TRANSACTIONS

of the

TWENTY-SEVENTH
NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE

Conference Theme:

NEW HORIZONS FOR
OUTDOOR RECREATION

March 12, 13, 14, 1962

Denver Hilton Hotel

Denver, Colorado

Edited by James B. Trefethen

Published by the
WILDLIFE MANAGEMENT INSTITUTE
WIRE BUILDING
WASHINGTON 5, D. C.
1962

Additional copies may be procured from
WILDLIFE MANAGEMENT INSTITUTE,
Wire Building, Washington 5, D. C.
for $4.00 Postpaid

PRINTED IN
U. S. A.

Printed by
MONUMENTAL PRINTING CO.
Baltimore, Md.

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The Wildlife Management Institute wishes to express its appreciation to The Wildlife Society and to the many organizations and individuals who contributed to the success of the 27th North American Wildlife and Natural Resources Conference.

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PART I
GENERAL SESSIONS

GENERAL SESSIONS

Monday Morning—March 12

Chairman: QUIGG NEWTON
President, University of Colorado, Boulder, Colorado

Vice-Chairman: JOSEPH W. PENFOLD
Conservation Director, Izaak Walton League of America, Washington, D. C.

STRENGTH THROUGH RECREATION

FORMAL OPENING

C. R. GUTERMUTH

Vice-President, Wildlife Management Institute, Washington, D. C.

Friends: It is a pleasure and a privilege to open the 27th North American Wildlife and Natural Resources Conference in this beautiful, mile-high city of Denver. The last time that this large international meeting was held here was in February, 1943, when the 8th Conference was staged at the Cosmopolitan Hotel. Although many changes have taken place here, there, and everywhere since that time, I see in this audience many people who attended that meeting, and some who have been present at nearly every one of these annual conferences since the early 1930's. I, myself, have been coming since 1934. It is a grand and most refreshing thing to see all these old friends each year, as well as to welcome and make the acquaintance of the newcomers who are attending the Conference for the first time.

I believe that, when you study your program, you will find that the Program Committee has succeeded in bringing together a truly outstanding list of authorities to discuss a wide variety of subjects in-

[1]In the absence of Mr. Penfold, due to illness, the Vice-Chairmanship was assumed by Dr. Clarence Cottam, director, Welder Wildlife Foundation, Sinton, Texas.

volving the better management of natural resources. Many of you, I feel sure, have not had an opportunity to read the recently released report of the Outdoor Recreation Resources Review Commission; and the papers presented here under this far-reaching theme, "New Horizons for Recreation," will be of real interest to you.

Last year, in an effort to minimize the conflict between the conference sessions and the many related meetings that are held each year, we eliminated the once customary Tuesday afternoon General Session and scheduled all of the related meetings on Sunday and on Tuesday afternoon. Actually, this was done on the recommendation of the General Program Committee. In earlier years, it was evident that many conferees were obliged to miss scheduled papers that they wanted to hear or to absent themselves from important related meetings that were of especial interest to them. The new scheduling last year prevented such conflicts and increased the attendance both in the conference sessions and the related meetings. That rather drastic change is being tried again this year, and, if it works as well again, we may continue the procedure in future years.

Practically all of the related meetings, incidentally, are open to the general public, and we urge you to attend those that are of particular interest to you. I already had one little rift with a good friend this morning, and would like to say that if we cause a little trouble and make a few people mad because we are not going to permit the scheduling of related meetings in competition with this conference, you are going to have to be a little patient with us. As I said, we eliminated the large Tuesday afternoon General Session in order to prevent conflicts, since we do not want the conference sessions to be in competition with related meetings.

The success of all of the General and Technical Sessions depends almost as much on the participation from the floor as it does upon the quality of the papers that stimulate this discussion. A period of time is allowed at the end of each formal presentation for discussion from the floor, and we hope that you will take full advantage of the opportunity to question the speakers. All discussion will be recorded and printed in the Transactions as usual. We impose no restrictions on the discussion except that all questions be pertinent to the main topic of the speaker; and, of course, the chairmen are asked to keep the sessions moving along on schedule.

For the benefit of those who may be attending one of these conferences for the first time, and even at the risk of boring the veterans, it should be pointed out that this is a conference and not a convention. Many of the people here are officials of state and provincial, and federal and dominion agencies. Others are delegates and officers of private organizations who are responsible to a general membership or to a governing board. Many of them are not authorized to commit their agencies or organizations to specific policies by spontaneous action in meetings of this kind. The purpose of this conference is not to attempt to crystallize public opinion into the adoption of resolutions, but to provide new information, new ideas, and new philosophies that can be used as the basis for action in their own meetings by the organizations and agencies here represented. Because of this diverse representation, the chairmen of the respective sessions have been instructed to entertain no resolutions from the floor in this conference. We hope, of course, that the information that you obtain at the scheduled sessions and in the various formal and informal meetings will stimulate many resolutions and much action by the participating organizations, but, as I said, not in this conference.

The Institute hopes that all of you will get from these discussions a fresher and broader viewpoint on the problems that all of you face in your attempts to make North America a better place in which to live. We also hope that those of you who are administrators will find much here that will help you in your future work and in the carrying out and making of important decisions on major issues.

In behalf of the Institute, I welcome all of you to this 27th Conference.

