liberated during a 4-year period. The highest percentage of kill was made on a commercially operated preserve where the hunting pressure was great and the lowest percentage of kill was on an individually operated preserve where the hunting pressure was relatively small. On these preserves there has been an unaccounted for loss over a period of years of at least 35.6 per cent of the birds liberated and on one preserve this loss was as great as 84.9 per cent. It seems reasonable to believe that some, if not the greatest proportion of this loss, can be accounted for by the fact that these birds drift away from the preserves and help to restock the surrounding covers. Such restocking is of benefit to open shooting areas.

I do not believe that at the present time these private shooting preserves have appreciably lessened the hunting pressure on areas that are open to public shooting.

The expense of operating a preserve is more than the average hunter is willing or able to pay. The cost of shooting on a commercially operated preserve is at the present time prohibitive except for the more well-to-do class of sportsmen. In view of the relatively small percentage of kill obtained, a revision of the regulations which would provide for a decrease in the cost of operation and permit the establishment of more preserves might be advisable.

SUMMARY

1. Regulated private shooting preserves have been operating in Connecticut for the past six years.
2. Private shooting preserves, operated under the regulations cited, do not seem to be harmful to the public interest.
3. At the present time hunting on private preserves does not appear to appreciably lessen the hunting pressure on public shooting areas.
4. The variation in percentage of kill on the different types of preserves is believed due to the hunting pressure.
5. Over a 6-year period on the private shooting preserves, there was a difference between the number of birds liberated and the number killed of 21,252 birds.

It is concluded that a considerable percentage of these birds drift off the preserves and are available to hunters on areas open to public shooting.

WHY MORE WILDLIFE IS NOT PRODUCED ON AGRICULTURAL LAND

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AND

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Your attention is directed to the title of this paper—"Why More Wildlife Is Not Produced on Agricultural Lands." That means that the authors have been assigned the unenviable task of pointing out weaknesses and shortcomings in our present farm-game programs and policies.

We approach this task with apprehension, if not trepidation, and ask that you consider our expressions in the spirit in which they are offered—a sincere desire to advance the cause of conservation. Please do not think that the remarks we are about to make are our final or complete conclusions on the matter. In analyzing the situation we feel that we have a job to do and we hope that we will do it convincingly. Unqualified statements are often subject to a considerable degree of misinterpretation, but they have value, however, in throwing into bold relief points on which attention should be focused. Such positive statements can be made as the result of the study of wildlife as a supplementary farm enterprise and although they do not apply universally, yet they reveal shortcomings that are sufficiently general to demand serious consideration.

One of the most evident weaknesses of present farm-game policies disclosed by the study is the approach commonly taken by game technicians in attacking wildlife problems. It appears that as technicians, we have apparently remained too close to the problem, we have put wildlife first, last, and always.

How important is it that we reverse our position and consider the problem first from the farmers' point of view? Statistics compiled during the course of this investigation revealed that 89 per cent of the potentially huntable area of the United States is devoted primarily to agricultural uses, and as nearly as can be estimated, farm-game species constitute 85 per cent of all game killed in the entire country.

Our statistics further indicate that 82 per cent of the available food and cover for wildlife and 84 per cent of the food and cover that it is economically feasible to manage are on land devoted to agriculture.

At present game-management methods recommended to farmers often involve change in accepted farming practices. That does not come easily. As Lord Ernle, in his "English Farming, Past and Present," points out: "Changes in farming practices are always slow; without ocular demonstration of their superiority and without experience of increased profits, new methods are rarely adopted." Please note that Lord Ernle emphasizes two things—visible ocular and profitable results. The truth of his statement has been demonstrated throughout the ages.

Let us consider some of the points that we, as game technicians, have used in attempting to sell our programs, and determine whether we have been able to convince the farmer of the desirability of wildlife management. Have we been able to show him increased wildlife commensurate with the money and effort expended, or that he can make a monetary or other profit by having more wildlife?

Conservationists have contended that if he would follow certain practices, he could increase the wildlife on his property many fold, but have not told him that if and when he reached the optimum, he probably would be able to harvest not more than one unit of wildlife to every 3 or 4 acres of agricultural land. Our survey disclosed only isolated and exceptional instances in which even this low wildlife yield was realized for any considerable period. Wildlife enthusiasts have implied that with adoption of recommended management techniques. game would be abundant enough to supply the demand. We know better but hitherto have not publicly denounced such claims. We know that under present conditions no large area (county or similar unit) produces anywhere near the head of game mentioned, i.e., one unit on 3 to 4 acres. Most game commissions would be more than satisfied if each year their sportsmen bagged an average of one unit of game for every 20 acres of land in the state.

Farmers recognize the limitations on game production and they also know that it is not practicable to devote good agricultural land and labor to a crop of such low productivity and of such mobile character as game. Also, it should be remembered that we are constantly informing the farmers that they do not own the wildlife. Do you feed and groom your neighbor's dog, fertilize his lawn, or trim his rose bushes just so he can enjoy the neighborhood more?

Have we been able to demonstrate to the farmer that with reasonable cost and effort we can produce wildlife, incidental to farming activities, in any quantity that will return a profit, monetary or otherwise, without materially altering established practices? From the farmers' point of view, *NO,* otherwise the changes that have been commonly recommended would already have been accepted.

It has repeatedly been suggested that there are possibilities of the farmer obtaining adequate monetary returns from game. Some farm-game programs have even been sold on this hypothesis, yet the question remains: Is this a statement of fact that can be generally accepted?

It is evident that sportsmen cannot afford to pay the farmer several dollars a head for farm game whether on the basis of units taken or of privileges granted; yet the farmer cannot afford to put forth much effort for the small monetary return that it is logical to expect the hunter to pay. The investigators found that with few exceptions (and most of these were in communities where only extensive types of agriculture were practiced) the low productivity of game limits the possible net monetary returns to inconsequential amounts.

In practically every instance, the task of collecting compensation for game is left entirely to the farmer. This requires patrol and constant surveillance, and the receipts are almost always absorbed by the marketing costs. We have been told many times in the past, but we must now once and for all abandon the idea, that farm game constitutes a money crop for the farm, except in a very limited number of instances where the areas are favorably situated and where only extensive land-use is practiced.

Our investigation clearly revealed that the matter of incidental income to the farmer through the sale of produce and services to the sporting public is more a dream than a reality. The monetary returns that may be realized from such sources are probably more than offset by the destruction and theft of farm products by irresponsible hunters.

Sportsmen, as a further inducement to farmers to encourage the production of wildlife on their farms, frequently mention the value of game birds in the destruction of insects and weed seeds. This survey brought out clearly just how controversial this subject is and how some disinterested authorities and farmers view hunters' contentions in this matter. Game birds are not highly insectivorous, and farmers are fully aware that they will have to continue to use insecticides against insect pests and to combat weed pests, regardless of the presence of the game species. Furthermore, entomologists have pointed out that some of the practices frequently recommended in the interests of game management constitute insect hazards.

Exponents of wildlife management have repeatedly used the destruction of weed seeds by game as an argument in favor of encouraging wildlife production on the farm, but they have yet to demonstrate that bird activities actually reduce the prevalence of weeds. On the other hand, we frequently recommend the planting of weeds for the benefit of game, for example, ragweed. The two ideas, one contending that birds control weed pests, the other recommending encouragement of weeds to benefit wildlife, do not harmonize.

Let us not forget the farmer's inalienable right to the peaceful possession and occupancy of his land. We know it is the farmer's right to say who shall enter upon his farm, when they shall enter, where they may go, and what they may do while they are on his property. Usually the farmers find themselves unsupported in the enforcement of these rights. Consequently, the farmer frequently considers the increase of wildlife on his place in the same category as putting out sugar to draw flies.

The disregard of their rights by the public frequently compels farmers to forego the pleasures they might otherwise enjoy from wildlife. When wildlife is considered a liability rather than an asset, farmers are not likely to devote time or land to its production. That condition is widespread and we have so far failed to convince the farmer that his solution of neglecting game and posting his land is not the best one.

The reason that the majority of farmer-sportsmen programs have not stood the test of time is obvious. The findings of this study demonstrate that programs are sold to farmers on the basis of protecting the farmers' rights and controlling public hunting. Failure to provide the promised protection leads to collapse of the programs. The associations that have survived have one thing in common; the farmers have provided their own protection, all of which goes to prove that apparently the farmers must depend upon themselves.

We have attempted many times to superimpose wildlife management on agricultural programs where circumstances and conditions did not warrant such activities. Intensive agricultural use of the land frequently must entirely prohibit public hunting. Claims of damage to crops by wildlife are often justified, and those on the border line are made almost as impressive by the farmers' objection to gunning too close to his flocks and farmstead. In either instance, logic is on the side of the farmer.

The original question was: Why is not more wildlife produced on agricultural lands? We have mentioned what we believe are a few of the reasons.

The situation is not one that can be remedied by wishful thinking. The following suggestions, however, may be of some avail. They are not advanced as a panacea, but to show that although the present writers consider the situation serious, they do not think it altogether hopeless. They feel that perhaps we have been trying to get in by the front door when we should have been using the tradesmen's entrance; that future investigations should be made and techniques designed with a thorough consciousness of the fact that up to the present it has not been demonstrated that farm-game species are a dependable economic asset to the producer. In our investigations we found that when a logical perspective has been evidenced in wildlife-conservation programs, proper recognition has been forthcoming from those who ultimately determine the place of wildlife in our social structure: THE FARMERS.

This demonstrates that the concept of wildlife production and utilization needs to be reoriented to the extent that researchers, technicians, educators, and administrators view wildlife-conservation problems and approach their solution from the standpoint of the producer as well as that of the user.

Obviously it is up to us to fit our recommendations into prevailing agricultural practices and land-use programs.

The acceptance of this philosophy will assure the ultimate inclusion of the sound principles of wildlife management in the farming practices of the United States.

FIFTH TECHNICAL SESSION

Wednesday Afternoon—March 20

Chairman: P. A. DuMONT
U. S. Bureau of Biological Survey

WATERFOWL HABITAT MANAGEMENT

COLLECTING AND STORING SEEDS OF WATERFOWL FOOD PLANTS FOR PROPAGATION

W. F. Kubichek
U. S. Bureau of Biological Survey

During the past few years water development has been undertaken by several federal agencies. Water impoundment as carried out by the Bureau of Biological Survey is designed to restore lakes and marshes that have been drained and to improve existing areas primarily for waterfowl. The Biological Survey, in a number of instances, also manages the wildlife values of federally owned storage reservoirs developed for irrigation, flood control, navigation, or hydroelectric power. While waterfowl interests are necessarily of secondary importance on these units, such areas can become valuable feeding grounds through proper biological development. If the revegetation of impoundments and restored areas is undirected, the natural development of marsh and aquatic plants often results in domination by species that are undesirable or of low wildlife value. To avoid this occurrence, it is essential to propagate plants that give the most promise of success in and adjacent to each unit and that will be most attractive to the waterfowl species commonly found in the environs and therefore to the potential waterfowl population of the area. Inability to procure propagules with ease and economy is often responsible for the postponed vegetative improvement. As time progresses noxious species encroach upon territory well suited to the propagation of good food and cover plants; hence it is important that no time be lost in establishing the desired species by planting.

It is recognized that the use of tubers or underground stems of such species as sago pondweed, bulrushes, and duckpotatoes results in the earlier establishment of mature stands, but the cost of digging and handling such planting stock is often excessive and prohibits the planting of more than a small fraction of the area. Seeds may be gathered with much less expense of time and money, and even though seeds of some species remain dormant over one season, they will produce satisfactory stands by the end of the second growing period.

The economical methods hereinafter described of collecting and storing seeds are of course contingent upon the availability of the desired plants in relatively pure stands and in sufficient quantities.

Alkali bulrush (*Scirpus paludosus*) grows in shallow waters or on moist flats in alkaline regions from Nebraska and the Dakotas westward. By late summer the waters often recede and leave the plants on dry ground on which the usual grain-harvesting machinery can be operated successfully. Seeds of this species have been taken in large quantities in North Dakota during September and October with a grain combine slightly readjusted to handle them. A yield of 7 to 12 bushels per acre, and weighing 40 pounds per bushel was realized at a cost of $0.0063 a pound, or $0.25 a bushel, for harvesting.

In Montana a combine has been used on the ice after the marsh has frozen over; the yield was reduced owing to natural shattering of seed heads, but harvesting was economical. Seeds must be spread out thinly on a tarpaulin or smooth floor and dried thoroughly before sacking.

The more widely distributed wild millet (*Echinochloa crusgalli*) and Pennsylvania smartweed (*Polygonum pennsylvanicum*) grow on slightly higher ground and hence are more accessible to farm machinery. The time of ripening of wild millet varies with the latitude and the season. In northern Missouri, collection should be started about the first of September, while in North Dakota the seed is ready to harvest about the middle of August. Harvesting operations should begin as soon as the plants are dry, because if allowed to stand longer the seeds shatter too much for economical harvesting.

The air inlets on a combine or threshing machine must be almost completely closed to prevent this light seed from being blown out with the chaff. A good millet field often contains spots of beggarticks (*Bidens* sp.), which should be avoided, for the machine will not separate the seeds of that plant from those of millet. Wild millet seeds, averaging 12 pounds to the bushel, have been combined, dried, and stored on the Squaw Creek Migratory Waterfowl Refuge in Missouri at a cost of $0.04 a pound.

The seed heads of Pennsylvania smartweed ripen progressively, and it is impossible to get all the seeds that are normally produced, for early in September in northern Missouri mature seeds and blossoms may appear simultaneously on the same head.

A clover stripper may be used on small patches that cannot economically be reaped by combine, although this method is laborious and too slow for quantity production. In large stands the combine has proved satisfactory, although the seeds obtained are not so clean as those of millet or alkali bulrush similarly collected, since the plants are green and tough and remain so until after a good frost, making the inclusion of considerable stalk material unavoidable. This seed and stalk mixture should be dried and then screened through the smallest meshed wire cloth that will permit easy passage of the seeds. The seeds must be thoroughly dry before sacking to avoid heating and loss of viability. In September, 1939, 5,600 pounds of Pennsylvania smartweed seeds were harvested by combine on the Swan Lake Migratory Waterfowl Refuge at a cost of approximately $0.09 a pound.

Sago pondweed (*Potamogeton pectinatus*) seeds may be gathered during the latter part of September by pinching off the ripe seed heads or raking out the plants without disturbing the tubers. The seed-bearing tops must be spread out for thorough drying, after which they can be flailed and the seeds screened out or the whole put through a separator to remove the plant stems and other debris. No less than 1,600 pounds of clean seeds have been gathered in this manner on one Nebraska lake without reducing the succeeding year's growth. Sago-producing lakes with clean shorelines offer unusually easy means of obtaining seed, for the plants with the attached seeds are often washed ashore in windrows during the early fall, particularly after storms. This aggregate may be allowed to remain for several weeks for thorough drying by exposure to the sun's rays. On the Bear River Migratory Bird Refuge in Utah, 5,200 pounds of sago pondweed seeds were collected and cleaned in this manner at a cost of about $0.14 a pound. Sun-treated seeds have a slightly higher percentage of germination, but the difference does not warrant efforts to provide the solar stimulus.

Bushy pondweeds (*Naias* sp.) and wigeongrass (*Ruppia maritima*) produce small seeds borne in the axils of the leaves, and this makes extraction from the stalks impracticable. The seed-bearing plants must be gathered and spread out on a canvas to dry in order to save the seeds that may drop off during the sacking process. Both these species often grow in dense stands and, as in the case of sago pondweed, early fall wind storms frequently pile the seed-bearing stalks on the shore in windrows. Such an aggregate retains moisture for a long time

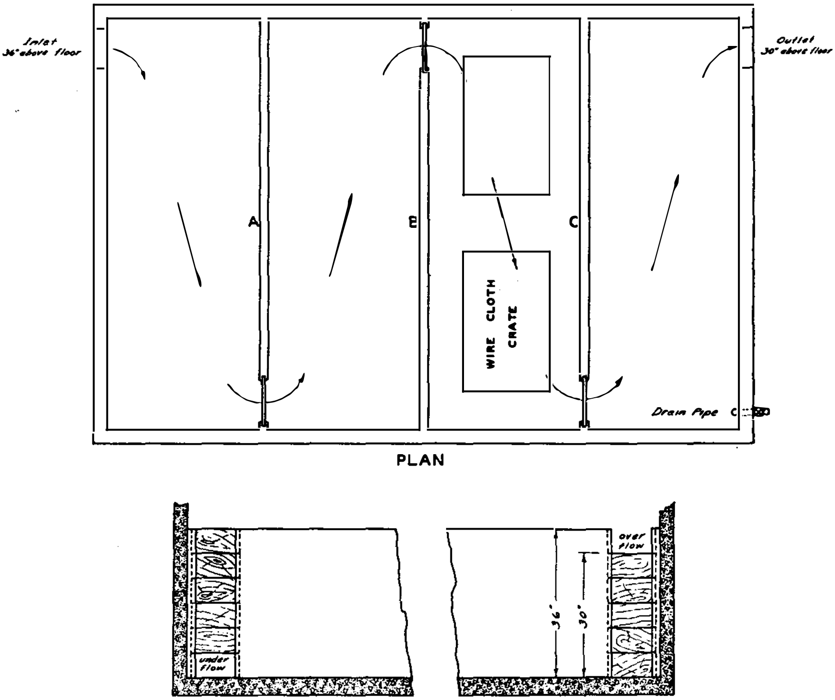

Figure 1. Construction of Cellar and Crates

and, like the hand-picked stalks, this material must undergo thorough drying before storage.

Seeds of delta duckpotato (*Sagittaria platyphylla*) and related species are easily hand-picked early in the fall. First-year germination of dry *S. latifolia* seeds has run better than 80 per cent.

Although sago pondweed, bushy pondweed, and wigeongrass are true aquatics, their seeds not only are able to withstand air drying but such treatment actually raises their percentage of first-year germination. Laboratory experimentation indicates, however, that the germination of the seeds of many species of aquatic plants is greatly retarded or seriously injured by prolonged drying.

The seeds of sago pondweed, bushy pondweed, wigeongrass, wild millet, smartweed, and sagittaria can be stored dry with no loss of viability. It is essential that these seeds be carefully air-dried to prevent heating in storage, which would result in premature germination or spoilage. Seeds should be thinly spread on a canvas or tight floor and turned frequently to facilitate drying. Under normal conditions the seeds will be ready for storage after drying for five days. The seeds should be stored in a cool, dry place and beyond the reach of rodents.

The Indian method is recommended for gathering wild rice seeds. This consists of carefully bending the stalks over a boat with a stick and with another stick lightly tapping the seed heads to remove only the mature seeds. Since the seeds ripen progressively, they must be gathered at intervals of three or four days; and if the same paths are followed, unnecessary damage to the plants can be avoided. These seeds must not be allowed to dry and should be stored in cool water within a few hours after harvesting.

For over-winter storage, excellent results have been obtained by placing the wild rice seeds in wire-cloth crates and keeping them in specially constructed cellars provided with a constant flow of cold water (Figure 1). The temperature of the water may vary from 42° to 48° F., the lower temperatures being preferable. Each crate, about two-thirds full of seeds, is elevated about 4 inches from the floor to insure the circulation of water under it and projects about 4 inches above the surface of the water. The seeds should be stirred with a paddle about twice a week and the nonviable floating seeds skimmed off. The seeds may be removed and sown as soon as the ice breaks up on the lakes. A test of wild rice seeds stored in this manner on the Arrowwood Migratory Waterfowl Refuge in North Dakota showed a germination of 89 per cent just prior to planting time.

The size of the storage cellar, which has been used successfully for five years by the Bureau of Biological Survey, is 20 by 30 feet. The floor and side walls are poured concrete. Five baffle partitions divide it into six units, each of which accommodates two screen-wire crates containing the rice seeds. The partitions are so arranged that the water must flow around and above or below alternating ends, thus creating complete circulation in every part of the cellar. Water enters at one end about 36 inches above the floor and the outlet at the other end is at a 30-inch elevation; thus a 30-inch depth is maintained in all the storage compartments. An outlet in the floor permits draining the cellar when the seeds are to be removed.

STUDIES PRELIMINARY TO A WATERFOWL HABITAT RESTORATION PROGRAM ALONG THE ILLINOIS RIVER

HARRY G. ANDERSON
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The Illinois River, a main tributary of the Mississippi, is geographically situated to serve as one of the most important single waterfowl routes along the Upper Mississippi Flyway. The average width of the valley floor is 3.1 miles and is pot marked by numerous small soft-bottomed lakes whose waters have varying densities of suspended silt. The section of the valley between LaSalle and Meredosia, Illinois, is one of the better duck habitats of the Mississippi region.

Drainage, erosion, pollution and divergence of water from lower Lake Michigan are factors that have markedly affected the original Illinois River habitat. The reclamation and drainage of bottomland has turned swampy areas into extensive cornfields which amount to several thousand acres. Erosion and turbidity are growing problems resulting in lake filling which induces better conditions for an undesirable plant succession. The pollution evil is being abated because of the rapid installation of disposal plants, but recently it was intensified along the upper Illinois River due to reduction of water inflow out of Lake Michigan. This reduction of influx of water into the river has resulted in a lower base water level along the entire length of the river, introducing serious problems in many localities.

These profound changes in the environment have progressively decreased the utility of the Illinois River Valley to waterfowl populations. Specifically, this has been accomplished through the reduction of marsh and open water area, the destruction of desired natural food and the concentration of duck populations on fewer resting and feeding grounds. The most important environmental change having a possible benefit to waterfowl is the introduction of large quantities of corn into the immediate habitat.