We are having more than our share of misfortunes this year. In the first place, I think most of you have heard that the Vice-Chairman, Joe Penfold, since he arrived in Denver, was taken to the General Rose Hospital and had a serious heart operation. I think it was an operation involving the aorta as it enters the heart. We haven't had a report this morning on Joe's condition, but I understand that last night he was getting along quite well. So I hope the report this morning will be good. We have asked Dr. Clarence Cottam, who is known to all of you, to pinch-hit for Joe as the Vice-Chairman of this meeting. We have had another misfortune, but that substitution will be explained by Dr. Newton.

So at this time I will formally open this Conference by turning the meeting over to the distinguished Chairman, Dr. Quigg Newton, President of the University of Colorado at Boulder.

REMARKS OF THE CHAIRMAN

QUIGG NEWTON

I should like to thank Mr. Gutermuth for inviting me to serve as Chairman of this opening session. I accepted the invitation not only because of the honor involved, which I consider to be a large one, but also because I believe that higher education should play a very major role in assisting in the expansion of our outdoor recreational resources in this country; and I am here to learn from all of you how this can be done and what part I can play in this in the years ahead.

The theme of this international conference, "New Horizons for Outdoor Recreation," expresses a consideration of paramount importance in our modern-day life. Outdoor recreation now is a significant social and economic force throughout the land. The demand already exceeds the supply in many areas. How well outdoor recreation will meet human needs for physical and mental refreshment in the coming years will depend largely on the decisions that may or may not be made in the months immediately ahead. In a sense, we truly are on the threshold, and the horizon is before us. It is frightening to contemplate an environment consisting wholly of the houses and works of man. No one questions the imperative need for examining our ability to meet the challenge that lies ahead. We must know the adequacy of our land and water resources base; we must assess its availability and suitability for outdoor recreational purposes; we must inspect current programs and activities and evaluate their present and potential contributions. We also must know the relationships between all consumptive and non-consumptive uses of natural resources in order that opportunities for outdoor recreation can be fitted in wherever possible.

Today's recreational demands are but a shadow of those of the future. Outdoor recreation deficits exist near many of our major metropolitan centers, and recent studies indicate that there is no end in sight. Prime recreational land is a scarce commodity and is becoming more so all the time. We must husband, and we must improve what we have. It also is clear that as individuals and as a society we must bring to bear on this problem the best thinking and the most imaginative action on all levels of private and public endeavor.

The term "outdoor recreation" is descriptive of all forms of recreation performed by all people in the outdoors. It is a vast and convenient classification of the sum total of human outdoor activity, whether it be the contemplation of a tree or the climbing of a mountain. It ranges from the backyard to the backwoods, from the coasts to the crests. It is comprised of thousands of diverse situations, each requiring utmost understanding and consideration. That is why I say that its successful advancement requires the cooperation of individual groups and agencies at every level. No single agency can undertake the task alone. The over-all problem is too diverse. It requires knowledge, understanding, finances well beyond the capacity of any single agency.

While there is agreement on the need to do something, many questions are being raised on what should be done and how and when it should be done. It is reasonable to expect that we can be successful in accommodating these tremendous demands. What programs, actions, and authorizations should be considered? How can the existing knowledge, information, and finances best be used? How much land and water should be devoted essentially to recreational purposes? How should recreational opportunity be distributed in relation to population concentrations? Can necessary public interests and support be obtained? Can outdoor recreation co-exist with the incessant demands for the commercial and residential use of lands and water resources? These are only a few of the questions being asked today. Many more are bound to arise, particularly in areas where the mounting demands of the expanding populations exert unparalleled pressures on essential resources.

To my mind, two points should not be overlooked at this time. The first is a matter of practical philosophy. It is positive thinking that must prevail on the very essential and human problem. We need no specialist to tell us of the pitfalls and drawbacks. We need no long list of the dangers and difficulties that will be encountered. We are all aware of them already. What we do need are persons to suggest the means of overcoming these difficulties, who will recommend the ways in which the influential forces of our society can be assembled to be sure that outdoor recreation will continue its great national contribution to our physical well-being and intellectual growth. Let's think in terms of opportunities and not in terms of hurdles.

The second point can be illustrated by the theme of the first General Session, "Strength through Recreation." We should not lose sight of the fact in this present situation, with something obviously needing to be done, that we can have recreation only through strength and cooperation, that unity of purpose will help to accomplish the task before us.

Dr. Paul Dudley White, who was to have addressed this session today, has found that he will be unable to attend, and has extended his regrets. He returned very recently from a trip to Asia.

Now, ladies and gentlemen, our first speaker today was to have been Mr. Laurance S. Rockefeller, Chairman of the Outdoor Recreation Resources Review Commission in New York. Mr. Rockefeller had a recent operation from which he is now recovering and, therefore, is unable to be with us; and he asked me to extend to you his very deep regrets. But to speak in place of Mr. Rockefeller today, we have with us a very eminent jurist and distinguished conservation leader in the Congress of the United States. His name has been linked with many of the greatest conservation achievements in Congress over the past decade. His actions never leave any doubt about his sincerity and concern about this nation's natural resources and outdoor recreation opportunities.

I am pleased to present a man who is very well known by word and deed to all of you here present, the Honorable Lee Metcalf, United States Senator from Montana.

RECREATIONAL NEEDS IN THE YEARS AHEAD

THE HONORABLE LEE METCALF
United States Senator from Montana, Washington D. C.

As the Chairman has already told you, Mr. Laurance Rockefeller was originally scheduled to make this address, and he is unable to come. Clint Anderson, my Chairman of the Interior and Insular Affairs Committee, had to cancel at the last minute on doctor's orders. He has the flu and has been running a high temperature this weekend. So I'm it, and there is nowhere I would rather be than here talking to you and making this first address, and there is nothing I would rather be doing than talking about the status of our battles for resource conservation. You are and have been the very important participants on the right side of the battles.

I'm sorry that Mr. Rockefeller and Senator Anderson are unable to be here. Mr. Rockefeller is one of those men of means who has devoted both his wealth and a good share of his own time and energy to public service. He has done a great constructive job for the nation as chairman of the Outdoor Recreation Resources Review Commission. Senator Clint Anderson is the nation's outstanding conservation leader today, not just as the Chairman of the Senate Interior and Insular Affairs Committee, but also as author and sponsor of many of the bills which are necessary to keep our conservation programs within gunshot of our needs. Those of us who work with him on the Commission have a great admiration for his drive, his effectiveness, and his tireless devotion. He has not only to meet all the responsibilities which accompany his job as Senator, but he is also a member of the Space and Finance Committees, Chairman of the Interior Committee, and various commissions, but he makes the most of his opportunities for public service which present themselves to him in all of these capacities.

I want to say a word about a former chairman of mine, Congressman Wayne Aspinall, with whom I have served for eight years in the House, and who, too, is a great conservation leader. Congresseman Aspinall was also my chairman when I was on the House Interior and Insular Affairs Committee, and it has been his interest in the development of Colorado that has caused us in Montana and all over the West to go along the same line with recreation and resource development. Congressman Aspinall and Senator Anderson were the authors of the bill for the Outdoor Recreation Resource Review Commission. One of the tasks that they have successfully undertaken was the sponsorship of this bill, and I was privileged as a member of the House to coauthor the bill on the House side. The first time I introduced the bill, I was a member of the House Interior Committee, and I thought that perhaps if we could get the bill passed at that time I would be privileged to become a member of the Commission. So we voted in the bill. In order to be a Congressional member on the House side, you must be a member of the respective Interior Committee. But by the time the bill passed, I had gone on to other committees and Messrs. Pfost and Saylor, and some of the others, did the outstanding work in the House that Senator Anderson, Senator Jackson, Senator Dworshak, and others did in the Senate. But this has been my first opportunity since those days to participate in a real discussion of that Commission's work.

Whether or not the great report of that Commission, created by the Anderson-Aspinall bill and chaired by Laurance Rockefeller, brings into reality the laws, the policies, and the programs which are needed to assure American citizens adequate recreational opportunities in the years ahead now depends in a very large measure on the people gathered in this room at this moment—conservationists from all the fifty states of the United States.

The Commission has given us a blueprint for the job. Incidentally, its report has already become a best seller. It is very difficult to get from the members of the committee or the Members of Congress, but it can be obtained from the Superintendent of Documents, United States Government Printing Office, and it is recommended reading for all of you.

President Kennedy, in his March 1 message on resources to the Congress, called for legislation to carry out the recommendations of the Commission. He proposed several specific steps to be taken by the Federal Government. There are more to follow—the enactment of the necessary federal legislation and the implementation of the program by state and local governments. The states are made the keystones in the recreational program recommended by the Commission, and this depends on the support, the initiative, and the zeal generated among you people in this room.

I will have more to say a little later about the importance of your role, and the importance of what the states are doing, in relation to water policy and recreation. But first, I think we should take a look at the blueprint for adequate recreational policies and the program which has been laid before us.

Senator Anderson has provided me with his answers, which he had intended to present to you himself this morning, to five questions about the work of the Outdoor Recreation Resources Review Commission. Not just because it is the easiest course for me to follow, but because it is a splendid authoritative job, I am going to give you his answers to these questions:

What did the commission study?

Why did it study?

What did it find out?

What should be done?

A second reason, of course, for using Senator Anderson's resume of the Commission's work as he prepared it is that another of the members of the Commission was going to serve as co-chairman of the program this morning. With all his other friends, I was saddened when I arrived and learned of Joe Penfold's illness and the fact that he is confined to the hospital. He is a much more authoritative member of the Commission than I would be in discussing this report. It was Joe Penfold who brought the first draft of the original ORRRC and, as co-sponsor, I introduced it in my office. It is Joe Penfold's energy and initiative which are chiefly responsible for putting through the bill authorizing the Outdoor Recreation Resources Review Commission, and it was he who obtained the original appropriations for that Commission. Then he was assigned to the Commission by President Eisenhower. So he knows about the Commission from its very beginnings down to the day the report was issued.

Let's start with the first of these questions that Senator Anderson has asked: What did the Commission study? Senator Anderson replies:

"The Commission's three-year work sought essentially to answer three questions:

1. What are the outdoor recreation needs of the American people now and over the next forty years?
2. What resources are available to satisfy these needs?
3. What should be done to ensure that these resources are so managed to meet the demand?"

The Chairman, in his introductory remarks, already pointed out that the demand is outrunning the supply of recreational resources.

"To study the outdoor recreation needs of the American people, we asked people what they are doing now for outdoor recreation. This was done through a household survey carried out by the Bureau of the Census. The survey also found out a good deal about the background of interviewees—age, income, education, family status, and so on.

"We came up with a pretty good picture of what Americans now do for outdoor recreation and how these various background factors affect their participation. Then we projected the effect of changes in our society—income, leisure time, travel, education, and so on. By applying these factors to what we found out about how they each affect present participation rates, we projected total changes in the recreation pattern over the next forty years.

"To find out what resources are available for outdoor recreation—the second of our questions—Congress directed the Commission to carry out an inventory of the recreation areas of the country. This was done with the cooperation of many of you here today as we relied on our friends in the States to supply much of the information. For all the areas of forty acres or over, detailed data on capacity, use, development, and future expansion were gathered. Less detailed information was collected on the smaller areas. In all, more than 20,000 areas were covered.