The southward migration of ducks through the Illinois River Valley during each of the last two years was estimated at its peak fall population to be well in excess of 1,000,000 ducks. Mallards composed 80 to 90 per cent of the total flight; black ducks, pintails, greenwing and bluewing teals, gadwalls, baldpates, shovelers and lesser scaup ducks made up most of the remainder of the flight. Puddle ducks are far more numerous than divers, a situation to be expected since there are very few large open lakes suitable for diving species.

Throughout the fall flight, the ducks are more or less uniformly dispersed in the northern, central and southern sections of the valley from LaSalle on the north to Meredosia, Illinois, on the south, a distance of 165 miles. This uniformity of distribution is probably due to a corresponding uniformity in the habitat which is almost entirely of shallow lakes and swamps, adjacent to extensive cornfields. This dispersion relieves the pressure on cultivated and native foods in any one of the three sections, especially on the none too abundant native foods.

Approximately 50 per cent of the valley formerly subject to overflow has been reclaimed by a combination of diking and pumping. The land is chiefly planted to corn. Of the remaining half, 16 per cent is now duck habitat and only a small portion of this dependably produces native duck foods. A fortunate correlation exists between the ducks and their food supply. Mallards, pintails and black ducks comprise at least 90 per cent of the total duck flight, and they feed largely on waste corn, which covers an area thirty times greater than the acreage productive of native foods. Thus, both the corn feeders and native food consumers have supplies that usually last well into the fall.

The feeding habit of the ducks using the cornfields are of special interest. Besides the mallard, pintail and black duck, wood ducks resort regularly to the cornfields. Bluewing teals may be seen in the grain earlier in the fall, but usually these early migrants make greater use of shallow marsh areas. In some localities, however, these corn feeders are content to feed on wild millet, cutgrass, pondweeds and other native foods rather than corn. In late fall, mallard flocks may be seen toward dusk circling over cornfields as much as 25 miles away from the river. As the food supply adjacent to the river is consumed, these daily flights become larger, more diverse and cover greater distances.

It is apparent, therefore, that, in order to take care of the present and anticipated larger future flights adequately, it is imperative to improve the marsh habitat along the Illinois River. This is the management program proper, and it involves such far-reaching problems as water level stabilization, close supervision of land reclamation, the production of more native food and full encouragement of soil conservation activities. Of the problems listed, fluctuating water is by far the most important, since the Illinois River is subject to great changes in water levels, both seasonally and over a period of years.

The chief injury by fluctuating water is to aquatic vegetation which is especially susceptible to the Illinois combination of turbid floods and great variation in seasonal levels. This variation at present may be 15 feet in the spring and as much as 3 or 4 feet from May to November. This degree of change plus the high turbidity characteristic of spring waters, is extremely detrimental to aquatic, semi-aquatic and low marsh vegetation.

Of the 16 per cent of the valley now suitable as duck habitat, only 2 per cent, or about 11,000 acres, is subject to any appreciable amount of water stabilization during the growing season. Through careful comparative studies of important waterfowl foods on both stabilized and non-stabilized areas, it has been possible to determine the effects of water levels thereon. Some of these findings are as follows:

1. American lotus grows best under fluctuating water conditions and is adaptable to both seasonal and gradual changes.
2. River bulrush grows about 80 per cent better under stable or semi-controlled levels than under fluctuating conditions.
3. Marsh smartweed grows about 60 per cent better under controlled water conditions.
4. Coontail is entirely dependent on stable water levels.
5. Pondweeds, *Potamogeton pectinatus* and *P. americanus* thrive about 90 per cent better under stable water conditions.
6. Cutgrass is entirely dependent on controlled water levels.

For purposes of checking field observations and determining the degree of correlation between food availability, food use and the actual importance of corn in the diet, a total of 5,000 gizzards and gullets of ducks have been collected from every important point along the river. Areas subject to both controlled and uncontrolled water conditions are fully represented. About 1,200 of these gizzards have been examined and the resulting data are applied in the following discussion.

It has been revealed that on areas subject to stabilized water conditions and seasons, such species as marsh smartweed, coontail, cutgrass, pondweeds, *Cyperus esculentus* and *C. erythrorhizos* are taken by most ducks in greater volume than corn. Areas subject to fluctuating water yielded gizzards, particularly of mallards, containing a greater volume of corn rather than native foods. The conclusion to be drawn from these statements is not only that native foods are more scarce in fluctuating waters, forcing the ducks to forage afield, but undoubtedly convenience, availability, proximity to water are important factors in influencing ducks to take native foods. Corn, especially if in or near water, is almost certainly a preferred item.

The case of baldpates and gadwalls is particularly pronounced. These ducks are known to concentrate in certain definite areas and stomach analysis disclosed them to be feeding heavily on coontail, a plant incapable of thriving anywhere except under conditions of clear and stabilized water. These concentration areas do have fairly stable water.

Controlled water levels will not solve all of the duck marsh problems along the Illinois River, since even in some of these areas certain species appear to a degree not desirable in the waterfowl habitat. American lotus is such a plant. It is so vigorous of growth and so adaptable to conditions that it may not only take over large portions of open marsh but may even crowd out the more valuable food plants. Apparently, the lotus nut is the only part of the plant taken by ducks, and in the 1,200 stomachs analyzed to date, this item has occurred but five times. Since this plant will adapt itself readily to varying conditions, stabilized water levels would not eliminate this species.

River bulrush, which is of little more value to ducks than lotus, spreads rapidly under semi-controlled water conditions. Seeds of this species are occasionally taken by Illinois River ducks, but it does not form any great part of the food. This plant, also, requires some other means of control than water level manipulations.

It is unfortunate that an appreciable percentage of the Illinois River habitat produces little waterfowl food, due to the vigorous and dominating growth of lotus and river bulrush. Practical methods of control are urgently needed.

Through food habit analysis, a fairly comprehensive list of the most important foods of ducks using the Illinois River have been determined. Some seventy species of plants have been taken from twelve species of ducks. Of this number, fifteen are readily eaten in certain localities, if available in quantity, and may be taken in preference to corn, wheat and buckwheat. These plants consist of three species of *Potamogeton,* three of *Polygonum,* three of *Cyperus,* one each of *Ceratophyllum, Leersia, Cephalanthus, Acnida* and *Echinochloa.* All would respond to a marsh restoration program designed for waterfowl habitat improvement.

In summary, the preliminary investigation has disclosed the following significant points:

1. The present condition of the Illinois River is due to drainage, erosion, pollution and divergence of water from lower Lake Michigan.
2. The Illinois River has large and generally non-productive areas capable of being restored to good marsh conditions.
3. Ninety per cent of the duck flight is composed of mallards.
4. Mallard, pintails and black ducks are heaviest feeders of corn; other species tend to concentrate on areas subject to stabilized water conditions where native foods are abundant.
5. Stabilization of water levels is the most important present step required for restoring satisfactory marsh conditions.
6. The 15 most desirable native duck foods, observed in the field and verified by stomach analysis, are generally dependent on controlled water conditions for satisfactory growth.

7. High turbidity is detrimental to satisfactory aquatic plant growth, especially of submerged species. Stabilization of water level tends to lower turbidity, but general soil conservation practice over the watershed is the final answer to this problem.

8. Practical control methods must be developed for checking invasion and growth of such dominating species as American lotus and river bulrush.

WATERFOWL MANAGEMENT ON ATLANTIC COAST REFUGES

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The fundamental principles underlying management of coastal marshlands for waterfowl are the selection of areas amenable to development of both fresh and brackish water habitats and the maintenance of optimum conditions through management practices based on waterfowl food habits and a knowledge of ecological factors affecting the food supply.

Briefly, in the development of coastal refuges, it is necessary to provide a combination of fresh and brackish feeding grounds and to make provision for water level manipulation within the impounded units. There are four types of coastal refuges, each of which presents a different management problem. These types are: (1) coastal islands; (2) shallow, brackish-water bays separated from the ocean by a barrier beach; (3) broad expanses of salt marsh, dissected by fresh-water streams; and (4) tidal marshes near the mouth of large rivers in places where the volume of fresh water is sufficient to permit a diversified growth of fresh and brackish marsh vegetation.

No single area combines all the features of optimum habitat for the species of migratory birds indigenous to the Atlantic Coast. Thus it is essential that management be concerned with providing the fundamental habitat requirements in order that a refuge may be of maximum value to the greatest number of species, particularly during emergency periods. Of course, plant associations vary with the type of refuge and its location. The specific details of management are accordingly different, but the basic principles apply equally well to each refuge type. The five principal management practices are: water manipulation, planting, vegetation control, controlled burning, and the production of supplementary food crops.

Coastal refuges are deficient in fresh-water areas, which provide the varieties of food of primary importance to surface-feeding ducks. This deficiency is being met by impounding fresh water on the inner margins of marshes or where natural depressions occur on an expansive flat by dyking the low area in such a manner as to retain surface run-off and thereby establish a permanent fresh-water pool. The ponds thus created furnish an abundance of food for surface-feeding ducks to supplement that available on the salt marshes. In addition, the fresh-water ponds provide an alternate feeding ground for diving ducks common to the Atlantic Coast. There are two phases of water manipulation: (1) the regulation of levels within impoundments for food-plant production and to permit proper utilization, and (2) the erection of temporary dykes to retain surface run-off or tide water on marsh areas to make food plants available over a longer period.

On fresh-water tidal marshes it has been possible to produce an abundance of food on otherwise unproductive marshlands by the seasonal regulation of water within dyked units. Wild millet, smartweeds, and wild rice are the species best adapted for this purpose. Where wild rice has to compete with other vegetation, it does not become established in extensive stands. By removing the competitive growth, however, and then permitting a rhythmic rise and fall of water within impounded units, good yields can be produced. In other units the water is drawn off during the early part of the growing season and the field seeded to wild millet or to a mixture of millet and smartweeds. By keeping the field moist but not flooded, a good yield of seed can be obtained. The food thus produced is made available to surface-feeding ducks by keeping the fields shallowly flooded during the fall and winter. It is not necessary to reseed the millet and smartweed unit annually, since stands of these volunteering species can be maintained by periodically disking or plowing the soil.

Although the fresh-water units impounded on marsh areas are very productive of waterfowl-food plants, they also provide an ideal habitat for such species of undesirable vegetation as cattail (*Typha* sp.) and giant cutgrass (*Zizaniopsis miliacea*). Unless controlled, these species would quickly supplant other emergent growth on the margins of the pond and also rapidly invade the shallow areas; thus they would seriously reduce the value of the impoundments. The cattail problem is being met by periodically cutting back the undesirable growth. The initial cutting should be made during the early part of the growing season prior to the formation of seed heads, and if followed by two successive cuttings, the undesirable growth can be temporarily eliminated. Considering the ease with which cattail seeds are disseminated by wind and water and the wide distribution of the species, it is obviously impossible to obtain more than local control, and cuttings must be made in subsequent seasons to prevent reestablishment of the plant.

Giant cutgrass is found in abundance on the fresh tidal marshes along the south Atlantic. Established stands are brought under control by draining dyked areas, cutting the grass and burning the tops, and plowing the soil to destroy the rootstocks. The area is then again flooded to a depth of 2 or 3 feet to prevent recurrent growth. It should be pointed out that absolute eradication cannot be obtained by one treatment and that control must be systematically followed out at periodic intervals.

Many important waterfowl-food plants, including wigeongrass, sago pondweed, redhead grass, bushy pondweed, and wild celery, reach their best development in slightly brackish water but are quickly destroyed by influx of large quantities of sea water. Brackish-water feeding areas separated from the ocean by low barrier beaches are being protected against storm tides, which would destroy the plant growth, by developing a bulwark of sand through the use of drift fences. Although the sand dunes built up in this manner may not successfully withstand coastal storms of hurricane intensity, they do resist severe storm tides.

Salt and brackish marshes produce a variety of food which is often unavailable except during the flood tides. During periods of low tide or of high off-shore winds, feeding grounds may be largely free from water for several days and thus be of little value to waterfowl. The three-square bulrush (*Scirpus americanus*), the roots of which are an important source of food for Canada geese, grows in greatest abundance on the upper limits of the marsh or on sand flats that are often free from standing water for relatively long periods. The geese are unable to puddle out the roots except when the three-square beds are flooded. For greater utilization of three-square bulrush roots, a double furrow has been plowed across the low side of feeding grounds in such a manner as to form a temporary dyke that will retain a sufficient quantity of surface water to permit the geese to feed on the rootstocks. The same practice of dyking is carried out in the fresher marshes of coastal margins where such emergent plants as smartweed and wild millet produce an abundant seed crop but which are seldom available except during periods of high water. It is necessary, however, to break these temporary dykes in the spring to avoid impoundment of water, which would tend to drown out some of the desirable food plants during the growing season.

Another important factor in coastal waterfowl management is the controlled burning of marshlands to obtain some value from such species as needlerush (*Juncus roemerianus*), which would otherwise be absolutely worthless as food. By burning dense stands of this vegeta tion late in fall or early in winter, an early growth of tender green shoots is obtained through the removal of the dead overstory, and by this means additional grazing areas are provided for Canada geese. Controlled burning is also applied to mixed stands of *Spartina patens* —*Scirpus americanus* to improve spring grazing for Canada geese and to permit the utilization of three-square rootstocks by greater snow geese (*Chen hyperborea atlantica*). Unless controlled burning is practiced, the extensive acreages of *Spartina patens* are of only slight value to waterfowl. After removing the dead grass by burning, however, the same area is intensively used by Canada geese, snow geese, greater and lesser yellowlegs, and Wilson's snipe.

Another means of obtaining greater utility of high marsh areas, which otherwise are of little value, is the development of small pools 12 to 18 inches in depth. Irregular pools up to half an acre in size have been excavated with dynamite and then planted to wigeongrass. By this means it has been possible to provide brackish-water pools on salt-marsh islands where impoundment would be out of the question.

Marsh management for the greater snow goose is a problem of no mean proportions. In feeding on the rootstocks of *Spartina alterniflora,* the snow geese extirpate the plant over large areas. In one season, a flock of 5,000 snow geese denuded about 300 acres of this grass in six weeks. As a result of their feeding activities, the general elevation of the area was lowered from 1 to 2 inches. This depression held sufficient water during the growing season to inhibit the reestablishment of this staple food plant of the snow geese. To obtain another stand of *Spartina alterniflora* it is necessary to exclude tide water by plowing a double furrow to form a temporary dyke and make provision for surface drainage. In this way seedling plants have an opportunity to become established, and the exclusion of standing water during the winter season prevents the snow geese from puddling out the rootstalks. This practice is of course limited to those areas in which drainage and exclusion of tides can be satisfactorily effected by ditching and dyking.

The reestablishment of vegetation on the denuded areas is augmented by seeding and by setting out sods. Shallowly flooding nearby three-square bulrush flats by means of temporary dykes relieves the pressure on the *Spartina alterniflora* marshes and tends to accelerate the recovery of denuded areas.

Three-square is being replaced in some parts of the marsh through natural succession. Plowing and disking have been successfully used in arresting this undesirable plant succession and in maintaining a dense growth of three-square.

The production of supplementary food crops to provide for waterfowl during emergency periods when natural foods may be unavailable is an important factor in coastal waterfowl management. The kind of crop grown is of course determined by the type of lands available for the purpose and the species for which the crops are intended. Corn and buckwheat are the principal crops planted to provide food for the surface-feeding ducks during emergency periods. Buckwheat is utilized as it stands, but corn to be made available must be broken down. The usual practice is to harvest a part of the corn crop for distribution during critical periods. Oats, winter wheat, and rye have been found most satisfactory for the production of green forage, which is extensively used by Canada geese during the winter and spring periods when natural foods are at a premium. It is essential that forage crops for geese be planted about six weeks in advance of the fall migration, thereby permitting the plants to establish well-developed roots which prevent their being pulled up by geese. The fields will thus continue to provide forage throughout the winter and will be of particular value during the spring.

It is recognized that the dynamic forces of nature are constantly at work and that the vegetation on marshlands, as on uplands, is in a state of flux. Coastal areas are subject to sudden and catastrophic changes, as attested by severe storms which have obliterated productive feeding grounds. The influence of man has destroyed or greatly modified extensive areas of marshland. If refuges are to function effectively it is essential to direct plant succession so that it will be of continuous value to the wildlife dependent upon it. The Atlantic Coast refuge program is designed to serve the indigenous species by creating and maintaining the essentials for waterfowl habitat.

RESTORATION OF WATERFOWL HABITAT IN WESTERN CANADA

B. W. CARTWRIGHT
Ducks Unlimited, Canada

Ducks Unlimited was sponsored by the More Game Birds in America Foundation; and became an actuality in 1937 when Ducks Unlimited, Incorporated, was organized in the United States. Ducks Unlimited (Canada) was incorporated in January, 1938, and commenced operations in the field on May 1st of that year. In 1938 $100,000 was made available and $125,000 in 1939.

The first essential was to secure the active cooperation of the people of western Canada. By the end of 1938, we had 3,200 key-men reporting on duck and water conditions throughout Manitoba, Saskatchewan and Alberta. Ten days after opening our head office in Winnipeg, a temporary dam was completed in the Big Grass Marsh in Manitoba and a death trap was eliminated. That same year, two permanent stop-log timber dams, each 60 feet long, were constructed. In Saskatchewan, a temporary dam was built in the drainage ditch at Waterhen Lake, near Kinistino; and this was followed that fall by a 4,400-foot earth dam with a stop-log spillway 40 feet long.

At Many Island Lake in southeastern Alberta—described by A. C. Bent as a waterfowl paradise in 1907—we rounded up 780 survivors of ducks, geese, coots and shorebirds and transported them to permanent water 20 miles away. Thousands had already died and this had been going on for eight years. An earth dam, 1,000 feet long and 14 feet high, was constructed to cut down the water area from approximately 8,000 to 700 acres. An auxiliary canal 2 miles long with timber dam control gates and a traffic bridge were also constructed. In 1939, the results were spectacular. The normal run-off filled the dam with 5 feet of water, overflowed and restored 1,000 acres of marsh. W. Ray Salt, our Alberta ornithologist, estimated an adult breeding population of 6,000 in May. The July census gave him 21,000. At Ministik Lake, 30 miles east of Edmonton, a 27,000-acre project, 8,320 rods of fencing, 15 miles of fireguards, a lookout tower and cabin for our resident project manager have been constructed. Predators have been controlled, fire has been kept out, illegal shooting and poaching stopped, haying and grazing brought under control. The results here have also been spectacular. The results can be no better stated than quoting from the letter of Mr. Wallace Mason, a Supreme Court official of the Province of Alberta, dated February 13, 1940:

> *"Dear Mr. Main: I wish to offer Ducks Unlimited my cottage at Ministik Lake for the use of anyone connected with your organization as long as you have control of the Ministik Lake Sanctuary.*
>
> *"It gave me the greatest thrill on going out there last fall with your Dr. Watson to see such vast numbers of ducks, etc., which goes to prove what a properly run and controlled sanctuary can do in regard to increasing the duck population as the flocks were far greater than they have been for the last twenty-six years. Yours sincerely, Wallace Mason."*

The results have not been quite so spectacular on Waterhen and Big Grass. Waterhen had been burning for fifteen years and many hundreds of acres of former marsh were beds of wind-blown ashes. We flooded approximately 1,300 acres, put out the fires, planted bulrush, cattails and pondweeds, built twenty islands from a borrow pit alongside the dam and planted them with willows. The remaining peat has become saturated and the stage is set for the next step in restoration. The impounded water eliminated a duck trap; and large numbers of ducks were raised. It will take several years to restore this former teeming marsh.

We suffered a water shortage on the Big Grass Marsh last year. Our dams held all the run-off; and if they had not been there we would have had a completely dry marsh. As it was, we held and still have about 1,200 acres of water in the north end of the project on which a nice crop of ducks was raised, particularly redheads.

Before I leave the construction work, I would like to give one or two samples of the smaller projects. Stalwart Marsh for instance is an ideal duck production area of about 2,000 acres which was dry in 1938. A dam 100 feet long and a spillway protected by sheet piling and rip rap were constructed. The result was a pocket edition of one of the great marshes like the Delta at the south end of Lake Manitoba. It was particularly fruitful in redheads and canvasbacks. We have several similar projects.

One of the most troublesome problems is the country where we have thousands of potholes, sloughs, and lakes from less than 1 to 100 acres, which all dry up about the same time. This is the type of country which has proved so deadly to ducks during the long siege of drought years. It is no exaggeration to say that millions of ducklings died in this type of country in the last ten years. The potholes and small sloughs run from ten to fifty per section of land. A short study of sixty-nine roadside sloughs and potholes made by myself on May 24 last year revealed an average of three breeding pairs to each pothole. The average production would be six young per pair. The sixty-nine sloughs and potholes were alongside a well-travelled highway between Saskatoon and Watrous a distance of 67 miles—roughly one slough or pothole for every mile of the way. The indicated production, assuming that six young would be the average, would be 1,236 young. This will give you an idea of the productivity of this type of country of which there are millions of acres in Saskatchewan alone. One of the reasons for the substantial increase in ducks in 1939 was because opportune rains in June kept these potholes full of water until the young were able to fly. It was touch and go throughout the season and the bulk of the crop was no sooner on the wing than the dry period set in and these waters disappeared with astonishing speed. Now the area of which I am about to speak covers 175,000 acres in the Caron district—about 20 miles west of Moose Jaw, Saskatchewan. There were approximately 5,000 sloughs and potholes here in the spring of

1939. By the end of July, only two held water. It is estimated that a duck crop of 90,000 was hatched in this area, 95 per cent of which perished before they could fly. This was one of the local areas which did not receive the opportune rains which brought off a larger percentage of the Saskatchewan crop than had been the case for some years. We have constructed twenty-five projects in this area. The acreage actually improved is about 5,000 but the projects are so placed that the ducks will not have to trek overland more than 3 miles in any direction over 80,000 acres in order to reach permanent water. The system is to drain two to five potholes into one by ditching and deepening the centre pond. In other cases a small dam across a coulee will hold permanent water 5 to 7 feet deep, or a dyke was thrown up to cut down a large flat slough to a fraction of its size. The borrow pit would hold water deep enough to last through the summer or at least until the ducks could fly to more permanent waters. Dugouts were put in on a number of sites to insure key ponds. In another case, a temporary stream which carries the flash spring run-off was diverted into a slough by ditching 700 feet, 1 foot deep and using the earth as a dyke to hold the water at a level likely to be permanent. In these ways, dugouts, dykes, dams and diversions were used singly or in combination to spot twenty-five key ponds in seven townships.