"To supplement the inventory, we carried out special studies of particular problems, such as shoreline, wilderness, the problems of sparsely populated Alaska, and the heavily populated Northeast. We studied hunting, fishing, and water. These studies added an element of depth and evaluation to the facts produced by the inventory.

"In the area of what should be done—the third question—the prime source of information was, of course, the judgment of the Commission. There were, however, some studies directed toward specific policy problems. The efforts of the Federal Government, state administrative arrangements, and the private effort in outdoor recreation were all surveyed.

"The results of all these studies contributed to the report of the Commission presented to the President and the Congress, but obviously all the detailed findings could not be included. Therefore, these studies are being made available in a series of twenty-seven reports over the coming months. The first will be coming out shortly."

May I add that when Congressman Aspinall, Senator Anderson, others, and I first introduced this bill five or six years ago, we didn't realize the importance that the Chambers of Commerce and some of the mining and lumber people were going to put on it and say we had to halt all recreational activities until this report was out, that we couldn't go forward with the developments of any shorelines or the Wilderness Bill, and so forth, until we finally had the report. Now we have the report, and it is time to go forth.

Why did we study this thing?

"Why was this large-scale study carried out? To those of you who daily wrestle with the problems of providing outdoor recreation opportunities for all of our citizens, I am sure the need is clear." We don't have to tell you why we made this study.

"In the years after World War II, the public sought more and more of the good life that the outdoors offers. The increased population had more leisure, more income, and better means of travel, and they sought the outdoors in larger numbers than ever before.

"This surge in demand brought about traffic jams in the parks, overcrowding on the beaches, campground swarming with people, and long lines at the boat launching ramps. These situations were reflected in legislative and administrative issues in the state capitols and in Washington.

"In many cases, they were particularly difficult to solve because of the same factors which created the increased demand for outdoor recreation. An eager nation, released from wartime restrictions, also wanted to use resources for new highways, schools, factories, airports, and subdivisions. Often these demands competed with those for more recreation, and in some cases they took land out of recreation use.

"The new demand for recreation brought new problems to many of the government agencies. To some, recreation was a new function and presented unfamiliar problems. Many of the less populated states, for the first time, felt the demand of the people for recreation places.

"As these problems became more urgent across the country, Congress was of the opinion that it was time for a broad look at this element of American life—a look that would include all levels of government and the private sector. To do this, it established a Commission made up of eight members of Congress from the Interior and Insular Affairs Committees—four from the House, four from the Senate, four from each party, and seven private cititzens appointed by the President.

What did we find out on this Commission?

"We are hopeful that those working in this field will find that the vast amount of data developed by the Commission is a helpful tool.

There is much still to be done and perhaps one of the greatest contributions these studies will make is the stimulation of further efforts to find out more. The ORRRC studies are, in one sense, a foundation on which further knowledge can be built.

"From this great amount of data, here are a few findings which stand out. They had a good deal of influence on the deliberations of the Commission.

"Outdoor recreation is a major leisure time activity of Americans and it is going to become even more important.

"Today 90 percent of the public participates in some form of outdoor activity. In total, they participated on 4.4 billion separate occasions in 1960. This will grow over the next forty years. The increase, we predict, will be about threefold in the next four decades. As the population doubles, other factors, such as income, leisure and mobility, will increase the individual participation rates.

"The relatively simple pleasures are the most popular and are likely to remain so.

"Not surprisingly, the activities which require the least skill or added expense are the most frequently engaged in. Driving and walking for pleasure are the most popular. Swimming, bicycling, and sightseeing are high on the list. While the zeal, energy, and expense devoted to other activities make them quite important, the mass of the population seeks largely the simple pleasures. It does not appear that this is going to change. Hunting and fishing activity occasions will approximately double by the year 2000.

"There is a great amount of land theoretically available, however, and the problem is not one of the number of acres but of effective acres.

"There are over one-quarter of a billion acres available for outdoor recreation in the publicly designated non-urban areas. But this seeming plenty is misleading because, for reasons of location, access, or development, these acres are not as effective as they might be in meeting the recreation needs of the public. Much of the land is where people are not and, even when the land is relatively close by access is often difficult or there are no facilities available. In some cases, development can increase effectiveness greatly, but in others, such as shoreline, immediate public acquisition is essential."

This brings up water which is the focal point of outdoor recreation.

"Americans like water. They like to swim in it, fish in it, ski across it, skate on it, and sit beside it. Swimming and fishing are among the most popular activities, and boating is one of the fastest growing. Other activities, such as camping, picnicking, or hiking, are made more attractive by the presence of water. The campsites or picnic tables near the stream or lake are always the most crowded."

Let me say on my own, parenthetically, that I will have more to say about water later.

"There are a great many people in the outdoor recreation business.

"More than twenty Federal agencies have some responsibility for outdoor recreation although it is a sideline for many of these agencies. The pattern is duplicated on the state and local levels with the result that there are hundreds of public agencies concerned with outdoor recreation.

"Outdoor recreation is big business.

"The Commission estimates that some $20 billion annually is spent on outdoor recreation goods and services. In some areas it is a mainstay of the local economy. Public investment in outdoor recreation often brings about great economic benefits for nearby local communities as new businesses spring to serve the visitors, and these businesses, in turn, pump money in to stimulate other local concerns."

What should we do?

"The findings of the Commission—these few I have mentioned and many more—led to these recommendations. The recommendations can be divided into five broad categories—a basic five-point program for securing the benefits of outdoor recreation for the American public over the next forty years.

"First, a national recreation policy is needed. We urge that it shall be the policy of our country to:

> '. . . preserve, develop, and assure accessibility to all American people of present and future generations such quality and quantity of outdoor recreation resources as will be necessary and desirable for individual enjoyment, and to assure the spiritual, cultural and physical benefits that such outdoor recreation provides.'

"These words are taken from the first section of the Act establishing ORRRC, and the Commission has adopted them as the foundation stone of a national policy.

"The implementation of this policy is a shared responsibility—shared among all levels of government and the private sector. Some responsibilities the Federal Government can discharge best, such as the preservation of our natural and scenic heritage. Some, the States are best equipped to handle, such as the provision of weekend and out of city day-use areas. Some, local government must bear such as providing for many of the needs of the citizens and many of the needs of the citizens of our metropolitan areas. And the private sector, too, must play a large role in all of this. The individual citizen and the commercial enterprises must continue to provide outdoor recreation opportunities for a vast number of people.

"Second, we recommend a classification system for all recreation resources. This system—a kind of zoning for recreation areas—would serve as a guideline for all those administering such areas. It would use six different classes ranging from high-use areas usually near centers of population to primitive areas with an additional class for historic sites.

"There are more than twenty Federal agencies which now have some responsibility for outdoor recreation, but there is no central unit to coordinate their efforts—efforts that are often in connection with related programs and not primarily concerned with outdoor recreation.

"The Commission recommends the establishment of a new Bureau of Outdoor Recreation to serve as a focal point for the Federal efforts. The Bureau, located in the Department of the Interior, would coordinate Federal efforts, administer grants-in-aid, sponsor research, take the lead in recreation planning, and help in interstate arrangements.

"To help guide the policies of the Bureau, the Commission recommends a Recreation Advisory Council. It would be made up of the Secretaries of the Interior, Agriculture, and Defense, with the heads of other agencies to serve as needed.

"To stimulate and help the States in meeting their important responsibilities for outdoor recreation, the Commission recommends a Federal program of matching grants. Planning would be emphasized and grants made for this purpose. It would require that all grants for acquisition and development be in accordance with the statewide plan.

"The Commission recommends that funds allocated among the States on a basis which would consider population, area, and need, and also take into account the amount of Federal recreation programs already going on in the state. The grants would offer an incentive for interstate cooperation by increasing the Federal percentage in those cases.

"Expansion, intensification, and modification of existing programs is a very important group of about fifty specific recommendations. They generally urge that more be done for recreation under programs currently going on. Some present outdoor recreation programs need bolstering, and there are related programs in which outdoor recreation should be given more consideration. Here are a few of the key recommendations.

"All levels of government should take immediate action to secure more shoreline recreation opportunities. This is one area in whch immediate public acquisition is vital.

"Wilderness should be protected by legislation.

"Farm programs should be modified to allow greater recreation use of the improvements they bring about.

"Federal surplus property suitable for outdoor recreation should be made available to States and local government at no cost.

"Outdoor recreation should be given greater consideration in Federal water development projects. Where the need is warranted, it should be considered in the cost benefit ratio in the planning of such projects.

"The programs of the Bureau of Indian Affairs should seek to stimulate commercial recreation development by the Indians.

"Acquisition of wildlife areas should be stepped up."

The final question: "When should we begin?" I think this was answered by President Kennedy's inaugural address when he pointed out that many of the things he wanted to accomplish would not be accomplished in his lifetime or maybe not even in the next century, but that the time to begin is now; and the time to begin this recreation program is now.

"The time is right for a national recreation and conservation effort. The Federal Government, the States, local government, and private groups are beginning to move. If action is well directed, the '60's may stand out as important an era in the conservation of our nation's resources as was the first decade of this century.

"President Kennedy, in his conservation message this month, took giant steps toward that goal. We were most heartened that he embraced many of the recommendations of the Commission.

"The new Bureau of Outdoor Recreation should provide a focal point of leadership for the Federal effort. The Advisory Council, to be made up of the heads of the departments and agencies concerned, should lend valuable support.

"The proposed Land Conservation Fund, to be supported from fees and charges from the Federal areas, should provide the funds and necessary energy for a vigorous acquisition program. This program should expedite the acquisition of the specific areas which the President recommended.

"I was particularly pleased to see that the President urged passage of two items I consider vital to this national recreation effort: S. 174, the Wilderness Bill, and S. 543 for a study of the ocean, lake, and river shoreline of the nation leading to a national shoreline preservation program. Both of these have, of course, already been approved by the Senate and are awaiting action in the House.

"In all, this message and, I hope, the ORRRC report constitute an effective and practical plan for action on the Federal level for the Federal role in the outdoor recreation effort, one that must be carried forward immediately.

"The matching grants to the States for recreation planning, which the President proposed and ORRRC recommended, will stimulate action in the States. Many are already doing a fine job. In the past two years, there has been an encouraging awakening of state action. New York and New Jersey have enacted conservation bond issues—issues approved overwhelmingly by the voters. Pennsylvania, Wisconsin, Michigan, and California are all undertaking similar programs. The Federal grants program should stimulate still other states to action.

"On the local level, there is also renewed vigor. More and more local government officials and planners are beginning to work at making our cities and suburbs better places to live by building conservation and recreation opportunities into the local environment.

"We are now facing what may be a great era for recreation and conservation in America. All levels of government are on the move to achieve this goal, but it will take more than that.