I may mention that while the work was going on we always had an interested audience of ranchers and when the contractor was through and we were wishing him "good-bye" he informed us that the neighboring ranchers had hired him to continue with the work in adjoining districts. We believe that we have here a solution to the pothole problem. It has been tried in one or two places in Saskatchewan by local farmers or ranchers with complete success. We plan to extend this treatment of the pothole type of country on an extensive scale. It is not too expensive and the dividends in more ducks promise to be very high.

I should also mention that we have used dynamite in large shallow prairie lakes which go dry each year where the ground remains too wet to work with dragline or horses. We have treated four large areas in this manner. The duck-outs, as we have called them, are about 150 feet long, 20 feet wide and 5 feet deep and will insure permanent water in dry years. They are spaced from one-half to one mile apart and fenced. Eighteen such duck-outs have been put in four large prairie lakes, all of which were former well-known duck producing lakes. They are Whitewater in Manitoba, and Big Stick, Rush and Tatagwa in Saskatchewan. An added advantage is that in the case of salvage operations the ducklings are concentrated if we are forced to move them.

I have given you samples of the different types of construction work that we have been engaged upon. There are thirty-one completed projects, or projects on which work has been done. On many of them, of course, further work and improvements are still to do. They range in size from a few hundred acres to such huge projects as Gordon Lake, 207,000 acres, approximately.

By now I fancy you will be wondering how we have managed to do such a large amount of work over such a vast territory in such a short period of time and with such a relatively small amount of money. The answer is that for every dollar in cash sent north by your sportsmen, the Dominion and Provincial Governments, Municipalities and individuals have contributed what? If I said $10.00 in kind I think I would be absurdly conservative. But we will let it go at that.

We have 530,000 acres on which we have done work that will benefit duck production. In addition, we have made preliminary studies on another 150,000 acres, for much of which plans and specifications have been prepared for the 1940 construction program.

The Dominion Government treat us as an educational institution and permit us to bring in scientific equipment, materials and books free of duty. They remitted the incorporation fees when we were chartered in 1938.

We pay no taxes in any of the three provinces; in fact, Manitoba has passed special legislation exempting us from taxation.

We have purchased one-half section of land (320 acres) and this is all the land we have had to buy. The only reason we bought that was because it was in the middle of Ministik Sanctuary. All the rest of the land we have under long term lease or agreement is on a nominal rental, usually $1.00 per annum. In addition to the above, we have been granted the waterfowl management on approximately one million acres of Community Pastures by the P.F.R.A.—the Prairie Farms Rehabilitation Administration. This acreage is distributed over Saskatchewan in about fifty different projects. It represents submarginal land withdrawn from agriculture from which the farmers have been removed. The areas are fenced and a resident manager is in control. The entire area is game preserve and in some of the projects there are important waterfowl areas. So far we have done work on four or five pastures. This has chiefly been fencing to protect nesting cover around water areas. In this, the P.F.R.A. have been very generous with land. Wherever possible they have allowed us to take in all the land we needed.

You will see then that we have been relieved of practically all land costs and complications by the splendid cooperation of Federal, Provincial and Municipal Governments.

On a number of occasions we have appealed for advice and information to various divisions of the U. S. Biological Survey. This has always been forthcoming promptly and in generous measure. I can, I believe, give you some encouraging facts which reflect the results of the work of the Survey and cooperating state and private organizations. For three years in succession you have sent a larger breeding stock north. The increases have been substantial. For three years in succession you have sent a decreased number of crows north to breed. On the other hand, the magpies are increasing rapidly over the farm belt and we have inaugurated a special campaign against them in the duck breeding areas.

I cannot close without special reference to our Key-man organization. I mentioned that we had 3,200 active cooperators at the end of 1938. As was to be expected a large proportion of these were enthusiasts but of little use to us in a practical way. We selected the best and reduced our active list to 1,200 in the winter of 1938-39. It has since grown to about 1,600 selected observers. I believe we are now getting reports from as reliable sources as it is possible to muster outside the ranks of trained ornithologists. In fact, there is a nice sprinkling of trained men in the Key-man organization. In the census returns of 1939 I only found it necessary to discard about a dozen as unsatisfactory. The time these men will give and the trouble to which they will go in this work of observing, census taking and reporting is astonishing. It is all voluntary but if it had to be paid for in dollars and cents the cash value would match every dollar subscribed by your sportsmen to date.

We have also received the most cordial cooperation from the personnel of the waterfowl research unit established at Delta, Manitoba, under the auspices of the American Wildlife Institute, the Michigan State College and the University of Wisconsin. I refer to Prof. Aldo Leopold, Dr. Miles D. Pirnie, Mr. H. A. Hochbaum and Mr. J. F. Bell.

I would like to have told you about our census methods and results and to have asked your advice in refining these with a view to attaining greater accuracy but perhaps, after another year's experience in this field it will provide a fitting subject for discussion at the next meeting.

CANADA GOOSE HABITATS IN UTAH AND OREGON

C. S. WILLIAMS AND C. A. SOOTER
U. S. Bureau of Biological Survey

For the past several years the Canada goose (*Branta c. canadensis*) has been one of the species of waterfowl studied at the Bear River and Malheur Migratory Bird Refuges in Utah and Oregon. These two areas, which are administered by the Bureau of Biological Survey as part of the conservation program of the Department of the Interior, are probably the most important breeding grounds for Canada geese left in the United States, although certain sections of Idaho and northern California also produce many birds. Since the beginning of the studies at Bear River in 1937 and at Malheur in 1938, seven breeding localities have been examined, data on 1,043 nests recorded, and observations made on the character of most of the important wintering grounds in Utah and southeastern Oregon.

The types of areas most frequented by Canada geese were found to be lake, meadow, marsh, salt flats and knolls, and cultivated land. The habitats selected, however, vary not only with the season but also with the activity of the geese. This is well illustrated in the Bear River area by the change in food habits coincident with the shift from nesting to brooding activities; grazing predominates during the incubation period, but the birds at once seek aquatic foods after the eggs are hatched. Just what these seasonal and activity requirements are and what their relations are to each other still remain to be learned.

The environment most important to geese is that required for breeding. It must not only meet the needs for nesting but also must contain within a comparatively limited area acceptable conditions for molting, brooding, resting, and feeding. Only the briefest treatment of the habitats selected for these activities is possible here.

The extent of nesting is correlated with the availability of suitable nesting sites. Williams and Marshall[1] concluded that the presence of substantial nest bases was the critical factor in determining suitability and therefore selection. Analysis of data from all the breeding grounds studied lends added weight to this conclusion. Canada geese do not normally construct nest foundations, but rather rely upon sites requiring the building of only the nest proper. Nests found throughout the studies were invariably dry and firm, even though many were placed over water on matted emergents, old heron nests, or muskrat lodges.

[1]Williams, Cecil S., and William H. Marshall. Goose nesting studies on Bear River Migratory Waterfowl Refuge. Jour. of Wildlife Management, 1:77-86, Oct., 1937.

TABLE 1—LOCATION OF 1,043 CANADA GOOSE NESTS IN NORTHERN UTAH AND SOUTHEASTERN OREGON, 1937-39

Cover type	Number of nests	Percent of total
Hardstem bulrush	534	51
Saltgrass	152	14
Alkali bulrush	85	8
Cattails	60	6
Meadow	58	5
Carex		
Juncus		
Elymus, etc.		
Hay and straw stacks	52	5
Giant burreed	36	3
Weeds—banks	22	2
Brush	20	2
Artemisia		
Sarcobatus		
Chrysothamnus		
Cliffs	18	2
Olney's three-square	5	..
Cane	1	..
TOTALS	1,043	98

Certain types of vegetation are more valuable than others in providing suitable nesting sites. Table 1 shows the number and percentage of nests found in different covers for all breeding areas studied. Analysis of the data indicates that although the marsh type provides the most attractive nesting conditions, it is by no means indispensable. The order of utilization of covers is apparent in the table. Hardstem bulrush (*Scirpus acutus*) marsh was found to be the best. This growth contained 534 nests—more than all the other types combined. At Malheur 65 per cent of all nests found were in this bulrush, and in Utah the percentage was 36. Availability appears to account largely for the differences in these percentages. A truer concept of relative values of cover types for nesting could be had if acreages were considered, but it was not possible to obtain cover acreages of all the breeding grounds. Per cent acreage-use indices are, however, available for Unit 2 of the Bear River Refuge (Table 2). The data leave no doubt concerning the attractiveness of hardstem bulrush marshes. It hardly need be added that management efforts are being directed toward building up the acreage of this important cover-plant.

TABLE 2—PER CENT ACREAGE—USE INDICES* FOR SAMPLE AREAS—BEAR RIVER MARSH

Cover type	Unit 2 Bear River Refuge 1937-39 Average	Bear River silts 1938-39 Average
Hardstem bulrush	9.32	7.66
Cattails	3.21	1.25
Saltgrass	1.38	.12
Alkali bulrush	.44	No significant acreage available
Olney's three-square	No significant acreage available	.25
Weeds and other	.33	.02

$*\frac{\text{Percentage of nests found in cover}}{\text{Percentage of that cover available}}$

A complexity of factors conditions the acceptability of cover for nesting, even granting an abundance of potential nest bases. Nearness of sites to water was found to be important: over a 3-year period, on a sample area, 72 per cent of the nests were within 30 feet of channel, pond, or lake margins. Difficulty in leading goslings through dense marsh growths to brooding environments may explain this. As a result of these findings, extensive stands of emergents are to be broken up by mowing, digging of channels, and perhaps by dynamiting to create inner ponds.

Visibility from the nest is unquestionably a potent factor in the selection of nesting sites. Data from 397 nests at Bear River show that 53 per cent had excellent, 34 per cent good, and 13 per cent fair visibility. None had poor. Visibility is probably a need in protection, since geese cannot well conceal themselves and usually resort to flight for escape.

In general, muskrat lodges add to the attractiveness of all emergent-cover types. Their influence, of course, depends upon number, location, and character of other available sites. At Malheur, 33 per cent of all nests among hardstem bulrushes were on muskrat lodges. At Bear River muskrat activity was largely responsible for the nesting utilization of alkali bulrush (*Scirpus paludosus*), inherently a poor cover. On Unit 2 of that area, alkali bulrush makes up approximately 59 per cent of the available nesting vegetation but in three years it contained only sixty-seven nests, and forty-six (or 68 per cent) of these were on lodges. Because of this relationship, effort is being made to maintain muskrat populations at optimum balance points where lodges will benefit goose nesting and damage to roads, dikes, and other structures will be minimum.

A less apparent factor conditioning the use of potential nesting cover is the contour relation of the cover and a suitable brooding area. Of 249 nests found during 1939 in Utah, only 4 were downstream from the brooding area. The same condition held true in Oregon. In many areas excellent cover was neglected and poorer sites upstream were selected. The importance of this in locating impoundments in future developments of breeding areas is obvious.

Observations point to the need for a grazing area within easy cruising range of the nest during the incubating period. Grazing is pronounced at this time, but the cruising range is restricted by the requirements of egg incubation. Weather conditions also influence the cruising range. In the Bear River area, most of the grazing grounds used during the incubating period were within 2 miles of the nesting habitat; none was beyond 5 miles. Shore lines, river banks, greasewood knolls, wheatfields, and salt flats provide most of the birds' food in northern Utah at that time. Some of the plants grazed most heavily are peppergrass (*Lepidium perfoliatum*), junegrass (*Bromus tectorum*), foxtail (*Hordeum jubatum*), rabbitfoot grass (*Polypogon monspeliensis*), and glasswort (*Salicornia rubra*).

When adults and their broods begin to frequent open water, they feed extensively on sago pondweed (*Potamogeton pectinatus*), wigeongrass (*Ruppia maritima*), and other aquatics. This continues until after the adults are through the molt and the young are able to fly.

An aquatic feeding and loafing area easily available from the nesting habitat appears to be an essential part of the breeding environment. Shallow open water with aquatics within tipping reach of the young goslings is most frequented. Extensive shallows that prevent diving are avoided while the goslings are small but are used later on, after the birds are not so subject to attacks of winged predators.

Barren or slightly vegetated dikes, lake shores, and river banks that are dry and in proximity to acceptable aquatic foods and open water are used most extensively for roosting during the brooding season. The same situations may or may not be for day resting or loafing. The differences in utilization seem to depend upon dryness and visibility.

Molting requirements apparently differ little from those for brooding. There seems, however, to be a need for marsh cover for a brief period of the molt, during which broods disappear from their usual haunts for several days and then reappear without apparent change. Artificial banks constructed in the lower reaches of marshes have proven attractive to geese during this critical period.

After the restrictions on the cruising range no longer prevail, the birds travel long distances in search of attractive foods and resting places. Areas in which the birds are most numerous, however, are those in which feeding and resting cover are close together. Food is obtained mostly by grazing on river banks, greasewood knolls, stubble fields, winter wheatfields, reservoir bottoms and shore lines, seepage meadows, and flooded alkaline flats. Resting is done mainly on lake and reservoir shores and on river banks. All are important at one season or another. The foods vary with the locality and the season. In Utah, wheatfields supply some flocks of geese with food throughout fall, winter, and spring. Other flocks resort mainly to seep areas of reservoir bottoms where marsh cress (*Radicula* sp.) and rabbitfoot grass are attractive foods. Still others frequent salt flats and meadows where foxtail, saltgrass (*Distichlis stricta*) and glasswort are fed upon. A number of methods have been used as a means of attaining better feeding conditions for the geese. One of the most effective has been the irrigation of salt flats and meadows. The clearing of willows has been satisfactory in some areas, just as the thinning of sage brush and greasewood has in others. The fall planting of grasses and small grains was undertaken at Bear River last year as a means of increasing the acreage of attractive food plants.

The program of management is already showing results and with added data upon which to base future practices, we may hope for even better conditions for geese in the West.

SMALL AREA MANAGEMENT FOR WATERFOWL

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Although most small waterfowl projects develop without careful planning or management, general efficiency and economy call for *definite objectives* and *appropriate management* practices (Pirnie, 1935). The following suggestions are based on observations and experiences at numerous waterfowl areas, especially at Wintergreen Lake near Battle Creek on the W. K. Kellogg Bird Sanctuary, where the writer has been in charge since 1931 for Michigan State College. This sanctuary has less than 30 acres of water but includes 600 acres of woodlots and fields. The following discussion applies only to areas of less than 5,000 acres—"smaller" waterfowl areas. It is not the scope of this paper to deal with the hunting season management of duck clubs, nor to touch on the many problems of operating sanctuaries for public recreation and the teaching of natural history. These deserve separate treatments elsewhere. Unless they become very numerous, small areas managed for waterfowl are unlikely to contribute greatly as breeding grounds, for waterfowl scatter widely for nesting.

OBJECTIVES: These may be classed as follows:

1. *Aids to Birds*—protection and food
   a. Loafing areas and refuge from gunning
   b. Safe feeding grounds and special feeds
2. *Benefits to Humans*—education and recreation.
   a. Sanctuaries, aviaries and research stations
   b. Sport—hunting ducks and geese

The same small area may serve more than one purpose. A duck club may shoot several hundred ducks yet give refuge to thousands. All management hinges on a careful defining of objectives and on wise choosing of techniques.

TECHNIQUES: Regardless of the objectives, any management plan for small waterfowl areas is likely to include most of the following practices:

a. Fencing, posting, and patrolling
b. Habitat and other modification to afford better resting, loafing or feeding grounds
c. Natural and special feeding programs
d. Restocking with captives.

PROTECTION: All ponds and lakes do not become crowded with waterfowl just as soon as they are closed to shooting; and regardless of other attractions, waterfowl are not likely to concentrate where they are repeatedly disturbed. On small areas, in particular, it is almost imperative to fence, post, and at times to patrol. The toot of an auto horn, the bark of a dog, or people strolling across a clearing are likely to scare out the new flocks of bluebills or geese. Some species are very tolerant of such disturbances and may become very tame in spite of noise and confusion.

Fences serve chiefly to keep out dogs and to remind outsiders of the special nature of enclosed areas. They should be made strong, durable, and high. Chain link fencing (No. 11 gauge and without toprail) is not so expensive as to be prohibitive and it is almost impossible to climb. A less costly fence, but more climbable, consists of graduated poultry fencing topped by several strands of closely-spaced barbed wire. It is not economical to use lighter filler than 12½ gauge. This heavier fence is sold 58 inches wide, and by using long posts and the barbed wire, a fence 6 or 7 feet high can be built at moderate cost. Do not expect a 7-foot fence to turn foxes or cats, for they climb over. All fencing should be set a few inches in the ground. Several closely spaced strands of "hog-style" barbed wire may be laid just below the fence to prevent dogs getting through by enlarging skunk or rabbit holes. Barbed wire overhangs may at times be advisable.

Posting: Most card signs are unsightly in a year, and colored inks are likely to fade. Squirrels tear up paper or cloth posters and use them for nest materials. Wood signs (of pressed board and inch lumber) stained or painted and lettered with aluminum are very legible and durable. They usually are better than porcelain or metal signs. A *few large* signs are more informative than a lot of small ones. They should be placed at strategic locations, at an angle and well back from roads or trails for better visibility from passing cars.

Patrolling: Building up good will is preferable to sending out a guard waving his gun and displaying his badge—"chip on the shoulder" style. Observing the wildlife and getting acquainted with hunters and adjacent landowners are proper functions of a patrolman. Publicity should be given to happenings within the area rather than keeping all a dark secret. Win good will and patrolling tends to care for itself in many places!

OTHER HABITAT MODIFICATION: Most lakes and marshes can be greatly improved for waterfowl feeding, loafing, or nesting. Experienced wildfowlers know the tendency of ducks and geese to gather at islands, gravel bars and wide beaches. Brush and tall weeds may be mowed or trimmed out and the sod plowed to create new resting grounds free from sharp stubs. This is usually much cheaper than top-dressing with gravel hauled from a distance. Most ducks enjoy loafing on fallen tree trunks or rafts, and they like to perch on pilings, docks, stone heaps, and boulders in shallow water. Rafts should be anchored by strong cables and heavy weights. Timbers may be staked out, propped up, or they may be anchored off-shore. Loafing beaches should be at least several hundred feet long and 30 feet wide. A few planted willows should supply the shade which ducks enjoy. Bird concentrations require some attention to sanitation. Smooth logs are cleaned by waves and rain more easily than rough bark; and graded beaches can be quickly combed or raked. Building bars or islands requires greater expenditure but often are worthwhile. Good engineering is required to maintain them, however, unless water levels are controlled. *Control* of water levels is to be desired, but not always is it necessary or even advisable to maintain the same level at all seasons.

Food plantings: Many difficult questions arise in connection with plans to increase natural foods. Chapters in wildlife manuals and entire bulletins have been published on this subject, yet each local manager meets new problems in deciding how much and what to plant (Martin and Uhler, 1939; Pirnie, 1935). Not infrequently local supplies of natural foods are better than is realized; and cultivated grains may supplement the natural offerings. Wise handling of muskrat populations helps thin or protect cattail and bulrush as desired. Too many muskrats are likely to eradicate new plantings of duck potato, wild rice, wild celery or sago. Waterfowl may destroy wild celery if the beds are small, but on large areas they are seldom really destructive. Ducks and coots can clean up wild rice seed as fast as it is planted, especially in shallow water on firm bottom soils. Native stands of fine-leaved pondweeds (*Potamogeton*) are seldom eradicated by waterfowl or muskrats. The smartweeds, various sedges, cattails and the pondweeds usually meet most waterfowl needs in cover and food. Remember also that ducks glean much waste grain and grasshoppers from the stubble and they visit other marshes and waters before and after "hours." Almost equally important as food supplies is the favorable proximity to a larger body of water or "landing fields" for resting and feeding when the birds have been driven from the smaller area. Gull Lake of over 3,000 acres is only half a mile from the Wintergreen Lake Sanctuary of less than 700 acres. Diving ducks feed at Wintergreen Lake during the day but return to Gull Lake for night roosting. Similarly the Canadian geese trade back and forth, after feeding on the farm fields.

Special feeding: Any of the more available grains may be used for baiting or feeding. Barley, wheat and corn are favorites in the North, probably corn and rice farther south. Ear corn gives "busy work" and is recommended especially for cold weather. Grain may be fed in fields, on beaches, or scattered in shallow water. The dabblers may dive for it in several feet of water but they scarcely compete with the divers at depths greater than 6 feet. In winter the feeding can be done on wind-swept areas or wherever the birds have packed the snow. Feeding at heavily shot-over places is to be avoided, since doing so may invite the birds to deaths by lead poisoning from lead shot which perhaps are eaten by mistake for grit or seeds.