"In the final analysis, government at any level only reacts to the desires of the citizens. The action and support of private citizens are the key to the success of many programs, and this is particularly true when we seek to mold our environment by affirmative action.

"If this new era of conservation and outdoor recreation opportunities is to come about, it must have the vigorous support of the individual citizen and informed and knowledgeable leaders, such as are in this room today. Groups such as yours must bear the brunt of this crusade. We in the Congress and those in the legislatures of the States and those in administrative positions in the Federal and state government are responsible to your wishes. Make them known.

"Today's challenge is to assure all Americans permanent access to their outdoor heritage.

"I earnestly hope and expect that the 1960's will be known as the decade when that challenge was met."

That concludes Senator Anderson's answers to the five questions. Now I would like to mention two or three matters I believe to be of special interest to you.

President Kennedy's March 1 resources message recommended a program of aid to the States for recreation planning and a Land Conservation Fund to finance "national needs for adequate outdoor recreation facilities," among other things.

The ORRRC recommendation of Federal aid for state acquisition of recreational land has not been forgotten either in the Executive Branch or in Congress, although it was not specifically mentioned in the message. Such a program is being developed and will be proposed later this year or early in the next Congress. In the Executive Branch, the problem is how to finance it. A 10 per cent excise tax on certain recreational supplies—boats, motors, spleeping bags, cots, tents, lanterns, and several similar items—has been suggested. There is always opposition to excise taxes from tax theorists as well as the targets of the taxes. A counter proposal of a use tax—an annual license fee on pleasure boats—has been suggested. Various proposals are now being weighed. If the Executive Branch can't reach some internal agreement on the matter—and I am sure it will because the President has indicated his support of the aid-for-acquisition program, then I am sure that members of Congress will initiate such a program.

I can assure you that the Chairman of the Interior Committee and the junior Senator from Montana will both be interested in the views of the members of this Conference on this question of financing the aid-for-acquisition program which Senator Anderson regards as an essential part of the program, and so do I.

One of the important and significant statements of the Recreation Review Commission was that an adjustment of land management practices by Federal agencies need not result in changes in jurisdiction over the lands involved; that the designation of national forest lands as recreational areas need not mean their transfer from the Forest Service to the Park Service or some other agency. It commended the concept in the Wilderness Bill which leaves wilderness areas under their present agency jurisdictions and simply prescribes common standards for their administration.

So far as the ORRRC report, the views of the Chairman of the Senate Interior Committee, and my own views are concerned, there will be no mass transfer of lands between agencies which will mean removal of large areas from hunting and fishing or from the jurisdiction, as far as hunting and fishing is concerned, of the States, state laws, and state regulation.

I believe it is the view in Congress that new seashore recreational areas and similar Federal recreation area acquisitions administered by the Park Service should have continued hunting and fishing in accordance with the laws and regulations of the state in which they are located. There may be some rounding out of the National Park System. There should be. But it will not be at great expense to hunters and fishermen.

This brings me back to the point that our success in enacting Federal legislation necessary to create an adequate recreational program for America will depend on the work that you do out in the States.

If members of Congress know unmistakably that state governments and citizens want and insist upon an adequate program, there will be little trouble enacting the necessary Federal laws and the Federal programs. We'll get the job done at the Federal level if you will let us know decisively that you want them. Congressmen and Senators—again including the Junior Senator from Montana—are very responsive to the voice of the folks back home. But if the support from the States and citizens is not forthcoming, the recreation program of the '60's will not materialize and the ORRRC report will be put on some shelf down at the National Archives where the unimplemented reports of scores of similar Commissions gather dust, forgotten by all but a few students and the die-hards who make sporadic but futile attempts to revive them, or mention them in historical references to lost causes.

I fear that I have witnessed the beginning of just such a tragedy, in connection with a matter of utmost importance in the recreation resources field, within the past ten days.

A Senate Select Committee on Water Resources on January 31, 1961, recommended that the nation develop water resources plans for all its major river basins in the '60's, and have them ready by 1970. Apparently too few conservationists realize that recreation—hunting and fishing—has one of the biggest of all stakes in the outcome of our water resources efforts. The reports of the Select Committee on Water Resources show that if we maintain the present per capita level of hunting and fishing opportunity in the United States, fish and wildlife will be one of the largest users of water in the nation.

In 1980, water requirements to maintain swamps and wetlands, in terms of losses through evaporation, will increase 66.7 billion gallons daily over the 89.5 billion consumption in 1954, for a total use of 154 billion gallons daily. That compares to an estimated 104 billion loss in 1960 resulting from agricultural withdrawals, mainly irrigation.

In addition to swamp and wetland losses, sport fish habitat will require 171 billion gallons daily flow, compared to an estimate of 238 billion gallons daily flow required for navigation and 332 billion required for waste dilution.

There are, of course, other recreational needs for water, some consumptive and some of them only for flow. The Outdoor Recreation Resources Commission report devotes a chapter to describe water's key role in recreation. Cleaning up our water flows, elimination of pollution, would be the greatest conceivable boon to fishing today as well as to other water sports. But we may discover that instead of cleaning up pollution to provide greater fishing and recreation opportunity, remaining flows in streams suitable for fish habitat are appropriated to dilute excessive pollution and postpone the necessity of building disposal plants.

The Select Committee reported that five major areas in the West will be out of water in 1980. By the year 2000, water shortage areas will have moved eastward to three more major basins including the western Great Lakes area in Minnesota, Wisconsin, Illinois, Indiana, and Michigan.