It is *not* necessary to feed all the waterfowl which use an area, for not all the birds on a lake or pond belong to the same "behavior group." Some are star-boarders and others are day loafers which go elsewhere to feed. While some mallards answer our call at feeding time, others fly across the lake to feed on acorns at the oak ridge and some flocks depart for the river marshes or cornfields. Do not be surprised if most migrants stay only a short time. As pointed out above, all species, all flocks, and even the individuals of a flock are not equally attracted or "held" by baiting operations. Special feeding does not make paupers of wild ducks, nor does it reduce them to domestication. On the other hand, regular feeding usually attracts and holds practically all the local "puddle" duck which can fly. This makes it necessary to cull regularly if the wild standards are sought after.

RESTOCKING: At Wintergreen Lake, the release of several hundred wing-clipped black ducks has failed to establish new nesting, and mallards hand-reared in Michigan have "gone wild" and migrated in early fall to Wisconsin, Arkansas, and Louisiana instead of becoming resident. In brief, as yet we have little evidence that wild duck restocking greatly affects local nesting in succeeding years. On the other hand, captive stocks may give rise to more or less localized flocks of fair size, as in the case of the Canada goose restocking at Wintergreen Lake since 1931 (Pirnie, 1938). Where such local flocks are developed, there often arises the problem of preventing damage to winter wheat on neighboring farms where these geese feed during the closed season. "Scare-crows" made of fence posts, strips of cloth and pieces of tin were successfully used in the fall of 1939 to prevent over-grazing by geese on certain eroding slopes at the W. K. Kellogg Farm. Serious damage to crops usually can be prevented if refuge managers and farm operators work together.

SUMMARY AND CONCLUSIONS

1. Areas of 1,000 to 5,000 acres may be successfully managed to provide protection and food for waterfowl and also to furnish outdoor recreation and nature education for people.
2. Protection techniques include fencing, posting, and patrolling.
3. Habitat modifications often can create new resting and feeding grounds at relatively low cost.
4. Owing to their ability to forage for themselves, wild waterfowl concentrated at sanctuaries are by no means wholly dependent on artificial feeding.
5. Protection and feeding do not pauperize wild waterfowl or destroy their migration instincts. Waterfowl do not always use the protection and feeds available to them.
6. Small refuge areas may greatly increase the local kill of ducks and geese during the heavy flights. In average years they may cut down local kills and save many birds.
7. Restocking with captive waterfowl is yet in the experimental stage, although success has attended a few efforts with the Canada goose.
8. Caution must be exercised in drawing conclusions from brief tests or limited management experiments, because waterfowl behavior varies greatly from year to year. True causes are difficult to determine, and the results obtained one year cannot always be repeated even under apparently identical conditions.

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WOOD DUCK HABITAT MANAGEMENT IN ILLINOIS

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The carrying capacity of a wood duck breeding area is largely dependent on the number of tree cavities in which this species can nest. The nesting habitat of the wood duck in Illinois, as in many other places, is deficient in hollow trees. In 1937, the U. S. Biological Survey, aware of this cavity shortage, erected more than 400 nesting boxes at the Chautauqua Migratory Waterfowl Refuge, located in the Illinois River bottomlands. These boxes were built of slabs from several kinds of trees.

We inspected for occupancy about half of these slab boxes, during the spring of 1938, and found wood duck nests in about 15 per cent. Since many of the boxes were placed only a few feet apart, we considered this to be a fairly high rate of occupancy.

In 1939, Dr. Lee E. Yeager of the Illinois Natural History Survey designed a board box patterned after the slab box of the Biological Survey, and 450 such boxes were placed in various parts of the State. The outcome was gratifying. Near Havana, which is a few miles south of the Chautauqua Refuge, over half of 350 board boxes were used as wood duck nesting places before the boxes were 4 months old. As in the previous year, wood ducks used about 15 per cent of the slab boxes on the Chautauqua Refuge. Thus for the 2-year period, 1938-1939, more than a quarter of 1,000 boxes inspected contained nests of this duck.

Although indications are that the provision of artificial nesting places for wood ducks is a sound management measure, more extensive tests are planned for 1940. So far, only heavy concentration points for wood ducks have been adequately sampled. Present plans call for a study of over 1,100 boxes, widely scattered throughout the State, during the coming spring.

The following recommendations are based upon an intensive study of wood duck nesting in 1938 and 1939, a detailed account of which is now in press.

As far as the wood duck is concerned, the general appearance of the box seems unimportant. Cartridge boxes, nail kegs and even brick chimneys have been used as nesting sites in Illinois at one time or another. However, the artificial cavities should meet certain specifications. The basal area of the inside of the box should be about 10 inches square; the entrance hole at least 4 inches in diameter. The bottom of the box ought to be 12 to 16 inches below the entrance hole, and covered to a depth of about 3 inches with sawdust, in which the wood duck may bury its eggs.

It was dark inside most of the cavities in which we found nests, but whether the ducks actually prefer that it be dark inside the box is unknown. For convenience in cleaning, inspecting or fixing, our boxes are built with removable tops. Several small holes are drilled through the bottom of these boxes to permit drainage, in case water enters the box from driving rains or snows. Perches below the entrance were found to be unnecessary. We consider it advisable, and cheaper in the long run, to construct the boxes carefully of a durable wood such as cypress, spruce, or white cedar rather than to use scrap materials. Replacement then becomes unnecessary for a number of years. So far, we have not tried wood preservatives. Cypress boxes built by the Natural History Survey in 1938 cost about $1.00 each.

It should be emphasized that wood ducks readily accepted boxes placed in the uplands, as well as in the bottomlands. In fact, there is evidence that they preferred the uplands. Our experience was that in good wood duck territory, excellent results with boxes were obtained as much as three-quarters of a mile from the nearest water.

The boxes are fastened to trees not less than 12 inches in diameter and about 12 feet above the ground. Most satisfactory method of hanging the box has been a lag screw inserted through a small hole in the back of the box and screwed into the tree by a long-handled socket wrench. It is unnecessary to face the entrance of the box toward the water.

By placing the boxes more or less uniformly through timber tracts covering several acres, we learned that cavities in the interior of the woods were used by the ducks for nesting as often as were hollows near the edges of the woods. Differential density of the forest canopy made no noticeable difference in the selection of nesting sites. Apparently the ducks preferred to nest in blocks of timber, rather than in narrow strips. More than twenty-five duck nests found within a few feet of occupied human dwellings indicate that the wood duck will tolerate a certain amount of human interference. Several of these nests, in fact, were in the business and residential sections of small towns.

It would seem that the faith which the wood duck apparently has in humanity is entirely misplaced, since man, unknowingly or otherwise, is its worst enemy. Poachers and indiscriminating hunters take their toll, but operations, such as drainage, timber cutting and burning, which destroy the habitat, cause even greater inroads on the population of this handsome duck.

The breeding potential of the wood duck seems to be high; that is, its egg productivity compares favorably with certain species considered abundant enough to permit an annual take by hunters. Were it not for habitat limitations, part of which may be due to inefficient management of existing areas, it might be possible to rebuild the wood duck population to somewhere near its former level.

While man originally caused the wood duck shortage, other animals have helped to keep the population low. Competition for what cavities there are has been keen. Among the weaker species, first come, first served has been the rule; but the predatory species have another rule—the survival of the fittest. The combination of competition and depredation has created a difficult situation in areas where cavities are scarce. In bottomlands, mud dauber wasps and raccoons were the intruders; in uplands, squirrels, screech owls, honeybees and snakes took their place. In both habitats the effect on wood ducks was much the same—numerous nesting failures. Unfortunately, the predation problem is not solved by providing large numbers of nesting boxes in relatively small areas. The more observing predators, soon learning to associate the box with duck eggs and other easily-obtained foods, systematically go from box to box, destroying all nests found. To combat this problem, we plan, in 1940, to experiment with methods of predator-proofing the boxes.

It should be mentioned that squirrels, screech owls and raccoons, species which in certain localities may be more desirable than wood ducks, have used the boxes considerably in Illinois, both for wintering and breeding, as well as for temporary resting places. In the boxes occasional 'possums and more than a dozen swarms of honey-bees have been found.

In addition to suitable nesting places, the wood duck habitat must have a proper balance of cover and food. During flightless periods, before the young are fully fledged or when the adults are moulting, these ducks seldom venture far from dense emergent vegetation. Especially attractive to the ducks at this time of the year is flooded timber with buttonbush, *Cephalanthus,* or privet, *Forestiera,* underbrush. In Illinois, American lotus, *Nelumbo lutea,* river bulrush, *Scirpus fluviatilis,* and marsh smartweed, *Polygonum Muhlenbergii,* furnish excellent summer cover. In other parts of the country the plant species may be different but the general cover requirements of this duck remain the same.

All of the above plants, and in addition, coontail, *Ceratophyllum demersum,* duck weed, *Lemna* (several species), two pondweeds, *Potamogeton pectinatus* and *americanus,* and various animal species probably furnish a good share of the natural food taken by wood ducks while at their Illinois breeding grounds. During late summer and as long as wood ducks remain in the fall, grains, in addition to natural feeds, form a substantial part of their diet. Much of the grain near the Illinois River bottomlands is harvested by means of combines and mechanical corn pickers. Both machines scatter many loose kernels about the field during the harvest. These scattered kernels are very palatable to wood ducks. We observed, in September, 1938, an estimated 3,000 individuals feeding in a single wheat field and 8,000 in the wheat fields of one drainage district. Mechanical corn pickers not only waste much grain but also flatten the stalks. The joint effect of leaving much feed and flattening the stalks has made cornfields near the Illinois River very attractive to hungry ducks. In October, 1938, an estimated 2,000 wood ducks in company with at least 25,000 mallards were seen in one large cornfield adjacent to the river. Perhaps in other places inhabited by the wood duck, grain food patches, harvested in such a way as to flatten the stalks and scatter much grain, will solve food shortage problems.

In many areas, it is entirely feasible to improve the wood duck habitat through the erection of nesting boxes, the improvement of marsh food and cover areas, and the provision of supplementary feeding grounds in the form of grain food patches.

The studies referred to in this paper sought a sound formula for more wood ducks. The provision of nesting boxes for this species appears to offer not only the best, but also the only formula for prompt management, in habitats which, except for a scarcity of hollow trees, are suitable for breeding wood ducks. Some time in the distant future it may become unlawful or unethical to remove hollow trees, but that time is not yet in sight. Even though nature were allowed to take its course, many years would be required to increase substantially the number of natural cavities. Nesting boxes can be built quickly, easily, cheaply and in such a manner as to be acceptable to wood ducks. That much we have learned. It remains to work out certain refinements. The biggest job of all also remains to be done, to obtain widespread usage of the findings.

THE MUSKRAT: A FACTOR IN WATERFOWL HABITAT MANAGEMENT

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Good waterfowl habitat is generally good muskrat habitat. Often when a new waterfowl marsh is developed muskrats immediately invade it and the problem of their management is presented. Muskrat activities in marshes within the waterfowl refuges administered by the Bureau of Biological Survey have brought forcibly to attention the necessity for giving serious consideration to this factor. The present discussion of the matter is based not upon observations of the author alone, but also upon reports from refuges throughout the United States.

In a general way it can be said that during the early stages of development of a waterfowl marsh the muskrat may be a limiting factor. A new impoundment is often practically devoid of marsh and aquatic vegetation. Muskrats attracted by the new water area find themselves hard pressed for food and house building materials. This lack forces them to dig into the banks or, more often, into the newly constructed dikes that create the impoundment. Muskrat burrowing endangers these costly structures and renders constant maintenance necessary. Upon investigating a burrow in a large dike on the Medicine Lake Migratory Waterfowl Refuge in Montana the author found that the burrow traversed completely through the dike and in order to prevent undermining, it was necessary to rebuild an entire section of this dike. On the Lacreek Migratory Waterfowl Refuge in South Dakota, where a heavy muskrat population has been present almost from the first flooding, it has been necessary to trap constantly on and near the dikes to prevent disastrous washouts. As the marsh and aquatic vegetation develops in new impoundments, lodge-building material becomes available and the temporary dike burrows are evacuated.

Dike destruction in itself can be overcome by constant maintenance, but here the food requirements of the muskrat enter the picture. Permanent water areas are often developed in locations having few or no marsh plants. In such places we must resort to extensive planting to create optimum habitat and prevent other species from crowding out the plants most valuable to waterfowl. During the early stages of refuge development the dike-burrowing muskrat must turn to these new stands of vegetation for food, with the result that they are badly damaged or even completely destroyed. A typical example of havoc wrought by muskrats to newly planted marsh and aquatic food plants was found on the Seney Migratory Waterfowl Refuge in Michigan. In a report on observations made on this area during the summer of 1939 it was stated that of 22.31 miles of bulrush plantings made in 1938, muskrats destroyed 14.56 miles and severely damaged the remainder. It was also reported that all wild rice plantings on that refuge (1,000 pounds in 1939) were destroyed by muskrats.

Observations made during the summer of 1939 on the Medicine Lake Refuge in Montana point to the destruction of marsh vegetation by muskrats. Of one of the new impoundment units, having a shore line of about 20 miles and a determined muskrat population of 1,620, the report reads: "When the survey was begun in August the beds of Scirpus in various parts of the area were rank and dense; by October 1 they had been so heavily cropped by the muskrats that some of the beds were almost destroyed. Sago pondweed and bladderwort were taken in smaller quantities, but many of these plants were eaten before they had been able to produce seeds."

Under such conditions, the solution of the problem of marsh revegetation and dike protection on new impoundments would seem to require intensive trapping of muskrats during the early stages of habitat development. As the vegetation develops and the supply for muskrat food and building materials becomes adequate, trapping can be reduced to the minimum required to maintain good balance.

As the vegetation on a marsh develops into an adequate stand the muskrat relationship changes from a limiting factor to one of definite value. A marsh densely overgrown with emergent vegetation is of little value to waterfowl. For optimum use, it should be interspersed with channels and shallow ponds of open water, and a reasonably heavy muskrat population helps to bring about that condition through the normal activities of feeding and house building. The ecological effect of the muskrat on the waterfowl marsh is very important, and if the animal is allowed to increase uncontrolled, too much vegetation may at length be destroyed and competition for food between the muskrats and waterfowl may become serious.

In the writer's opinion, the Blackwater Migratory Bird Refuge, situated in the heart of the muskrat marshes of Maryland's Eastern Shore, offers an excellent example of the importance of the muskrat in the management of a waterfowl marsh. In 1931 this area was engulfed by an extreme high tide that killed many of the muskrats. This was followed in 1932 by an extended drought which likewise took toll of the animals. The accumulation of adverse natural factors lowered the muskrat population and thus permitted a heavy marsh growth, so that the only open water remaining was the main channels and sloughs. Use of the area by waterfowl was greatly reduced and waterfowl nesting practically ceased. Then the muskrat population slowly became re-established until, during the winter of 1938, 26,000 muskrats were harvested from the area without affecting the basic population. In the summer of 1938 the writer visited the area and found the marsh in a greatly improved condition for waterfowl. Shallow ponds opened by muskrat activities were scattered over most of the marsh area. In an hour's trip, in a small outboard motor boat, ten broods of young bluewing teal were observed. It is doubtful if this number of broods could have been found on the entire refuge in 1933.

The utility of old muskrat lodges for waterfowl nesting sites is another beneficial factor. Reports are continually being received of nests being found on such lodges, which seem to be especially attractive to the Canada goose and the trumpeter swan. At the Malheur Refuge in Oregon, a close relationship between the increase in muskrat houses and the number of nesting Canada geese has been noted. From Bear River Refuge, as well as from many others, come reports of extensive Canada goose nesting on these lodges. In the management of the trumpeter swan on the Red Rock Lakes Migratory Waterfowl Refuge in Montana the value of muskrat houses for nesting sites is considered so great that substitute mounds are being built to supplement the natural supply of these preferred foundations.

Thus we conclude that study and management of the muskrat should be considered important in the management of waterfowl areas. In new impoundments, control of the animal may be necessary to prevent damage to dikes and to prevent loss of food plants necessary for the maintenance of a satisfactory waterfowl population. After desirable vegetation has become established, the muskrat population should be managed, not only for economic reasons, but also for the very important ecological benefit it has in keeping the marsh open and attractive to waterfowl, as well as in increasing the number of desirable nest foundations for them.

CROW-WATERFOWL RELATIONSHIPS ON FEDERAL REFUGES

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During recent years the Bureau of Biological Survey has conducted duck-nesting studies on several federal refuges to obtain much needed information on the relationship of environmental factors to waterfowl production.

At the termination of a study of crow-waterfowl relationships on the Canadian breeding grounds (Kalmbach, 1937), it was believed desirable to obtain broader information on this problem by research at the Lower Souris Migratory Waterfowl Refuge in North Dakota. During the subsequent four years, it was possible to observe the effects of both light and abundant crow populations on nesting waterfowl.

The data resulting from the studies at Lower Souris, combined with information obtained from similar work at other refuges, have served as the basis for this paper. Replies to a questionnaire requesting data from refuges in seventeen Northern States facilitated the gathering of material from localities at which nesting studies had not been made.[1]

The word "crow" as used in this paper includes the subspecies of the common crow (*Corvus brachyrhynchos*) that may be present on

[1]The coöperation of refuge managers and biologists in contributing data for this study is greatly appreciated.

the respective refuges and the fish crow (*Corvus ossifragus*) at refuges on the Atlantic Seaboard.

Kalmbach (1937) stated that the northern limit of crow abundance (breeding range) extends to the northern border of agricultural development in Canada, thus embracing all the northern United States. The southern limit ''extends below the southern edge of the productive breeding areas of most North American ducks.'' Hence ''the crow-waterfowl problem of this country is restricted largely to the northern States of Minnesota, North Dakota, South Dakota, northern Nebraska, Montana, and sections of the coastal region in the Northwest.''

Crow damage was reported from four states not included in those mentioned, namely, Maine, New York, Michigan, and Maryland, but apparently was of no particular importance except at refuges in the last two.

In Iowa, Bennett (1938) found that crows destroyed 4.8 per cent of the bluewing teal nests studied on state and private lands.

Many important waterfowl-nesting grounds within these crow-waterfowl States have no crow problem, owing primarily to the absence of favorable crow environment near the duck-nesting areas.

As would be expected, there was an apparently direct correlation between the density of the crow population and the degree of nest destruction attributable to those birds on federal refuges.

Of thirty-four refuges considered, fourteen may be eliminated at the outset because of the rarity or absence of crows from nesting areas during the duck-nesting season. Two other refuges are principally resting and wintering area, and two had mainly wood ducks as nesting waterfowl. On the remaining sixteen refuges, all situated in the states listed above, nest destruction by crows ranged from possibly 1 to 30 per cent, depending upon the density of the local crow population and on the amount of crow control. Crow predation on some seventy additional easement refuges in North Dakota varied from none to possibly 30 per cent.

On these refuges, local crow-control activities ordinarily have been

TABLE 1—SEASONAL STUDIES OF NEST DESTRUCTION

Year	Refuge or locality[1]	Early nests Per cent	Late nests Per cent
1934-35	Canada[2]	47.0	22.0
1936	Lower Souris Refuge, N. Dak.[3]	1.7	1.7
1937	Lower Souris Refuge, N. Dak.[3]	7.7	.3
1938	Lower Souris Refuge, N. Dak	4.0	[4]1.7
1939	Lower Souris Refuge, N. Dak.[5]	40.4	17.6
1938	Lacreek Refuge, S. Dak.[6]	5.7	0

[1]No crow control was carried out in these localities except at Lower Souris in 1936, 1937, and 1938.
[2]Kalmbach 1937.
[3]Kalmbach 1938.
[4]In 1938 an intermediate nest study gave 1.3 per cent.
[5]Rubble-masonry unit only.
[6]Young 1938.

sufficient to prevent damage of any considerable proportions, and on the majority crow control is unnecessary.

Comparison of losses among early and late nests indicated that, at most refuges, crows exerted less pressure on the duck-nesting population during the latter part of the nesting season. Early and late nests in Table 1 were segregated by a division of the nesting season according to the midpoint of the termination dates of the nests under study.

Nesting studies at Nine-Pipe and Pablo Migratory Waterfowl refuges in Montana led Girard (1938) to believe that "depredations were not so intensified during the latter part of June and the first part of July" owing in part, at least, to crow-control operations.

At two refuges results of a different sort were obtained. Black (1940) stated that crows appeared to keep up their destructive work with the same intensity throughout the season at Blackwater Migratory Bird Refuge, Maryland. Krum (1940) believed that crows at Mud Lake Migratory Waterfowl Refuge, Minnesota, are "most destructive during the period they are raising young."

The importance of nest availability (by reason of numbers) as a factor in determining crow predation is shown in Figures 1 and 2. In them are charted 1,279 nests on the Lower Souris used in computing the peak of nesting activity, and 75 nests, either crow-destroyed or partially destroyed. Forty of the seventy-five crow-destroyed nests were on controlled areas, and it is not believed that the control practiced on other areas modified the data to any great extent.

Contrary to common belief and logical expectation, at most of the refuges duck nests with good concealment, as judged from human viewpoint, were destroyed as readily as the more exposed ones. In fact, crow damage appeared to be more common at the better hidden nests. These findings conform to those obtained in Canadian studies (Kalmbach, 1937, and Furniss, 1938). Nest studies at Lacreek, South Dakota (1938); Seney, Michigan (Bradley, 1940); Mud Lake, Minnesota (1937); and Lower Souris, North Dakota (1939), led the observers to believe that nests with good concealment generally are as vulnerable to crow attack as are the poorly concealed nests. Observations at Blackwater, Maryland, disclosed that well-concealed nests were molested "about as much as . . . nests that are more open." (Black, 1940.)