The estimates of water shortage, on the requirements side, include water for the maintenance of present per capita levels of hunting and fishing opportunity. They assume we will build the necessary reservoirs to conserve floodwaters and wet season flows for time of need. They assume that the areas will have established waste treatment plants to prevent intolerable levels of pollution and minimize requirements for dilution of wastes. But with all of these measures, we are faced with shortages and acute water supply problems.

It is not difficult to predict what is going to happen if we do not develop plans for the optimum use of every drop of water in our great river basins now, and provide for recreation, fish and wildlife in those plans. The water supplies we need for fish and wildlife are going to be raided if we don't make plans today. Congress is going to be told that we can't afford to waste water on frivolous needs like recreation. We'll hear the cry that has already arisen from the Indiana Dunes fight: "We need payrolls, not picnics!"

Just a few days ago, I introduced a bill, S. 2767, to provide that the Fish and Wildlife Service must be consulted in the location and building of interstate and Federally aided highways, and already the cry is being raised, "Well, we need to build roads and we can't wait. We haven't time to consult the Fish and Wildlife Service or the state commissions because we need to get on with this job of building the roads." And this will go on and on this way. "We need jobs. We need domestic water supplies," and so forth, "and we don't need fish and wildlife and these other frivolous things."

Pollution will go on unabated, necessary reservoirs will be left unbuilt to save money, and even planning for them will be resisted just as long as there is another wetland area that can be drained.

The Senate Interior Committee held a hearing on President Kennedy's and Senator Anderson's Water Resources Planning Bill on March 1. The manufacturers of 90 per cent of the nation's chemicals filed a statement. They don't like Federal planning commissions. They prefer state-controlled planning commissions. The navigation interests were there. They don't want Federal planning either. And the Interstate Conference on Water Resources of the Council of State Governments was there speaking for the States—your states and mine. They don't want Federal planning commissions for water either, but commissions clearly controlled by the States.

This pattern of opposition to planning for optimum use of the water of our great river basins began to be completely clear. An alliance of forces is determined that if any bill passes, it shall be so modified that it will transfer Federal rights, powers, and prerogatives in relation to water resources planning over to the States, leaving the Federal Government only a minority role on the planning commissions even in basins where international relations with Canada and Mexico are involved.

Your help is desperately needed to help us achieve water resource planning that will provide for recreational needs and let the nation enjoy both payrolls and picnics. The attitude of state governments in that regard is crucial today. I am sure that this great Conference is going to result in that help being forthcoming.

The Outdoor Recreation Resources Review Commission included a page near the end of its report, almost an afterthought, which I want to quote. The Commission said:

> "After three years of surveying the needs, we have presented in this report a program that, in our judgment, can assure the benefits of outdoor recreation for all American people now and in the future. It contains recommendations for action along a wide front. Now the task must pass to others.
>
> "The next step is for legislative bodies and alministrative agencies at all levels of government, for private land owners, and for individuals and their organizations to take action. We urge all to push forward in a nationwide effort to secure the contribution that outdoor recreation can make to the well being of the Nation and its people."

Those who are at this meeting constitute a substantial number of the leaders in America to whom the Commission just passed the responsibility. I have no doubt of your response and of what it is going to be.

DISCUSSION

CHAIRMAN NEWTON: Senator Metcalf, as a second substitute pinch hitter once removed, you have really done a magnificent job. You have given us one of the most informative talks I have ever heard. It is no wonder that you are in great demand in the big league.

Now we have come to the discussion period in our program and Dr. Clarence Cottam is here to assist me and to join with me in leading the discussion.

MR. GUTERMUTH: While it may be improper, I think some word of particular public thanks must go to Senator Metcalf for coming here today. I talked with Mrs. Rockefeller about Laurance's delayed operation. I think she was quite concerned by the fact that he delayed this major operation until after this report was completed and the job of this great Commission was done, and so he simply could not come.

Then I want to thank his special assistant, Carl Gustafson, who is here in the audience, for working out the first substitute, Senator Anderson, who is in effect the Vice-Chairman of this great ORRRC. We had him all set, and then the doctor said "No" to him.

Then at the last minute—and really at the last minute, we went to work to see who we could get to come out here and do this job, and naturally we turned to the fellow who did come. I had the very distinct personal privilege a few years ago, in behalf of a number of the national conservation organizations, to present a conservation award to this distinguished Senator when he was an outstanding conservationist in the House of Representatives. And, Lee, I want to thank you profoundly, not only on behalf of the Institute but of all these people, for coming out here in this emergency and doing the splendid job that you did. Thank you very, very much.

RECREATION FOR YOUNG AMERICA

JULIAN W. SMITH

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One of the certainties of the present age is that there will be change. Barring war or complete catastrophe, no phase of man's living shows more signs of change than the way he will use the time in which he is free to engage in activities of his own choice or what has been termed "recreation." Our concern here is to take a look at the potentials for the more important kinds of leisure time use — outdoor recreation, more aptly called outdoor living.

One needs first to consider the meaning of recreation in its broadest sense; e.g., the creative use of the time spared from the necessities of life. In the United States, particularly, the golden age when people have the time and means to live creatively is within the grasp of millions. The greater abundance of leisure time offers opportunities for human beings to find some of life's values through self expression—a heritage which has been largely taken away during the era of industrialization and automation. Today's great paradox is found in the situation where large masses of people are not equipped with knowledge, skills and attitudes to partake fully of the newly acquired leisure time. The society which has created the era of leisure has failed largely to prepare people to use it or to provide adequate resources for individual and family pursuits. In a sense, we are in the proverbial dilemma, recreation-wise, "all dressed and no place to go." The importance of recreation is well stated by the Outdoor Recreation Resources Review Commission, "Leisure is the blessing and could be the curse of a progressive, successful civilization."[1]

[1]Outdoor Recreation Resources Review Commission, *Outdoor Recreation for America.* A Report to the President and to the Congress. (Washington, D. C., January 1962) p. 22.