An interesting anomaly was noted at Lower Souris. In 1936, 1937, and 1938, when crow damage was slight, data on 1,537 nests showed that crow destruction was less at the better concealed nests. In 1939, data on 207 nests located on a part of the refuge relatively free from crows indicated slightly less (0.7 per cent) predation on well-concealed nests; but a study of 104 nests at a crow-infested locality revealed a

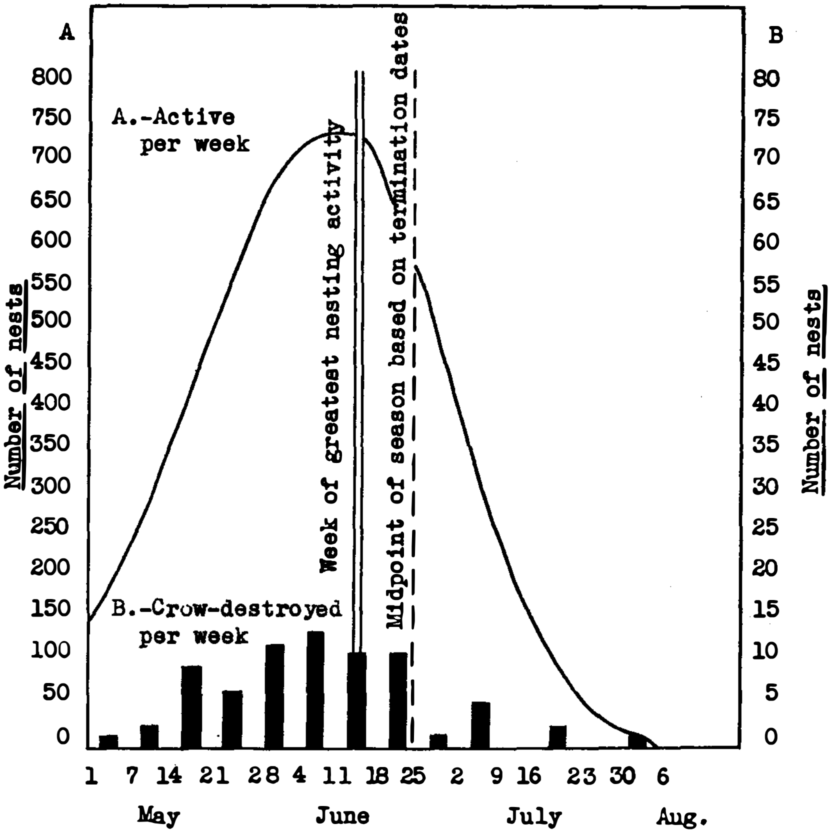

Figure 1-Total number of nests, A., Active per week, B., Crow-destroyed per week. Lower Souris Refuge, North Dakota, 1937-39.

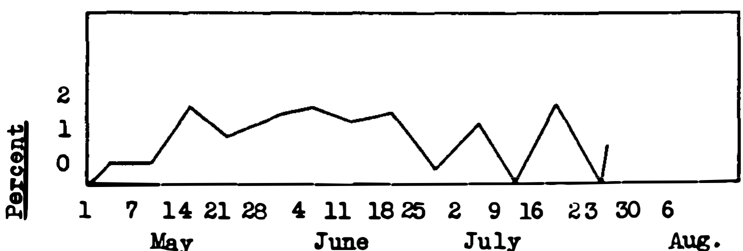

Figure 2-Percent of available (active) nests crow-destroyed each week. Lower Souris, 1937-39.

6 per cent greater destruction of well-concealed nests than of exposed ones (25 and 31 per cent, respectively).

It would appear that several factors may be responsible in determining the degree of concealment least subject to crow predation. Environments may differ in the availability of foods, nest density, crow density, the degree of nest destruction attributable to predators other than crows, number of deserted nests, cover types, and physical characteristics—all of which may have some influence on the ultimate amount of crow destruction. Habits and behavior of ducks and crows also may vary considerably, and, even though a nest may be well concealed, other factors than concealment may decide its fate.

Comparison of the relative percentages of crow destruction among the various species of waterfowl at the different refuges and the annual percentage of loss for several years at Lower Souris disclosed that there was much variation in apparent susceptibility of the different species to crow attack. Some ducks suffered considerably from crow depredation at one locality during a certain season but were quite free from it on other areas during the same period, or on the same area in another nesting season. It was found, however, that the nests of the mallard and the redhead were more frequently despoiled than those of other species, and that the nests of the baldpate and the greenwing teal were rarely preyed upon.

It is probable that nests during the early egg-laying period are more vulnerable to crow predation than they are later. The first eggs are frequently left uncovered, or poorly covered, most of the down being added toward the end of egg deposition. In addition to being very conspicuous, the eggs in the nests during the laying period are unattended for a length of time (daylight hours) amounting to about twice that during the incubation period.

The histories of active nests studied in 1937, 1938, and 1939 at Lower Souris indicate that nests are more vulnerable during the laying period, and the fate of twenty-nine nests found destroyed by crows during that season furnished additional confirmation.

Data obtained at Lower Souris were analyzed to determine the degree of duck-nest destruction that might be attributed to a given crow population, in terms of crows or pairs per unit of area.

It was believed that a crow population averaging about 0.5 pair to a section was present on two nesting units comprising about 21 square miles of marsh and neighboring upland. Nest destruction during 1936, 1937, and 1938 amounted to 2, 3, and 2 per cent, respectively.

In 1939 the rubble-masonry unit of the refuge supported four or five pairs to a section. Here destruction by crows amounted to 29 per cent of the 104 active nests on the area, and the ratio of marsh-feeding crows to duck nests was about 1 to 7.

It is of interest to compare these figures with those from the Waterhen Lake district in Saskatchewan (Kalmbach, 1937). An estimated crow population of about five nesting pairs per section was present on the wooded area facing the Lake. The ratio of egg-stealing crows to duck nests was, roughly, about 1 to 20, and nest destruction amounted to between 30 and 40 per cent. The greater availability of nests was apparently the factor responsible for the great degree of nest destruction.

Bennett (1938) found that in Iowa a crow population of one pair to a section inflicted a destruction of 4.8 per cent of the duck nests.

SUMMARY

1. The crow-waterfowl problem on federal refuges was practically limited to localities in Minnesota, North Dakota, South Dakota, Nebraska, Montana, Michigan, and Maryland.

2. At not more than eight refuges in the states listed was duck-nest predation by crows looked upon as important.

3. Nest destruction by crows showed a decided tendency to follow the curve of nest availability until the midpoint of the nesting season, after which destruction became less frequent and very sporadic.

4. Good concealment was generally of no value in protecting nests from crow attack.

5. Mallard and redhead nests were more generally vulnerable to crow attack than those of other species. Baldpate and greenwing teal nests were rarely destroyed.

6. Duck nests were especially susceptible to crow attack during the egg-laying period.

7. The correlation between the density of the crow population and duck-nest destruction was as follows:

Locality	Crow density—pairs to a section	Nest destruction, per cent
Lower Souris (1936-38)	0.5	2.3
Iowa (Bennett, 1938)	1	4.8 (B. W. Teal)
Lower Souris (1939)	4 to 5	29
Canada (Kalmbach, 1937)	5	30 to 40

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SIXTH TECHNICAL SESSION

Wednesday Afternoon—March 20, 1940

Chairman: T. S. PALMER

Formerly of the U. S. Bureau of Biological Survey

INTRODUCED SPECIES

THE HUNGARIAN AND CHUKAR PARTRIDGES IN PENNSYLVANIA

RICHARD GERSTELL
Pennsylvania Game Commission

The Pennsylvania Game Commission in 1925 took the first steps in its attempt to establish the European grey partridge (*Perdix perdix perdix*), or Hungarian partridge as it is commonly called, within the Commonwealth. Private individuals had at times previous released small numbers of birds at widely scattered points within the State, but without exception these plantings had been failures, as the birds shortly disappeared.

The principal method followed by the Commission was to purchase and release wild-trapped birds secured from other countries. Roughly 96 per cent of the birds stocked were obtained from Central Europe, including portions of Hungary, Austria and Czechoslovakia. In recent years, approximately 2,100 partridges artificially propagated at the state game farms were turned out, while roughly 100 others were obtained from Canada in 1932.

The stocking program has now been intermittently carried on for a period of fifteen years. For purposes of discussion, however, these activities may best be treated as three separate periods. The first extended from 1925 through 1930; the second, from 1931 through 1934; and the third, from 1935 to the present.

From 1926 to 1930, inclusive, a total of 9,806 birds was received alive and released. The largest annual planting, made in 1926, involved 3,941 birds, while the smallest consisted of 1,106 individuals stocked in 1928.

During the period when these releases were being made, little information concerning the species was at hand. Thus, the early plants were made in numerous representative areas in the State for check purposes. Included in the sites were sections in the intensively farmed counties in southeastern Pennsylvania, the anthracite coal fields, the Allegheny Plateau, the Susquehanna River Basin and the rolling farm lands in western Pennsylvania. Naturally, the partridges were placed on agricultural rather than forested areas. In all, birds were placed in forty-three of the sixty-seven counties of the Commonwealth. As a rule, not more than twenty individuals, in even pairs, were put out at any given point. The largest county allotment for the period was 740 birds, while the smallest, an accidental escape, was one.

During the latter part of the winter of 1929-30, an extensive survey designed to disclose the status of the partridges was completed. In this, all the Commission's field employees cooperated by checking the number of birds in their respective districts. Counts were made at feeding stations and by the use of bird dogs.

The survey disclosed a total of 311 coveys of partridges containing 3,543 individuals. This represented only 36 per cent of the total number of birds released, but the fact that the census obviously could not have included all the Huns actually resident in the State must not be overlooked. Bevies were found in thirty-one of the forty-three counties in which releases had been made. Four counties showed totals higher than the stocking figures, the largest increase being roughly 90 per cent. Strange to say, the single individual accidentally released in Wyoming County had been joined by two companions, though the nearest point of release of other birds was approximately 30 miles distant.

The results obtained from the earlier plantings clearly revealed the fact, now so well known, that the Hun most frequently thrives on the richer soils where small grains are the principal agricultural crop. With the information gained, the stocking program was altered in 1930 so as to allow for a wiser use of the birds release.

In 1931 and 1932, additional birds in the number of 1,572 were turned out in nineteen counties. Following the plantings, a second survey similar to that just described was made.

This census revealed a total of 4,419 birds located in thirty-three counties. One county in which no birds had ever been released reported the presence of birds, while once again four showed populations greater than the total releases, the largest increase being 170 per cent. The population total disclosed by the count represented 37 per cent of the total number of birds planted. The single Wyoming County bird and its two companions had disappeared.

A total of 1,194 birds was released in 1933, while no plantings were attempted in 1934. Field checks indicated that the birds were slowly increasing in the grain growing sections, while the converse was true in other areas.

The restocking program was resumed in 1935 when 200 artificially reared birds were released. Also, the purchase program was then resumed and enlarged. From January, 1935, through October, 1939, a total of 21,287 birds was turned out. Of these, 19,132 were wild-trapped specimens imported from Europe, while 2,155 were raised on the state game farms. The birds were released, usually not less than 100 at one place, in the grain growing areas in twenty counties.

Bird dog censuses were made during September and October, 1938 and 1939, in sections of the Upper Susquehanna River Basin where the partridges appeared to be making their best stand. It was found that the distribution of the species was exceptionally "spotty," but numerous areas, from 100 to 300 acres in extent, were found to be supporting population densities of from one to two birds per acre. Because of the unusual distribution, which disclosed many areas apparently not carrying a single bird, it was impossible to arrive at any sound figure on the total number of birds in the district.

At its meeting in July, 1939, the Game Commission deemed it wise to subject the resident population in one particular region to a period of open shooting. Accordingly, the three counties of Lycoming, Northumberland, and Montour, which embrace the basin just discussed, were declared open to the killing of Hungarian partridges for a period extending from November 1 to 21, inclusive, Sundays excepted.

The area in question represents a portion of the State's best pheasant range, which is, consequently, quite heavily hunted. The total kill of partridges within the three counties was, however, estimated to be only 275. Field checks constantly conducted during the open season clearly showed that the small kill could not be attributed to the presence of relatively few birds. In the first place, it was found that the great majority of Pennsylvania hunters, being unaccustomed to the quick rise and relatively long flights characteristic of the species, failed to make the most of their opportunities. Secondly, after the first day's intensive shooting, the birds had become so frightened that even experienced hunters with good dogs rarely found it possible to get within gunshot of the ever alert coveys. Though many persons had believed that the open season would result in the complete annihilation of the entire population in the district, it is definitely known that only an exceedingly small portion of the birds fell prey to the gunners.

Since the open season in the three counties apparently did not reduce the resident partridge population appreciably, it has been decided to refrain from making additional plantings in the region this season and to again subject the birds to gun pressure during the fall of 1940, checking carefully the results of such action. As a matter of fact, the Commission is giving serious consideration to the wisdom of declaring a short, carefully regulated, state-wide open season for the shooting of Hungarian partridges during late 1940.

The experiences so far encountered would seem clearly to point to the fact that the Hungarian partridge is now permanently established on a sporting basis in Pennsylvania. It is, however, well realized that good shooting can be expected only in those few sections of the State which are primarily devoted to the production of small grains and that additional plantings either of wild-trapped or artificially reared birds may from time to time be necessary.

To state and federal administrators, as well as to research workers and sportsmen, the cost of establishing any exotic species is of particular interest. Fortunately, in the case of the Hun, Pennsylvania is in position to present accurate figures on the subject. Including the purchase of 1,850 birds which were lost during a quarantine period in force during 1929, the total delivered cost of the thirty-one odd thousand wild-trapped birds was $124,545.76. Though accurate records are difficult to obtain, it is felt that $3.00 is a fair figure for the cost of raising one partridge on the state game farms. Thus, the expenditure involved in producing the 2,155 artificially reared birds was approximately $6,465. This means that the total cost of all birds utilized in the fifteen-year-stocking program was just under $131,000.00. Since little or no other money was spent directly and solely for the program, the sum stated may fairly be considered the cost of establishing the species on a sporting basis.

At first glance the figures just presented may seem exceptionally high, but if additional data on the expenses involved in establishing the same and other species in various regions were available, it is entirely possible that the program might be shown to be comparatively inexpensive.

The Commission's first tests with the chukar partridge (*Alextoris graeca* sp.) were made in 1936 when sixty-eight birds were liberated in northwestern Pennsylvania. In that and the succeeding years a total of 2,021 birds was released in carefully selected areas within the Commonwealth.

Some few of the birds were wild-trapped individuals secured from Indo-China through the well known "Bring 'Em Back Alive" Frank Buck. The remainder were artificially propagated individuals of several different strains.

As a general rule, regardless of the time and place of release, the birds shortly dispersed in all directions, completely vanishing within a period of a few weeks. Several pairs of birds are known to have brought broods off the nest, but their ultimate fate is unknown. One bird, planted in the spring of 1937, is definitely known to have survived the winter immediately following. Shortly after it was turned out, this individual appeared at a farm roughly 20 miles from the point of release. There it "took up with" a flock of domestic turkeys on free range, accompanying the latter during their daytime wanderings and roosting with them at night. Apparently it suffered not at all from the winter extremes. In the spring of 1938, an additional forty birds were turned loose at the place the one individual had wintered, but within one week all the flock, including the winter resident, had disappeared.

The only release which showed any particular promise of success was one made in the spring of 1939 on a high, rocky and comparatively barren mountain top in northeastern Pennsylvania. It was there that the few broods of young previously mentioned were observed some months after the birds were liberated. In that place too the characteristic bowl-shaped "workings" hollowed in the snow and earth by the birds were frequently noted. It is from this habit that the chukar's scientific name is derived. Eventually, however, these individuals also disappeared.

Apparently all plantings made by the Commission have failed, while private efforts along the same lines have met with the same fate. In view of this fact, attempts to establish the species are being discontinued, though 500 birds now on hand will shortly be released in the wild because it has been impossible to dispose of them otherwise.

Since the majority of the birds stocked were raised incidental to the regular activities at the state game farms, no cost records are available. Thus, in this case, it is impossible to state the expenses incurred in the experiment.

THE INTRODUCTION AND TRANSPLANTATION OF GAME BIRDS AND MAMMALS INTO THE STATE OF NEW YORK

GARDINER BUMP
New York State Conservation Department

The history of wildlife conservation, as with any other great movement, is a story of trial and error, of advances and retreats, of pushing forward three steps and sliding back two. But because of the interest, intensive and active, but not always understanding, which a large section of our population takes in this work, our progress is likely to be at best lopsided. Panaceas and "quick result" remedies catch the public eye and inspire our imagination. There then arises a hue and cry for such projects out of all proportion to the probable productiveness of the supposed panacea.

This is particularly true when we consider the introduction or transplantation of game birds and mammals. Beginning with the migratory quail in the 1870's, the hunt for new game species has been widespread and persistent. A few outstanding successes have effectively minimized the failures that have characterized most attempts. Even today we keep up the search, for many still believe in miracles.

It is not here necessary to evaluate the two schools of thought governing the shifting of wildlife populations. Leaving aside the biological implications involved, it is rather the purpose of this paper to preserve the fast vanishing record of man's attempts to fit exotic species into new ecological niches in New York State, or to re-establish depleted native wildlife. The amount of time, effort and money involved has been substantial, and the results are well worth recording. In a state like New York, with its wide range of environments and its still increasing number of individuals who look to the out-of-doors for recreation and diversion, there are wide areas, notably the deep woods, and our cultivated although usually agriculturally submarginal uplands, where no game birds today exist in any numbers. The same may be said of many of our watercourses, though certain waterfowl are extending their utilization of them in this State. As long as a wide public interest in and demand for this type of wildlife management exist, the search for species desirable as game and adaptable enough to fill these and other ecological situations will continue. Herein lies our opportunity to rationalize the selection of species and to improve our introduction practices.

The records here presented come from a wide variety of sources and individuals. Some, notably from the great preserves in the Adirondacks and from State files, are relatively complete, informative and accurate. By way of rounding out the picture, there have been included some records of species introductions, the exact time, place or number of which are not now available.

The story opens with the introduction of the migratory or Egyptian quail prior to 1880, and the end is not yet in sight. During this period at least eighteen species of game mammals and twenty-one game birds have been imported, many in considerable numbers. From 1890 through 1910 the most active group in the introduction of the larger game mammals and birds was the great preserve owners of the Adirondacks. Thereafter, interested individuals and clubs took over the bulk

GAME BIRDS

When Introduced	*Where Introduced*	*By Whom*	*How Many*	*Age*	*Physical Condition*	*Background*	*Reported Results*
Mallard Duck (*Anas platyrhynchos*)							
Annually	Dutchess Co., Delaware Co., Long Island	Individuals or Private clubs	10,000-15,000 yr.	Adult	Good	Semi-domestic	A few nested
1912 to date	Sherburne Game Farm	State of New York	25-500 yr.				Spread 40 miles
1934 to date	Research Ctr. Delmar	State of New York	25-200 yr.	Adult	Good	Semi-wild	Many nested, slowly extending territory
1934 to date	Howlands Is. Refuge	State of New York	25-200 yr.				
1934 to date	Tompkins, Chenango, Madison, Jefferson, Albany, Saratoga Co.	State of New York	801 923 834	3 5 7	Good	Semi-domestic	Survival until full-winged: 3 wk. about 50% 5 wk. about 60% 7 wk. about 70%
1934 to date (spring)	Favorable situations over State	State of New York	2,979	Adult	Good	Semi-wild	About 70% nest on ponds where liberated
1920	Cayuga Lake	State of New York	150-500	Adult	Good	Semi-wild	Non-migratory; increasing slowly
Cayuga Duck or Flanders Duck (*Anas rubripes* × *A. poecilorhyncha*)							
?	Cayuga Lake	Local residents	?	Adult	?	East India Black × Black Duck	Non-migratory; increasing slowly
?	Suffolk Co. (L. I.)	Flanders Club	100-500 yr.	Adult	Fair	East India Black × Black Duck	Non-migratory; occasionally nest
Wood Duck (*Aix sponsa*)							
1913 to date	Sherburne Game Farm	State of New York	2-150 yr.	Adult	Good	Semi-wild	Migratory, nest locally
Canada Goose (*Branta canadensis*)							
1919	Sherburne Game Farm	State of New York	2-40 yr.	Adult	Good	Semi-wild	Non-migratory, breed locally
1934	Research Ctr. Delmar Howlands Is. Refuge	State of New York State of New York	5-40 yr.	Adult	Good	Semi-wild	Non-migratory, breed on area
Mute Swan (*Sthenelides olor*)							
Prior to 1900	L. I., lower Hudson	Private estates	?	Adult	?	Domestic	Non-migratory, increasing slowly
Guinea Fowl (*Numida meleagris*)							
1886-90	Tuxedo Park	Tuxedo Pk. Club	?	?	?	?	Disappeared
Wild Turkey (*Meleagris gallopavo*)							
Before 1893	Tuxedo Park	J. L. Breese	?	?	?	Wild-trapped	Disappeared
1912-14	Skylake Preserve, Broome Co.	W. S. Kilmer	150 (?)	Adult	?	?	Disappeared 3-4 years
1932	Cattaraugus Co.	Local game club	12 (?)	Adult	?	?	Disappeared 2-3 years

When Introduced	Where Introduced	By Whom	How Many	Age	Physical Condition	Background	Reported Results
1930-36	Capt. Dist., DeBar Mt., Howlands Is. Refuges	State of New York		Adult	Good	Hand-raised in State by W. Randall, W. Sanderson and State of N. Y.	Migrated or gradually disappeared
Black Grouse (*Lyrurus tetrix*)							
About 1900	Litchfield Park (Hamilton Co.)	E. H. Litchfield	6	Adult	Poor	From Germany	Disappeared
1906	Bay Pond Preserve (Franklin Co.)	Wm. Rockefeller	6 (male) 12 (fem.)	Adult	?	From Germany	One brood raised following yr.; one male seen 1 yr. later; one seen about 1912 (?)
Capercailzie (*Tetrao urogallus*)							
1906	Litchfield Park	E. H. Litchfield	12	Adult	?	?	Disappeared
1906	Bay Pond Preserve	Wm. Rockefeller	4 (male) 8 (fem.)	Adult	?	Via Germany	Disappeared
Ruffed Grouse (*Bonasa umbellus*)							
1931	Conn. Hill Refuge	State of New York	40	Adult	Fair	Wild (Alberta)	Apparently survived, few bred
1931	Conn. Hill Refuge	State of New York	5	Adult	Good	Hand-raised	2 survived to following season
1934	Conn. Hill Refuge	State of New York	13	Adult	?	Hand-raised	Apparently survived, few bred
1934	Alder Cr. Preserve (Franklin Co.)	Robert Lehman	56	Adult	?	Wild, from Alberta	?
1935	Conn. Hill Refuge	State of New York	27	Adult	Poor-Good	Hand-raised	Apparently survived, few bred
1935	Hyde Park (Dutchess Co.)	State of New York	10	Adult	Good	Hand-raised	?
1933-36	Aknusti Preserve (Delaware Co.)	Robert L. Gerry	96	Adult	?	Wild, Alberta	Apparently survived, few bred
1938	Conn. Hill Refuge	State of New York	12	Adult	Poor-Good	Hand-raised	Apparently survived, few bred
1938	Pharsalia Refuge	State of New York	81	Adult	Poor-Good	Hand-raised	Apparently survived, few bred
1939	Camp Fire Club Preserve (West. Co.)	State of New York	6	Adult	Good	Hand-raised	Apparently survived, few bred
Eastern Pinnated Grouse or Heath Hen (*Tympanuchus cupido cupido*)							
1916	Long Island Game Farm	State of New York	21	Adult	Good	Wild, Martha's Vineyard	Killed by predators or disease
Pinnated Grouse or Prairie Chicken (*Tympanuchus cupido americanus*)							
1872	Pine Barrens, L. I.	W. E. Newton (Smithtown)	60 (?)	Adult	?	Wild, Iowa	Bred but later disappeared

When Introduced	Where Introduced	By Whom	How Many	Age	Physical Condition	Background	Reported Results
Sharptail Grouse (*Pedioecetes phasianellus*)							
March, 1939	Partridge Run Game Mgt. Area (Albany Co.)	State of New York	22	Adult	Fair	Wild, Wisconsin	Disappeared shortly
March, 1939	Conn. Hill Game Mgt. Area (Tompkins Co.)	State of New York	10	Adult	Good	Wild, Wisconsin	3-4 birds contacted 9 mo. later
California Quail, Valley Quail and Mountain Quail (*Lophortyx californica* and *Oreortyx picta*)							
1874	Gardiner's Island	?	About 48	Adult	?	Wild, part Mt. and part Valley	Disappeared
?	Wayne Co.	H. W. Griffith	?	Adult	?	?	Bred, later disappeared
Bobwhite (*Colinus virginianus*)							
1886-90	Tuxedo Park	J. L. Breese	3,000-4,000	Adult	?	South (?)	Strayed and disappeared
Since about 1890	Principally L. I.	Private individuals and clubs	?	Adult	?	Wild, from West, Southwest and South	Interbred with native stock
1930	Long Island	State of New York	750	Adult	Fair	Mexico	Interbred with native stock
1930-39 (summer)	Principally Southern N. Y.	State of New York	422	Adult	Good	Hand-raised	Bred widely
1932-39	44 Cos. in State	State of New York	39,672	Immature	Good	Hand - raised, State Quail Farm, Wis., Va., L. I., breeders	Bred widely
1930-37	44 Cos. in State	State of New York	23,164	Immature	Good	Purchased, hand-raised, mostly from Va.	Bred widely
1937-39 (spring)	Long Island and Westchester Co.	State of New York	3,728	Adult	Good	Hand-raised	Bred very widely
Hungarian Partridge (*Perdix perdix*)							
Prior to 1917	Batavia (Genesee Co.)	?	?	Adult	?	?	Bred, a few survived to date
Prior to 1925	Northeastern N. Y.	?	?	Adult	?	?	A few survived to date
1927-32	Statewide	State of New York	17,731	Adult	Poor-Good	Wild, Europe	Mostly disappeared and holding own or abundant in 1 or 2 sections
Chukar (*Alectoris graeca*)							
1936-39	Aknusti Estate (Delaware Co.)	Robert L. Gerry	25-150 yr.	Adult	Good	Hand-raised	Many shot and none bred; a few remain
Migratory or Egyptian Quail (*Coturnix coturnix*)							
About 1875	?	?	?	?	?	?	Disappeared

When Introduced	*Where Introduced*	*By Whom*	*How Many*	*Age*	*Physical Condition*	*Background*	*Reported Results*
Ringneck, English, Chinese or Mongolian Pheasant (*Phasianus* sp.)							
1886-90	Tuxedo Park (Orange Co.)	J. L. Breese	4,000	?	?	English pheasants, hand-raised at Tuxedo Park	Strayed and disappeared, many shot
1891	Tuxedo Park (Orange Co.)	?	120	?	?	Hand-raised	100 shot immediately, rest disappeared
About 1895	Litchfield Park and Nehasane	W. H. Litchfield W. Seward Webb	A few	Adult	?	Hand-raised	Disappeared
1896-1902 (?)	Harriman Estate (Orange Co.)	E. H. Harriman	300-500	?	?	Hand-raised English ph.	Strayed and disappeared
1897	Central Park (N. Y. City)	American Acclimatization Soc.	?	Adult	?	English ph.	Disappeared
1897-1904	Generally over State	State of New York	1,191	Immature	Good	Hand-raised, Pleasant Valley Hatchery	Disappeared
1903	Geneseo	Wm. Wadsworth	350	Adult	?	?	?
1909-39	Statewide	State of New York	538,964 3,519,179	Immature Eggs	Good	Hand-raised on 5 game farms	Established, up to 500,000 shot annually
1909-34	Statewide	State of New York	More than 15,000	Adult	Good	Hand-raised, Sherburne Game Farm	Established, up to 500,000 shot annually
1916	Bay Pond Preserve	Wm. Rockefeller	50 (male) 100 (fem.)	Adult	?	English ph.	Bred but could not winter
1934-39	Statewide	State of New York	39,901	Adult	Good	Hand-raised, Wis., Iowa, Mass., Conn., N. J., Pa., N. Y.	Established, up to 500,000 shot annually
Melanistic Mutant (*Phasianus* sp.)							
1931-33	Conn. Hill Refuge, Pharsalia Refuge, Capt. Dist. Refuge, Over State (few)	State of New York	Over 600 Over 40	Young Adult	Good	Semi-wild	Inter-bred with ring-necked pheasant
Reeves Pheasant (*Syrmaticus reevesii*)							
1931	Chenango Co., Dutchess Co. (few)	State of New York	102	Adult	Good	Semi-wild	Disappeared
1932-33	Conn. Hill Refuge	State of New York	29 ('32) 1 ('33)	Adult Adult	Good	Semi-wild	Last reported Nov., 1934
1932	Conn. Hill Refuge	State of New York	34 E	Eggs	Fair, all hatched	From semi-wild stock	Disappeared
1933	Conn. Hill Refuge	State of New York	14	Young	Good	Semi-wild	Last seen May, 1934
1933	Capt. Dist. Refuge	State of New York	54	Adult	Good	Semi-wild	Disappeared

GAME MAMMALS

When Introduced	*Where Introduced*	*By Whom*	*How Many*	*Age*	*Physical Condition*	*Background*	*Reported Results*
Raccoon (*Procyon lotor*)							
1939	?	Western N. Y. Coon Hunters Ass'n	50	Adult	Good	Pen-raised	?
Red Fox (*Vulpis fulva*)							
Occasionally	Geneseo, Millbrook (Dutchess Co.)	Wadsworth Estate Moffatt Estate	?	Adult	?	Imported from within and outside State	Increased
Coyote (*Canis latrans, nebracensis* or *lestes*)							
About 1928 (?)	Ontario Co.	?	8 (?)	?	?	Imported and escaped	Killed several years later
About 1934	Saratoga, Columbia, Franklin, Albany Cos.	?	?	?	?	?	Gradually disappeared (?)
Timber Wolf (*Canis lycaon*)							
About 1930	Southern Franklin Co. (?)	Local residents	?	?	?	Imported and escaped	Crossed with dogs; increasing slowly (?)
Fox Squirrel (*Sciurus niger*)							
?	Ithaca	Cornell University	?	?	?	Wild-trapped	Survived for several years
1939	Howlands Is. Refuge	State of New York	44	Adult	Good	Wild from Wisconsin	Good survival to date
Beaver (*Castor canadensis*)							
1901-06	Litchfield Park	E. H. Litchfield	12	?	?	Wild-trapped	Increased
1902	Lake Kora (Hamilton Co.)	T. L. Woodruff	2	Adult	?	Wild Canadian	?
1902-03	Whitney Preserve	W. C. Whitney	?	?	?	Wild, Canadian origin	Rapidly increased
1904	So. Branch (2), Moose River, Head of Big Moose Lake	State of New York	6	Adult	?	Wild Canadian	Increased
1907	Fulton Chain (8), Lake Teror (4), Little Tupper Lake (2)	State of New York	14	Adult	Good	Yellowstone Park	Increased greatly
1906	Lake Placid	G. A. Stevens	1	Adult	?	Wild Canadian	?
Muskrat (*Ondatra zibethica*)							
Occasionally	Central N. Y.	Muskrat marsh owners	?	Adult	?	Maine, wild-trapped	Interbred with native stock

When Introduced	*Where Introduced*	*By Whom*	*How Many*	*Age*	*Physical Condition*	*Background*	*Reported Results*
Varying Hare (*Lepus americanus*)							
1927-33	Mainly in Clinton, Essex, Warren, Franklin, Herkimer, St. Lawrence, Sullivan, Delaware, Cattaraugus, Albany, Rensselaer Cos.	State of New York	25,696	Adult	Good-Fair	Wild, from eastern Maine	Some bred; many disappeared
1933-37	Same as above	State of New York	32,700	Adult	Good-Poor	Wild, from Wis. and Minn.	Some bred; many disappeared
European Red Hare (*Lepus europaeus*)							
1890 (?)	Dietrich Estate (Dutchess Co.)	?	Many	Adult	?	Wild, from Europe	Increased
1893-1910	Millbrook, White Plains	?	Several thousand	Adult	?	Wild, from Europe	Increased slowly, now stationary or decreasing
Cottontail Rabbit (*Sylvilagus* sp.)							
1928-32-37	Many Cos. throughout State	State of N. Y., Game clubs and individuals	46,973	Adult	Good-Poor	Wild, mainly from Mo., Kan., Okla.	?
Annually			2,000-5,000 yr. (?)	Adult	?		
Wild Boar (*Sus scrofa*)							
About 1900	Litchfield Park	E. H. Litchfield	15-20	?	?	From Germany	Maintained themselves for 20 years
Elk or Wapiti (*Cervus canadensis*)							
1895 (?)	Litchfield Park	E. H. Litchfield	12	?	?	?	Remained several years; left by 1910
1896-1902	Litchfield Park	E. H. Litchfield	60	?	?	?	
1893	Nehasane Preserve	W. Seward Webb	37	?	?	Wyoming	Increased but apparently did not survive the fire of 1903
1894	Nehasane Preserve	W. Seward Webb	29	?	?	Wyoming	
1901	Forked Lake (Hamilton Co.)	State of New York	22	?	?	From Mass. Preserve	Moderate increase for several years but subsequently disappeared, poaching being a significant factor.
1902	Whitney Preserve (Little Tupper Lake)	W. C. Whitney	40	?	?	?	
1902	Raquette Lake	State of New York	20	?	?	?	
1902	Bay Pond Preserve	W. A. Rockefeller	8	?	?	Preserve at Greenwich, Conn.	Stags became ugly and were killed, after which rest disappeared
1903	Saranac Inn	Adirondack Guides Ass'n	11	?	?	?	Moderate increase for several years but subsequently disappeared, poaching being a significant factor
1903	Whitney Preserve (Little Tupper Lake)	W. C. Whitney	11	?	?	?	
1903	Paul Smith's	State of New York	51	?	?	?	
1903	Big Moose Lake	Binghamton Park Comm.	5	?	?	?	

When Introduced	*Where Introduced*	*By Whom*	*How Many*	*Age*	*Physical Condition*	*Background*	*Reported Results*
1906	Lake Harris (Essex Co.)	Adirondack Guides Ass'n	9	Adult	?	?	?
1906	Woodruf Pond (Essex Co.)	Adirondack Guides Ass'n	8	Adult	?	?	?
1906	Lake George (Warren Co).	Local resort owners	4	Adult	?	?	?
1906	Tongue Mt. (Warren Co.)	Local resort owners	5	Adult	?	?	?
1916	Adirondacks	State of New York, B.P.O.E.	Carload	?	?	?	?
1917	Harriman Estate (Orange Co.)	E. H. Harriman	60-75	?	?	Montana	Only 15-18 survived first winter but these increased
1932	DeBar Mt. Refuge	State of New York	6	Adult	Good	Blue Mt. Preserve (New Hampshire)	14 seen in 1937
Red Deer (*Cervus elephas*)							
1905-08	Bay Pond Preserve	Wm. Rockefeller	3 (male) 5 (fem.)	?	?	Semi-domesticated from his Conn. park	Stags became dangerous second fall and were shot; rest gradually disappeared
Japanese Deer (*Cervus sika*)							
1904-10	Bay Pond Preserve	Wm. Rockefeller	8 (male) 12 (fem.)	?	?	Via Germany	Bred; maintained numbers for several years
German Deer (*Capreolus capreolus*)							
1902-03	Bay Pond Preserve	W. A. Rockefeller	12	Adult	?	Germany	Disappeared
Siberian Deer (*Capreolus pyrargus*)							
1902-03	Bay Pond Preserve	Wm. Rockefeller	6	Adult	?	Germany	Stags became ugly and were shot; rest disappeared
Whitetail Deer (*Odocoileus virginianus*)							
1886	Tuxedo Park	Tuxedo Park Club	15-20	?	Good	?	Increased rapidly. About 50 turned loose in 1905
1896	State Park (Ulster Co.)	State of New York	45	?	?	Wild, Adirondack	Increased
1917 (?)	Adirondacks	State of New York	50	Good-Poor	?	Wild, on preserve	?

When Introduced	*Where Introduced*	*By Whom*	*How Many*	*Age*	*Physical Condition*	*Background*	*Reported Results*
Mule, Blacktail Deer (*Odocoileus hemionus* or *columbianus*)							
1894	Nehasane Preserve	W. Seward Webb	2	?	Adult	Western blacktail	Killed 1903 fire (?)
1895-1900	Litchfield Park	E. H. Litchfield	A few	?	Adult	Western blacktail	Disappeared
Moose (*Alces americana*)							
1894	Nehasane Preserve	W. Seward Webb	2 (male)	?	Adult	?	?
1895	Nehasane Preserve	W. Seward Webb	8 1	? ?	Adult Young	?	Probably died in 1903 fire
1902-03	Uncas Station (near Racquette Lake)	State of New York	6 (male) 6 (fem.)	?	?	?	Reported for several years
1903 (?)	Saranac Inn	W. C. Whitney (?)	A few	?	?	Semi-domesticated from Whitney's Mass. preserve	Reported for several years
Pronghorn Antelope (*Antilocapra americana*)							
	Nehasane Park	W. Seward Webb	2	?	Adult	?	Disappeared

of the introductions, with the State becoming the single largest importer (except for pheasants) since 1927.

For the sake of clarity the records are organized chronologically under each individual species.

As one scans this impressive list, it is impossible to escape the conviction that an enormous amount of time, energy, thought and funds have gone into the liberation of native and exotic game species in New York State. It is a dramatic story of the power of an idea in which men believe. But stimulating as the picture is, it also has its discouraging aspects. The proportion of successes to failures is rather higher than is the average for experiments. The difference lies, perhaps, in the lack of careful planning so characteristic of this particular type of project.

The inability to realize a few simple truths that largely determine success or failure in such projects, while human, might be difficult to understand were it not that we meet up with its counterpart today. Many of the species were of course hopelessly unsuited to the new environment into which they were introduced. Others might have survived had the initial stocking been followed up with repeated "shots in the coverts," giving the species a chance to really establish itself. Some, like the elk, probably would have thrived had not they fallen a prey to man's inevitable collecting instinct. Only the whitetail deer, the beaver and the adaptable ringneck pheasant stand out as beacons of encouragement.

Some may find in the items that should be considered before shifting game populations the answers they seek without the necessity of consigning dozens or thousands of individuals to separation from their native coverts, on the long chance that they may adapt themselves to a new environment. Briefly, some of these items are:

1. The environment in which the species is a native.
2. The ability of the species to adapt itself to changes in its native habitat.
3. The ability to live and increase rapidly on its native range in the face of strong competition.
4. The number to be introduced and the time over which the introduction is to be spread.
5. The condition of the new environment and the probable condition of the species upon arrival.
6. The time of year.
7. The proposed method and extent of distribution.
8. The willingness of man to protect and encourage the species.
9. The physiological adaptability inherent in the species itself.

All these and more enter into the ability of a game bird to adapt itself to a new environment. While the type of response cannot be predicted with certainty, many hopeless failures can be avoided, thus helping to place experimental acclimatization attempts on a more rational basis in the future.

THE ROLE OF EXOTICS IN THE OHIO VALLEY

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Few controversial subjects have resulted in more bias and misinformation, or in more heated battles of words, than discussions of what our policies should be concerning so-called "native species" as opposed to "introduced species." In most cases unreasonable prejudices have developed against exotic species, with bias rampant in favor of "native forms." Positions have been taken that are wholly untenable and that cannot be consistently maintained for any environment that includes man. The result has been, as happens in most controversies—no search for truth, no solution of the problem.

Criteria *can* be set up for determining species values, even though due allowances must be made for each point of view concerned. It seems obvious that the qualities of a species should be evaluated impartially, without respect to its origin. Men, as individuals, have inalienable rights to be judged on the basis of *what they are* and *what they can do,* irrespective of race, creed, color, or point of origin. Likewise, animal species, exotics or endemics, should be favored or discouraged by man according to the performance of each—judged on the basis of what each can contribute to conditioning habitats and populations toward desired objectives. A scientific attitude challenges any arbitrary classification of all exotics as "inferior" and all native forms as "superior."

Man, by land-use modifications, has been responsible for the introduction or the exclusion of hundreds of plant and animal forms. His propensities for thus conditioning habitats, result unintentionally in wholesale manipulations of plant and animal life. Compared with these, man's intentional changes in either flora or fauna, are trivial. Thus to content that all exotics should be excluded and American habitats kept "inviolate," is but the idealistic striving for a will-of-the-wisp.

If American civilization were to be limited to "native" forms for all required plant and animal products, yields would be so low that agricultural uses would necessarily confiscate every acre of land to support 130 million people. Horticulture, floriculture, and the plant and animal industries, have not been able to limit their "tools" to native stocks. In producing crops of cultivated plants and domesticated animals, it has been found to be good economics and good sense to bring in from every corner of the earth organisms that could exceed native types in performance.

Likewise, in the production of wildlife crops, performance records should dictate the species upon which the greatest management efforts should be centered. The record shows that many native species have low productivity ratings in "natural" habitats. Others are unable to produce adequate crop surpluses on lands modified through agricultural practices. If game crops approaching even present demands are to be produced, it necessarily follows that all species, of whatever origin, that can contribute to that end, must be utilized.

It is imperative that distinctions be made between new introductions and the utilization of exotics that have already become naturalized. The latter are now a vital part of our flora and fauna—and wishful thinking will not make it otherwise. The only sensible procedure is to so utilize and so manage these introduced forms that they contribute most and detract least from what already existed. Unfortunately man tends to lag behind other organisms in making adjustments to altered land-use shifts or biotic patterns.

New introductions should be made with extreme caution and under strict quarantine regulations to control disease. The hit-and-miss procedures followed in the past are now inexcusable, as well as dangerous and expensive. When exhaustive habitat analyses disclose that altered land-use changes have created new types of food and cover resources—brought into existence a new habitat niche that no desirable native species can occupy—then we should deliberately seek out an exotic form that has the specifications necessary to meet the given situation.

Long-time population and environmental analyses for both the old and the new home should be evaluated before making decisions about new species. Twomey (1936) made an initial contribution to this understanding. It should hardly be necessary to point out that exhaustive and continuous follow-up investigations of introduced species are golden opportunities for unraveling the true nature of environments, for determining the potentialities of species, and for understanding laws governing populations.

Several pertinent principles are self-evident:

1. It is impossible to maintain our fauna in anything like its original balance, whether new species are introduced or not, because of man's land-use modifications of virgin habitats.

2. There are very few foreign species that can or will gain a foothold in this country—hence, our potential utilization of exotics is very limited. We have few ecological niches, unoccupied or otherwise, into which exotic species can fit.

3. Primitive or even seminatural habitats are immune to invasion by most exotic species. In other areas, however, introduced species, if carefully selected, can make valuable contributions by occupying empty habitat niches. Only a limited number of native species are adapted to the immense tracts of open lands or ''artificial prairies'' known as agricultural areas.

4. As American land-use patterns and soil fertility levels approach those that have been existent for centuries in the Old World, the more likely we are to come to depend, at least where annual wildlife crops are concerned, upon Old World species that have demonstrated an ability to prosper under such conditions.

5. Wildlife planting or zoning should be practiced, i.e., management and stocking should give precedence to endemics in the natural environments to which they properly belong and restrict exotics (as far as practicable) to those artificial environments that bear the stamp of man's handiwork so markedly that native forms are excluded. Fortunately this zoning tends to be automatic as a result of the operation of natural (ecological) laws.

In 1928 there were about 700 species of exotic birds in the United States (Phillips, 1938). All were kept in captivity, however, except for about a dozen species that have been able to establish themselves under American conditions. Introductions of exotic birds have during some years averaged about a thousand individuals a day—nearly all consigned to zoos or private aviaries, except for irregular mass shipments of certain game birds that have long been established here. Hence, the actual or potential menace from introduced species has been much exaggerated, and successes with exotic mammals are even fewer than those with introduced birds. Scores fail for every one that succeeds and successes are usually partial or sharply restricted in area.

In the Ohio valley, save for house rats and mice, not a single exotic mammal has become generally established. It is inconceivable that any introduced game species could become numerous enough to acquire pest status, since our enormous hunting pressures guarantee adequate control. As with deer, rabbits, or elk, some may wish to maintain population levels that result in damage to the property of others, but such problems of policy develop as frequently with native species as with introduced forms.

Introductions of exotic non-game birds that consume grain or fruit are most likely to be unwise. The English sparrow and the European starling, outstanding examples, nevertheless, now occupy ecological niches that for the most part were not filled by native species. Both of these species have admitted ''nuisance'' values about the haunts of man. Their adverse effects on native species, however, have for the most part not been substantiated. Bias has colored most evaluations of their economic status. Actually that of the English sparrow is approximately ''neutral,'' and abundant evidence indicates that the starling has many more plus than minus values.

In Ohio and most of the entire Ohio valley, introduced plants provide the bulk of the food and cover resources of all wildlife species existing in open or agricultural areas. Such a list would include most of the grasses, grains, and other cultivated crops, and the weeds which these crops make possible—wheat, oats, rye, barley, buckwheat, green and yellow foxtail, soybeans, alfalfa, sweetclovers, clovers, several lespedezas, and several of the smartweeds, for example. Native species have, in many cases, demonstrated a limited ability to utilize these introduced and artificially produced types of food and cover. Hence, introduced game birds (pheasants and Hungarian partridges) play an important role owing to their frequent greater ability to utilize these untapped food and cover resources of agricultural lands, and at the same time produce game harvests. The Ohio valley, being largely zoned for agriculture, ranks high in its opportunities for the use of exotic species.

Of Ohio's 40,740 square miles, 80 per cent is in agricultural lands. Ohio has an average hunting pressure of 16.4 hunters on each and every square mile. Since for various reasons one-fifth of Ohio is nonproductive of game crops, the actual hunting pressure is 20.5 hunters to the square mile on hunting lands or one hunter to 31 acres. This tremendous recreational pressure is absorbed by the following species: (1) natives produced in natural or seminatural habitats (gray squirrel, ruffed grouse, deer, and waterfowl), 12 per cent; (2) natives that were rare or absent in Ohio when the white man arrived, but that have been able to establish and maintain themselves, utilizing agricultural lands where not too intensively cultivated (rabbits, bobwhite, and fox squirrel), 71 per cent; and (3) introduced game birds (pheasant and Hungarian partridge) that more effectively utilize agricultural lands and have sufficient mobility to follow shifting food and cover resources, 17 per cent. All three groups, plus a fourth (fur animals), are necessary to provide varied and adequate hunting.

At present exotic species absorb no more than one-fifth of the hunting pressure, the native cottontail one-half. Land-use trends indicate that during the next twenty-five years the relative contributions of exotic game birds and of forest wildlife species will increase—while the role of native species on agricultural lands (rabbits, bobwhite, and fox squirrels) will be less important than today.

No introduced game bird has been successful in the southern part of the Ohio Valley. Western and northwestern Ohio are more typical of the intensively cultivated portions of the Ohio Valley and the lower

Great Lakes region where the role of exotics is particularly important. Such areas are productive of only three game animals, two of which are exotics. Fifteen of these counties received exhaustive surveys of their upland game bird populations in 1938 and 1939. This district of 6,700 square miles had average game populations (as of November 1) per square mile as follows: 84.7 bobwhites, 89.00 pheasants and 8.6 Hungarian partridges. Thus exotics made up 51 per cent (in number) or 87 per cent (by weight) of the total upland *game bird* population.

Data are also available on the relative contribution of introduced and native species to recreation and hunting bags. In Wood County, with 93 per cent of all land in farms, save for a few fox squirrels, there are only three game animals to hunt—rabbits, pheasants and partridges. Monograph reports for 1937 and 1938 hunting seasons (Hicks, 1937, 1938 and 1939) indicated that the three classes of hunters participating in the Wood County game harvest had average season bags of 4.44 rabbits, 6.03 pheasants and 0.355 partridges. In this case the two exotic species furnished 59 per cent of the season's bag (in numbers), or if the relative recreational values of the three species be computed on a 1:3:4 ratio, the exotic species provided 85 per cent of the sporting enjoyment furnished by the game crop.

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GAME INTRODUCTIONS IN MICHIGAN

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Experience with introduced game species in Michigan is somewhat limited. Reindeer, moose, elk, pheasants, Hungarian partridge and sharptail grouse have been introduced by the State. A number of spasmodic introductions of other forms such as wild turkey, capercaillie and lately the chukar partridge have been made by private interests.

Reindeer—In 1922, sixty mature reindeer from Norway were imported and released at a total estimated cost of perhaps $125,000.00. Within five years the experiment was considered unsuccessful even though a few animals were reported after that time. The causes of failure were not definitely determined in spite of reports of veterinarians and others. An infestation of grubs (*Hypaderma tarandi*), tissue lesions, internal parasites, hemorrhage, partial paralysis, deficiencies in diet—none could be singled out as the one determining agent of success or failure. Young were born, twelve the first year, of which seven were born dead or died soon after birth, but no increase in the herd was noticed.

In 1922 whitetail deer were well established in the area where the reindeer were released and the deer were increasing. About 1929 or 1931 deer had reached a peak but no one knows whether the presence of deer had any effect upon the possibility of reindeer success.

Moose—As early as 1929 it was apparent to investigators that the moose herd on Isle Royale, estimated to number about fifteen animals per square mile, faced an inevitable shortage of food in the near future.

A live-trapping project during three winters from 1934 to 1937 took seventy-one animals, thirty-eight females and thirty-three males. They were released in the Upper Peninsula. A few native moose occupied these areas for several years prior to these releases.

Calves have been frequently reported in the spring, giving good assurance that the animals are breeding. Three calves have been produced from the animals held in captivity at Cusino for study.

Accidents and poaching have taken some toll. Two of the original animals identified by ear tags were shot by hunters and six others are known to have died of accidents or other causes.

At least one of the releases seems to be doing fairly well. The decrease of the herd on Isle Royale has been confirmed by numerous field investigations so that we believe the animals taken would possibly have died of starvation if they had remained. The moose is native to Michigan, so the work cannot be criticized on the basis of bringing in an exotic species. No one knows whether sufficient changes have taken place to make the habitat suitable enough for restocked moose to survive since the time when moose previously occurred on the Michigan mainland in any numbers.

Elk—In 1918 about fifty elk were released in Roscommon, Alpena, Otsego and Cheboygan Counties and a subsequent planting of sixteen was made in Roscommon County in 1932. The Otsego County planting has succeeded fairly well, the present herd being estimated at 300 to 500 animals. The other plantings have dwindled until only an occasional report is received of animals seen. It is probable that only the Otsego County herd will persist, although it is doubtful whether they will ever offer much hunting.

Pheasants—Due to clearing of the land for agricultural development, the range of native ruffed grouse and prairie chicken had been restricted in the southern part of Michigan. The first private introductions of pheasants were made in 1893 but it was not until 1916 that the Conservation Department established a game farm and greatly increased the release of birds. Between 1917 and 1925, approximately 35,000 adult birds and 222,000 eggs were distributed to private individuals and clubs who were to hatch, rear and release the birds in their locality. By 1925 the birds were plentiful enough to justify an open season which has continued ever since.

While pheasants have been released since 1925, it is evident that the role of production and release is becoming less important.

Sharptail Grouse — The sharptail grouse can hardly be called an exotic in Michigan, yet we are including it in this discussion because it presents a type of problem that must be recognized. In 1904, an expedition from the University of Michigan found the northern form of sharptail grouse on Isle Royale. Good records of the birds' occurrence on the mainland were not available until 1922. This sub-species was the prairie form (*Compestris*). The early records are greatly confused by the presence of the prairie chicken (*Tympanuchus cupido*). The sharptail apparently spread into Michigan from Minnesota and Wisconsin in the wake of clearings and fires, and has extended its range eastward until it now occupies the western half of the Upper Peninsula.

We have made an effort to hasten the eastward spread of this game bird. Several hundred have been trapped in the western part of the Upper Peninsula, or purchased from game breeders, and released in the northern half of the Lower Peninsula. This species has shown some evidence of becoming established in the Pigeon River State Forest, Cheboygan County and at Trout Lake in the eastern end of the Upper Peninsula.

We anticipated this species would spread naturally throughout the Upper Peninsula but it probably would have been several years under the most favorable circumstances before it reached the northern part of the Lower Peninsula.

Hungarian Partridge—The extension of the range of Hungarian partridge into Michigan from birds released in Ohio and Indiana stimulated interest in them. About 2,250 birds have been released in various parts of the state. In spite of the general spread of the birds in southern Michigan which have established themselves none of the releases have thoroughly demonstrated that the birds can or will take hold. Some of the plantings still persist and give some promise but at the present time there is no assurance that the Hungarian partridge can be established in the area which is occupied by the ringneck pheasant and quail and which formerly was occupied by the ruffed grouse.

Capercaillie—Two hundred and one capercaillie were released on Grand Island, Michigan, in 1904 and 1905 by the Cleaveland Cliffs Iron Company. The birds gradually disappeared and no trace of any of them was found after 1913.

Spasmodic introduction of such species as wild turkey and chukar partridge have failed as yet to establish any introduction.

We should point out that during the last 25 years the prairie chicken has spread from the southern half of the Lower Peninsula into the upper part of the Lower Peninsula. It is now established in many areas throughout the Upper Peninsula. Without releases cottontail rabbits, quail and opossum have likewise moved north from the southern portion of the State, Indiana and Ohio following the clearing and farming. It is our opinion that these species have taken up and occupied the biological niche which was available because the snowshoe hare and ruffed grouse could not maintain themselves under the changes associated with agricultural development.

We conclude:

1. Where a choice exists, it usually is better to work with native rather than exotic species.
2. Introductions should be made only after inventory of existing species and unoccupied range rather than on basis of successes elsewhere of exotics or the advice of pressure groups.
3. The value of introduction is far over-estimated by the public and by too many game administrators.
4. Introductions usually have failed except (a) where changes in environment have depleted native stock so as to leave an unfilled ecological niche; (b) where introduced species perhaps of better sporting qualities or better adaptability to heavy gunning, displace native species and (c) re-introduction of indigenous species.
5. The continued introduction and release of native species already established appears to be economically impracticable as far as proven biological results are concerned.
6. Additional introduction of exotics after such species have established themselves usually is impracticable at any cost consistent with the charges for public hunting licenses.

POSSIBLE TEMPERATURE FACTORS IN NORTH CENTRAL PHEASANT DISTRIBUTION

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This paper does not report the results of any field research by the authors. It is simply a contribution to the discussion of what continues to be a puzzling problem, *viz.*, the failure of ringneck pheasants to establish themselves naturally in large numbers south of their present successful range. In the Midwest this range is north of a line passing through southeastern Ohio, central Indiana, central Illinois, southern Iowa, southern Nebraska, and northwestern Kansas. South of the line pheasant populations have displayed on the whole one or more of the types of failure described by Phillips (1928) and Leopold (1931), though here and there moderate populations have been maintained with, and occasionally without, continuous stocking.

Pheasant releases are continuing on a grand scale, as the most recent biennial figures from these states show: Iowa, 3,467; Minnesota, 33,587; Wisconsin, 37,740; Illinois, 50,000[1]; Indiana, 57,506; Michigan, 5,448; Ohio, 62,807[2]; approximate total, 250,555. The average recent yearly releases of ringnecks in these states alone have been in the neighborhood of 125,000, exclusive of chicks and eggs sent out, and the cost not less than $250,000 for rearing, purchase, distribution, and release. As Leopold (1931) pointed out, this represents an investment the effectiveness of which might be increased if more were known about the factors limiting pheasants south of their present successful range.

The numbered points below are presented as *circumstantial* evidence supporting what we may term a *working hypothesis:* That one reason for the failure of pheasants to establish themselves naturally in large numbers south of the line already mentioned is high egg temperature and the resulting mortality of embryos. If this hypothesis should be substantiated the following must be true: (a) That embryos are killed by high temperature; (b) that lethal temperatures occur under natural conditions; (c) that this is seldom the case on successful range, but (d) that when it occurs unusually often the result is a shortage in the production of pheasants; (e) that it frequently occurs on unsuccessful range, but (f) that where it does not often occur some parts of this area may support local establishments.

[1]Estimated from correspondence. Other figures from conservation department reports.
[2]1935 and 1936.

There is no apparent correlation between successful pheasant range and either zonal soil groups, climatic humidity, or seasonal distribution of moisture. Pheasants have established themselves on podozols, prairie soils, chernozems, and others in some places, not elsewhere. They occur on both humid and semi-arid lands and upon lands with adequate or deficient moisture throughout the year. Moreover, there is no evident correlation between survival of the individual and atmospheric temperature *as such*. Pheasants live and breed in captivity in the South; individual birds survive there, sometimes for years; in a few places they both survive and breed regularly. Some circumstantial evidence relating to the effect of temperature on reproduction in the field, however, is presented in the following points:

1. From the Alleghenies to the Great Plains, the line separating generally favorable from generally unfavorable range follows very closely Thornthwaite's (1931) line separating the microthermal from the mesothermal climatic provinces. In these the temperature-evaporation indices are respectively 32-63 and 64-127.
2. The same line marks the boundary between Thornthwaite's subprovinces "b" and "c" in which, respectively, 35-49 per cent and 50-69 per cent of the heat is concentrated in the summer months.
3. In other words, nearly all of the present successful pheasant establishments are in cooler areas, where the summers are shorter but *relatively* warmer than farther south.
4. It has already been shown that not-very-high temperatures are required to kill pheasant embryos. Romanoff (1934) found that continuous exposure of the eggs to 103° F. resulted in 50 per cent mortality; to 104° F., 90 per cent mortality; and to 105° F., 99 per cent mortality. Destruction of the embryos was greatest just before hatching. The *shortest* period required to kill the embryos at these temperatures was not found, though in poultry Professor E. M. Funk of the Department of Poultry Husbandry, University of Missouri, has found that a three-hour exposure to 120° F. kills embryos at any time during incubation.
5. It seems very likely that lethal temperatures may occur under natural conditions. The egg temperature in ground-nesting birds would depend most upon the temperature of the ground and the degree of exposure to the sun. Hammerstrom (1935) found that in pheasants "many nests . . . were wholly without over-topping cover of any sort," and that only 2 of the 305 Iowa nests he examined were roofed over with vegetation by the birds themselves. Therefore, it is possible that the pheasant's occasional practice of leaving the nest during the hottest part of the day may raise the temperature of the eggs if the air and ground temperatures are unusually high.

Professor E. M. Brown of the Department of Field Crops, University of Missouri,[3] has recorded ground temperatures at Columbia, approximately in the center of the State. These were taken in bare soil and under unmowed bluegrass, orchard grass, and redtop, half an inch to an inch below the surface; the atmospheric temperatures and degrees of saturation of the soil were recorded at the same time. In Missouri most pheasant eggs are in the nest during June; therefore, we examined his figures for the periods from May 24 to July 6, 1935, and May 23 to July 3, 1936. Temperatures at the ground surface would in many cases have been higher than those below the surface, but the former were not recorded. On bare ground, half an inch below the surface, the maximum temperatures varied, from 9° to 12° F. above the air temperature on saturated soil, to 30° F. above the air temperature on dry soil; under unmowed grass the ground temperatures, half an inch to an inch below the surface, varied from 5° F. below to 1° F. above the air temperatures on saturated soil, from 7° to 10° F. above the air temperatures on moist soils, and as much as 13° F. above the air temperature on dry soil. Maximum temperatures were reached about 2 p.m., but since the variation from noon to 4 p.m. was usually between one and two degrees per hour, this would have meant a four-hour exposure to temperatures only slightly below the maximum. Thus if the air temperature exceeds 100° F., if the soil is dry, if vegetative cover is scant, or if these conditions obtain just before hatching-time, it is quite possible that the embryos may be killed.

6. The frequency with which air temperatures reach 100° F. in the North Central States during the time when most of the eggs are in the nest is shown by the following table, in which the periods were learned from the conservation departments and the temperatures were taken from Weather Bureau data (annual figures available only through 1938):

While the method of recording Weather Bureau data and the records available to us made it impracticable to derive figures for the northern and southern halves of Illinois and Indiana, the probability is that the air temperature reached 100° F. more often in the south, less often in the north, than the above figures indicate. It might be added that in Missouri the maximum daily temperature reached 99° F. in three years and 98° F. in six, making a total of forty-seven years (92 per cent) in which the temperature reached 98° F. or more during the season when most of the pheasant eggs are in the nest. Since the Weather Bureau temperatures were shade-temperatures, and since pheasant nests are often exposed to the sun, the likelihood of lethal temperatures is increased, especially in the southern areas.

7. Has high temperature been associated with "short" pheasant

[3]Unpublished data, Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. Dept. of Agriculture, and Missouri Agricultural Experiment Station cooperating.

State	(A) Period maximum number of eggs In the nest	Years since weather records began	Years in which temperature reached 100° F. during this period (A)	% of years in which this occurred
Minnesota	late May	48	3	6
Wisconsin	June	48	17	35
Michigan	June	51	21	41
Iowa	June	66	33	50
Illinois	late June	49	30	63
Indiana	late June	52	29	56
Ohio	late June	55	25	45
Missouri	late June	51	38	75

years on the northern range? Our data are meagre, but it appears that in Minnesota there was a shortage in 1934, when the maximum temperature while most of the eggs were in the nest reached 108° F.; in Iowa in 1934 (maximum temperature 111° F.) and 1936 (maximum temperature 108° F.); and in Wisconsin in 1936 (maximum temperature 96° F.). Leopold and Ball (1931) cited frequent reports of "addled" quail eggs in the drouth states in 1930, which may have been responsible for some of the reported 30-to-90 per cent shortage of quail that year. This they believed was caused by high temperatures, but unfortunately pheasants were not studied in the same connection. A more complete comparison of pheasant populations, maximum temperatures, and soil moisture in the northern states should prove interesting and might disclose a closer correlation.

8. In the southern part of the north-central region there have been some moderately successful, though usually somewhat local, pheasant establishments, even without continuous stocking. In Missouri, for example, beside a few pheasants near the Iowa border (north of Thornthwaite's line), there is an establishment in St. Charles and Lincoln Counties that has persisted since the mass-planting of several hundred birds in 1932 and 1933. Here, on the bottomland soil near the confluence of the Missouri and Mississippi Rivers, there is an average density of a bird per 40 acres, with a maximum of a bird per 7 acres; this was determined in 1939 by Terrill and other members of the Conservation Commission's staff. Also on Leopold's map of pheasant distribution (1931) most of the "scattering range" south of Thornthwaite's line is along the principal river valleys—Illinois, Wabash and its tributaries, Mississippi, and Ohio. These facts suggest a possible reason for the moderate success of these local establishments: that the soil here, being more moist and supporting in many places a considerable growth of slough-grass (*Spartina*) and related grasses, provides more suitable conditions for pheasant nesting by keeping down the ground temperatures and hence the egg temperatures.

We suggest therefore that the following subjects deserve investigation on the pheasant range: the relations of ground temperature, air temperature, nest temperature, and egg temperature, both to one another and to the soil moisture; the *minimum* time necessary to kill pheasant embryos at temperatures which the eggs might reach in nature and at the successive stages of their development; the degree of exposure of eggs by the parents under various circumstances; the prevalence of lethal egg temperatures while the eggs are in the nest, both where pheasant plantings have been successful and where they have not; and correlation of these conditions with known increases and decreases in the pheasant-productivity of the land.

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THE CHUKAR AND HUNGARIAN PARTRIDGES IN AMERICA

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WILDLIFE INTRODUCTIONS IN ALASKA

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Ordinarily one thinks of importation of exotic species as taking place where wildlife has been depleted, in other words, as a wildlife-restoration measure. Alaska would hardly fall in this class, since it is still essentially a frontier, retaining most of its original fauna. Yet even there importation of non-indigenous species has taken place and others are being considered.

I am not able to present for consideration completed experiments in most cases. Wildlife plants have been made, but generally a much longer time is required to note ultimate results. Therefore the present discussion must be confined, in most instances, to trends, indications, or theoretical possibilities based on experience elsewhere.

Less than a century ago there were musk oxen on the Arctic slope of northern Alaska. Old, weather-beaten skulls have been found here and there on the tundra, but the animals are gone. Then, in 1930, a small herd of musk oxen was obtained in Greenland and shipped to Alaska by the Biological Survey. These animals were kept by the Bureau for several years at the University of Alaska for experimental studies, but in 1936 they were placed on Nunivak Island, in Bering Sea, where they appear to be thriving. In due time, when the musk oxen there have become plentiful, it is planned to release small herds periodically in northern Alaska.

It is, of course, difficult to foresee success or failure. The Greenland musk ox is a different form from that originally occupying Alaska and in that sense it is exotic. But, practically, what we are doing there is really restoring a species to its original range and success is to be anticipated.

The bison is another animal that has been introduced into Alaska. In 1928 twenty-three animals were released in the Delta River country south of Fairbanks. They have taken up their abode in relatively flat country lying just north of the Alaska Range. The herd now numbers about 200 and appears to be doing well.

It is too early to evaluate the wisdom of this plant. It has been our experience elsewhere that while a big-game herd is on the uptrend following a period of scarcity, and while forage is abundant, we have been very enthusiastic and "point with pride" to accomplishments. But sometimes a day of reckoning has come, when the range has become overstocked and the game herd and range both suffer. It is expected that in this particular experiment the bison will find large areas into which to spread; but, just as a possibility, they may first overgraze the most favorable area in which they have been released. Furthermore, in search of winter forage, they are likely also to take to some of the bare ridges now used by mountain sheep and competition with these native mountaineers would not be desirable. Time alone will tell the story, however.

In the Kodiak-Afognak group of islands off the southern coast of Alaska lies a small island known as Long Island, on which a number of coast blacktail deer were released. They apparently thrived and became numerous. In 1936, when we visited the locality, it was learned that in 1935 many of these deer had died. The exact cause of death was not known and precise information could not be obtained. Apparently, on the basis of data we were able to procure on the ground and in various reports, there must have been an over-population followed by the inevitable die-off. It was another example of the unwisdom of stocking with big game a small island on which there is no check on population except the ultimate one of disease or starvation.

In this same island group the Roosevelt elk was introduced in 1929. At first the elk were placed on Kodiak Island, but were later transferred to Afognak. No doubt they would have become a pest in the agricultural areas had they remained on Kodiak. On Afognak some of them linger about the Indian village at times and have caused some inconvenience, but generally speaking they have been occupying adjacent ranges, and when I observed the herd in 1936 the elk were apparently thriving. They have found abundant forage to their liking, winters are not severe, there are no natural enemies that can be an effective check (I do not consider the Kodiak bear an effective predator), and it would seem that all the elk have to contend with there is possible overpopulation some time in the future. The Island is large, however, and no doubt in due time shooting will serve to keep the herd within bounds. Certainly the prospects are much better than in the case of the deer on Long Island nearby.

There has been agitation to introduce elk into the Tanana Valley in interior Alaska. Perhaps this is not the place to discuss an importation not yet accomplished, with no results available for consideration. Yet while speaking of elk in Alaska it may be well to point out certain probabilities. We have had experience with introducing elk here and there, under various conditions. Mostly it has been restoration of elk in original range of the species. In a great many cases the results have been beneficial. We have brought the elk back. But we have also had sad experiences and we have learned some lessons. We have learned that elk and livestock compete for range. We have learned that the elk is an effective competitor on some big game ranges. Now, when our mountain sheep are at a low ebb, we are finding, in some cases at least, that the abundant elk are competing seriously with them in winter, and we may learn eventually, when our various studies now under way are nearing completion, that deer and elk competition on winter range is one of the important factors in the decimation of the Rocky Mountain bighorn in localities in which elk are found. There are indications of it now.

What would happen in Alaska? Granted that the elk would thrive, would multiply until there were extensive herds, they would compete with the caribou, to begin with. Caribou are restless animals, roving hither and yon, with the result that they tend to preserve their lichen forage. It is likely that even under present conditions the caribou herds fluctuate in numbers, just as elk and other game have done in response to range conditions and that in Alaska as elsewhere the quantity of winter forage limits their numbers.

During the elk studies in Jackson Hole I received a shipment of "reindeer moss" from Alaska for experimentation with elk. Although it had been dried for a year or more and the elk were on a diet of good hay, the elk ate the lichens moderately when placed before them on the feed grounds. They would undoubtedly eat it more avidly if they found it fresh on the range and when their forage consisted of dried grass under the snow instead of good cured hay. Elk in the Olympic Mountains are very fond of lichens growing on trees.

Furthermore we can confidently expect that the elk would sooner or later find the windswept ridges in the mountains for part of their winter range. They have done so elsewhere. And then we would find them in direct competition with the Alaskan mountain sheep. On Afognak Island the elk are not supplanting a native species. In interior Alaska, when the herd became large, the elk would compete with several of Alaska's finest game species, even with the moose. Such considerations, in view of information on big game ranges slowly resulting from our present day research, should cause one to pause before placing a herd animal like the elk in the midst of the game lands of interior Alaska. It should be remembered that the introduced elk will not stay put indefinitely where released but will eventually establish migrations and will find the critical winter ranges which the native species found ages ago.

While speaking of big game introductions mention might be made of the reindeer. Although not strictly game, reindeer do enter the picture. They cannot occupy the same range with caribou. Either the reindeer herd is dissipated by the migrating caribou, as happened years ago when a herd of the former was placed in Broad Pass, or the caribou must be killed off or reduced in number so that the reindeer can be herded. Therefore, reindeer and caribou should be segregated in different parts of Alaska.

It is generally believed that the introduction of reindeer is always good for the natives. Sympathetic students of the Eskimo or other natives do not always agree with this. Many years ago reindeer were placed on Atka Island in the Aleutian chain for the natives. As long as the reindeer remained close to the village they were utilized. But after a few years the animals moved farther away and the natives lost interest. They preferred to fish.

On Umnak Island also there are some reindeer. The natives there use them for fox bait. One reindeer enthusiast admitted that in some districts natives do use reindeer for fox *bait,* not fox *feed,* but declared that the government was justified in introducing reindeer for that purpose. Admittedly, the reindeer in the Aleutians apparently have not done damage; but at least it seemed to have been useless to put them there.

Speaking of the Aleutians, blue foxes were placed on many of the islands for commercial purposes. They run wild, rustle their own feed, and are trapped at intervals. Some of these plants have been successful; others have failed. As usual in such cases, often there was not a good understanding of blue fox food requirements. Some of the islands lacked the necessary beaches, and where rodents were not present, the foxes preyed on the sea birds. When the birds were gone, after a period of successful fox years, the venture was no longer profitable. Ground squirrels were placed on one island for fox food. The ground squirrels multiplied, and the foxes preyed on them to some extent, but the fox venture was no more successful on that island than it was on some others with good beaches. Perhaps insufficient thought had been given to the fact that ground squirrels hibernate for a part of the year.

The Biological Survey found it necessary to make a two-year survey of the Aleutian Islands and to designate definitely which islands should be used for fox raising.

This is admittedly little more than a listing of some of the wildlife introductions in Alaska, accomplished or planned. There are others not mentioned here. It is too early to report success or failure. But I believe that examination of present circumstances in each case will indicate probable success in some ventures and unfortunate results in others.

I believe there are many workers who agree that such projects should rest, not on mere wishful thinking or a desire merely to "do something," but on a real need, after careful study of requirements of the introduced species and of the resident species with which they will come into competition.

THE EUROPEAN WILD HOG IN AMERICA

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The present European wild hog in America apparently is not a pure strain of the European wild boar.

From such records as we have the species was introduced about 1910 by a group of English sportsmen headed by Mr. George Gordon Moore of New York. Mr. Moore promoted the idea of having a large hunting club financed from funds subscribed by English sportsmen. Bonds were sold to these gentlemen, and the proceeds were used to build a large clubhouse and other buildings near Hooper Bald in North Carolina near the Tennessee line.

A 600-acre tract nearby was enclosed with a high fence, and elk, buffalo, bear, deer and wild hog were introduced. Ten thousand eggs of the ringneck pheasant were also imported. However, due to the rapid expenditure of funds and the failure of these various attempts to stock the area, the venture in its comprehensive aspects failed. At present the wild hog is the only species that was introduced which has become established in the wild. It has proved itself as adaptable as the feral domestic hog to the Appalachian territory.

Dr. Le Roy C. Stegeman, who conducted an intensive study of this species during the summer of 1937, reports that Colonel Herford at Tellico Plains, Tennessee, was the only one who could give a complete account of the source of the introduced stock. He stated that it probably came from the Hartz Mountains of Germany. This seems reasonable, since the characteristics of the stock resemble closely those of the animals of Prussia.

Although estimates of the number of individuals introduced vary considerably, it is felt that the one made by Mr. Cotton McGuire, who was caretaker for the hunting club for a number of years, is the most accurate. He states that about fifteen animals, all apparently of the same species, were introduced and kept inside the 600-acre fenced area for about eight or ten years.

In about 1920, an attempt was made to hunt the animals, which, however, became excited and broke through the fence in several places. Mr. McGuire estimates that about one hundred individuals escaped in this manner. These animals and their descendants have been roaming the neighboring mountains ever since. They are said to have become quite numerous before 1932, but that at that time hog cholera decimated their numbers. During their period in the wild, much crossing with domestic feral swine occurred, until a large percentage of them now show considerable domestic swine characteristics. At the present time, however, Mr. McGuire believes that several full blooded animals of both sexes still exist on the area.

Most of the wild hogs are now restricted to the north and south forks of Citico Creek, the Tellico River, the North River and the Bald River drainage. In 1937, Dr. Stegeman estimated the total number of animals at 115, with over one-half of these located on the Bald River drainage. He reports that a definite correlation exists between the type of habitat and the distribution. During early summer the animals were ranging largely in the upper portions of the higher, heavily shaded coves. As the season advanced, they drifted down into the blackberry thickets. When the blackberry crop began to wane they moved back on the drier slopes where huckleberries were plentiful. In general, the distribution of the animals was governed by the availability of berries, apples, and in the fall, acorns.

Local differences in distribution occasioned by the presence of other species occurred in combination with that dependent on the food supply. For example, the hogs were not found where the presence of the bear was in evidence. Where human occupancy existed, no hogs were found either. In addition, the absence of suitable wallowing areas had a marked effect on distribution.

The physical characteristics of the Tennessee wild hog were said to be similar to those of its European ancestor. It is a powerfully built animal, reaching a height of over 3 feet at its bison-like shoulder, and weighing as much as 400 pounds. In Germany it is reported that specimens as heavy as 661 pounds have been taken. A full blooded animal is high and massive in the forequarters and strongly tapered toward the rump. The snout is long and slender and the ears quite small, pointed and heavily haired. The tail is long and mule-like, with a large tuft of long hair at the tip. Canine teeth are well developed in both sexes, and in the boars are large, upwardly directed, curved tusks. As in the domestic hog, the skin is quite thick. In the males it is especially heavy over the shoulders, forming what is known as a shield. The pelage consists of coarse bristles, much heavier than those of the domestic hog, which develop a pronounced, more or less erect mane from the top of the head along the spine to the rump. In the winter these bristles are considerably longer than in summer, reaching a length of 5 inches in the mane. A dense coat of fine, curly, wool-like hair lies under them.

German writers report the normal color of the animal as being light to dark gray, although there are regions in which vigorous animals are coal black in winter, becoming silvery gray on the head. In addition, color variations of brown and piebald (black and white) have been observed. These color phases compare favorably with those seen in the Tennessee animals.

Dr. Le Roy Stegeman has reported a list of characteristics whereby the track of the wild hog may be distinguished in the field. Some of these are:

1. The hoof of the animal is narrower than that of the domestic hog. The leg is longer; therefore, tracks are spaced farther apart.

2. The trail of the hog is narrower than that of the domestic animal and the tracks fall almost in a single line.

3. The wild hog will climb slopes too steep for the domestic animal and will leap over obstacles where a domestic hog would go around or under them.

4. The wild hog will cross a stream by traversing footlogs, whereas a domestic animal will wade.

5. As the wild hogs are taller than the domestic species, they rub trees to a point considerably higher.

Young animals can readily be distinguished from the young of the domestic hog by the fact that they are longitudinally striped. This character has been the determining factor in segregating the new-born of the wild animals from the domestic strain.

In general, the wild hog is an alert animal with highly developed senses of hearing and smelling, on which it depends to the largest extent. Due to this fact it is a rather difficult animal to observe in the field. It is very shy and will migrate long distances to most inaccessible places if sufficiently disturbed. Due to its great stamina, it can readily elude at least most hunters if not all dogs.

Considerable information has been obtained on the habits of this animal which has been compiled by Dr. Le Roy C. Stegeman. For several years a small study of the genetics of the animal has been conducted for the purpose of developing as pure a strain of the animal as possible, as well as to determine the extent to which the species will cross with domestic animals. This study is now being expanded within the limits of available funds. In addition, the cooperation of other public agencies and private organizations is being encouraged with the hope that they may be able to conduct such a project on a scale more intensive than is possible under the present organizational administrative policy.

Since past hunting of this species has tended to remove most of the feral domestic swine, greater opportunity will exist in the future for the development of the wild species. The domestic species has been hunted more intensively because it was easier to pursue and bring to bay. Hunters who were not thoroughly familiar with this sport frequently brought in a feral barnyard hog under the belief that it was a specimen of the wild species.

Considerable headway has been made in the harvesting of the species since its habitat has been included in a wildlife management area. It was found that still-hunting of the animal was impossible, because it was too wary to be stalked successfully by anyone but an experienced woodsman. It was also found that "just any hound" could not keep up with the animal or bring it to bay. It was found that a system of placing hunters on stands became so complicated and elaborate, due to the irregular actions of the animals when pursued and the inaccessibility of the terrain which they sought under such circumstances, that it could not be considered the standard method.

From past experience it has been found that one strain of local mountain hound, the so-called "Plott Hound," originally bred as a bear dog, is the animal best adapted to this type of hunting. Such a dog must be trained particularly to hunt these animals and must be handled by a man thoroughly familiar with this type of sport. On the basis of these findings, plans are now being made to develop a kennel of dogs on the area which may then be hired out to hunting parties during the season.

Recently some other methods of hunting were tried, to determine their relative merits. From these it was found that hunting on baited areas, aside from being considered unsportsmanlike, was also without advantages to the hunter. Feeding occurs, apparently, primarily at night, and baited areas are visited much more rarely than one might expect in view of the evident palatability of corn and other items of food that were used.

Dog hunting at night with a light indicated that the animal can be bayed almost immediately, instead of after a chase of several hours. For collecting specimens for scientific investigation this system may be useful, but from the angle of sport it is undesirable.

Though the hunting of the European wild hog is unique and has caught the public fancy, few hunters have returned a second year. The sport in this rugged region is one of the most grueling known, and few people who are not in the best of physical condition care to engage in it to any great extent. If they are successful in taking an animal, they are satisfied for life, and if they are not, they feel that the more gentle sport of rabbit and quail hunting suffices.

In 1924 Mr. Moore shipped some animals from North Carolina and released them on the San Francisquito Ranch near the north end of the Monterey Division, Los Padres National Forest, in the vicinity of Carmel.

Hybridized numbers increased and expanded their range from San Francisquito Ranch to national forest land. In 1932 about two dozen yearlings were obtained from the Moore Ranch and transplanted to the Carmelo Creek watershed. The purpose was to supply a hunting sport on a commercial basis after the close of the deer season.

The wild boar continued to cross with local domestic swine. It has been reported that wild hogs have caused some damage to agricultural land in the vicinity. Although their range has expanded in the national forest, numbers have not noticeably increased in recent years. It is estimated that there are about 100 wild boar in the national forest and about 10 were killed last year by sportsmen. Hunting is difficult because of dense brush and rough terrain.

A specimen was collected in the fall of 1938. The head and hide are in the Museum of Vertebrate Zoology, University of California. Species classification has not been made. The animal was a male, estimated to be about 2½ years old. It weighed 172 pounds, not dressed. The general characteristics are similar to those observed by Stegeman; however, California wild boar do not seem to be so large as those described in North Carolina.

In April, 1936, it was reported that a hunter in Monterey County was knocked down by a 300-pound wild board when it was driven from cover.

The California Division of Fish and Game considers introduced wild boar in the same category as other wild animals; there is no protection by bag limit or seasons provided.

Damage to national forest resources has not occurred to such a degree that rigid control or extinction is desirable. The situation is being further observed by administrative officers of both the Forest Service and the cooperating agency.

ROCKY MOUNTAIN GOATS IN THE BLACK HILLS OF SOUTH DAKOTA

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The Rocky Mountain goats (*Oreamnos americanus* and subspecies) are purely a western North American genus, their nearest relatives being the mountain frequenting antelopes of the Old World, such as the chamois (*Rupicapra tragus*). In the United States, the goats occur naturally in but three states—Washington, Idaho and Montana. Northward, they range through Alberta and British Columbia to the southern portions of Yukon Territory and Alaska. Despite the general distribution of the goats along the northern backbone of the Rocky Mountains, they have never become established on any of the mountains east of the Continental Divide. In view of their rather general distribution to the west, this is a rather curious situation.

In the Rocky Mountains and the Coast Range, the goats prefer the areas above timberline—in fact are remarkable among hoofed animals for their ability to reside yearlong at such high elevations and severe climates. Hence, it is perhaps surprising to find that about twenty-five head are now established in the ponderosa pine belt about Harney Peak on the Harney National Forest in South Dakota.

The occurrence of Rocky Mountain goats in the Black Hills region of South Dakota is, however, accidental. It came about in this manner: The late United States Senator Peter Norbeck, of South Dakota, suggested that goats be included with the other North American big game species at the Custer State Park zoo and enclosure. Senator Norbeck, with the support of State Game Warden H. S. Hedrick and the State

Park Board, had the South Dakota Game Department finance the project. Arrangements were made with Rocky Mountain Park, in Alberta, Canada, to provide the goats, and in 1924 Deputy State Game Warden L. C. Hawley went to Banff and brought the animals to Custer State Park. These were the only goats introduced and consisted of six individuals—four females (a yearling and three adults) and two males (a yearling and an adult).

Shortly after their arrival at the Park, part of the goats escaped to the national forest area outside the enclosure. It is generally believed that only two individuals, an adult female and a yearling male, made their way to Harney Peak, a distance of 4 or 5 miles from the Park enclosure. There is, however, some evidence that another female escaped; but, in any event, it seems certain that the present herd descends from not more than three individuals.

Offhand, it would seem that the twenty-five head now on Harney Peak represent an unsatisfactory rate of reproduction. On further consideration, however, it is evident that the goats have done remarkably well to build up from probably two to twenty-five head over a 15-year period, despite loss from predators, old age and poaching. It is also important to note that, although the first young are born when the female is two years of age, the usual number of kids is one. Assuming no loss whatever, a single pair would build up to 30 in ten years and only 140 in fifteen years.

The marked difference between the territory inhabited by the goats in the Rocky Mountains and on Harney Peak is of particular interest. In their native haunts, the goats live in an environment chiefly characterized by rough terrain above timberline. In the Black Hills of South Dakota, they are considerably below their accustomed ecological level, since in the area about Harney Peak the dominant plant is ponderosa pine. Some Engelmann spruce, aspen and birch occur in favored spots about the peak, but for the most part, the plant associations are characteristic of the transition zone, whereas the normal home of the Rocky Mountain goat is in the Arctic-Alpine life zone.

The twenty-five goats limit themselves to a territory of about 20 square miles on and adjacent to Harney Peak. The peak itself is 7,240 feet in elevation and the highest point in the United States east of the Rocky Mountains. At various times, goats have been seen east as far as Mt. Rushmore and south to Buckhorn Mountain. Normally, they range in small groups, the usual segregation being three groups of from four to fifteen individuals.

In general, the Harney Peak area contains a type of terrain that fits in well with the Rocky Mountain goat requirements, even though it is at a lower ecological level. It is a rugged, granitic formation, having numerous bluffs, pinnacles and occasional shallow caves. Mr. Howard

Culver, who has been stationed at the Harney Peak fire lookout house for the past four seasons, has repeatedly observed the goats in their daily routine. They often loiter on the high points and granite needles. In good weather, they bed in the rocks as well, but during storms or on especially hot days, it is customary for the herd to seek protected places under overhanging rocks and in caves. In some of the caves, the floor consisted of loose soil, which the goats often worked into their coats. During the breeding season, they leave the high areas for more secluded spots about the sides of the peak.

Comparatively little data have been obtained on the food preferences of the goats in the Harney Peak area. Some observations indicate that they take considerable aspen and birch in the spring and summer, but do more grazing on lichens, grass and other herbaceous material in the fall.

Shedding starts in May and the individuals appear rather ragged until July. Thereafter, they become increasingly smooth and by November have a beautiful coat that is both heavy and long. As far as can be determined, the individuals are in good health and exhibit strong vitality.

That the Harney Peak Rocky Mountain goats are a permanent addition to the Black Hills fauna seems assured. They have built up to a group of twenty-five without any special aid from man. Possibly, they will do exceptionally well in the Black Hills, since such natural predators as the bear, wolf and wolverine do not occur there. Eagles are present in limited numbers and mountain lions are nearly extinct. Certainly the establishment of the Rocky Mountain goat in such unusual surroundings will always be of special interest to workers in the field of wildlife research and management.

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