THE SETTING FOR RECREATION

Today's challenge is to educate for the worthy use of leisure and to plan for adequate resources. A brief look at the decades immediately before us should give some clues of the magnitude and nature of the task that lies ahead in educating young Americans for creative living through the worthy use of leisure time and bringing the good life within the reach of all people. A few highlights from the Report of the Outdoor Recreation Resources Review Commission recently made to the President of the United States and the Congress, will give some idea of the shape of things to come.

1. By the year 2000, some 73 per cent of the population, which will then be approximately 350 million, will be living in metropolitan areas.
2. The age group under 25 years and over 60 years will be larger in proportion to the adult population.
3. The average income of families will rise steadily, which will provide more means for recreation.
4. The work week will edge toward 30 hours, increasing the amount of time for leisure.
5. There will be a greater percentage in the professional, technical and white collar categories, which results in more outdoor recreation.
6. Means of travel will be greatly increased, making it possible for people to reach the open spaces in a shorter time.
7. There will be more public funds, particularly through government, for education and recreation.
8. If the recommendations of the Outdoor Recreation Resources Review Commission are accepted, the rate of acquisition and development of outdoor recreation resources will be greatly accelerated.

The ORRRC Report also contains pertinent information about educating for recreation.

1. More than 90 per cent of all Americans engaged in some form of outdoor recreation during the course of the year. A parenthetical note should emphasize that since people have not been educated for outdoor recreation, they do not gain maximum satisfactions from their participation even though the desire and need is present.
2. The educational level of the population will be higher, resulting in more outdoor recreation.
3. One part of the Report dealing with the demand for outdoor recreation indicates that (a) when children and youth are taught outdoor skills they tend to participate in the more active forms of outdoor recreation as adults and as older age citizens; and (b) people expressed a desire to engage in a wide variety of outdoor recreation if they could learn the skills and have available outdoor resources and facilities.

The ORRRC Report and a look at the current scene leaves little doubt that "we haven't seen anything yet" in recreation, particularly outdoor recreation. Marion Clawson estimates that by the year 2000, there will be ten times as many people engaging in outdoor recreation in one form or another.[2]

OUTDOOR EDUCATION

Let us now consider some of the developments in education and trends that affect recreation for young Americans. In more recent years, education has become increasingly aware of both the needs and potential for learning in the outdoors and for the teaching of skills, appreciations and attitudes necessary for satisfying outdoor pursuits. A number of factors are responsible for this new emphasis in education, now termed outdoor education. They are briefly summarized as follows:

1. *Urbanization,* with a steady drift into largely populated cities, has deprived many children and youth from contact with the land.

2. *The tempo of modern living is frenzied* and much of man's work is meaningless, depriving him of the opportunities for creative expression formerly associated with work.

3. *Automation and mechanization,* paradoxically, have increased the amount of time available for off-the-job living, with little opportunity for the development of knowledge, skills, and attitudes necessary for the worthy use of leisure time.

4. *Industry and automation imposed on the long biological pattern* of the human being have suddenly removed many of the opportunities for physical exercise, making it necessary to find additional ways of keeping fit.

5. *The accumulative effect of the industrial* age has created a world of abstractions—of words—of spectators—thus producing a need for real and first hand experiences in the educative process.

6. *The shift in man's living* from a culture dominated by work to one where more time is available for leisure.

7. *More is known about the nature of learning,* and educational curriculum designers are finding that outdoor experiences enhance the learning of many subject matter fields and activities. One of the basic premises of outdoor education may be stated as follows:

That which can best be learned inside the classroom should be learned there.

That which can best be learned in the out-of-doors, through direct experience, dealing with native materials and life situations, should there be learned.[3]

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[2]Marion Clawson (Resources for the Future, Inc.), *The Crisis in Outdoor Recreation*, American Forests, March 1959.

Education for the worthy use of leisure and outdoor education, particularly, now appear to be firmly rooted in the curriculum. The following references would substantiate this premise:

> "The entire school curriculum must be conceived as a tool for developing attitudes, understandings, knowledges and skills required for leisure literacy."[4]
>
> "The *worthy use of leisure* is related to the individual's knowledge, understanding, and capacity to choose, from among all the activities to which his time can be devoted, those which contribute to the achievement of his purposes and to the satisfaction of his needs. On these bases, the individual can become aware of the external pressures which compete for his attention, moderate the influence of these pressures, and make wise choices for himself. His recreation, ranging from hobbies to sports to intellectual activity pursued for its own sake, can conform to his own concepts of constructive use of time."[5]

Fortunately outdoor education is not regarded as another discipline to be added to an already crowded curriculum. It is conceived to be an emphasis in education or a learning climate which helps develop concepts and insights about the natural environment and man's relationship to it; provides laboratory experiences for more effective learning in some of the essential subject matter areas; enables one to acquire skills with which to enjoy a lifetime of creative living; and gets us back in touch with those aspects of living where our roots were once firmly established.

Learning *in* the outdoors applies to the educational activities that take place in outdoor settings; while education *for* the outdoors encompasses the skills and knowledge necessary for satisfying participation in outdoor pursuits. Learning through the use of the outdoors as a laboratory contributes to the phase of outdoor education which might be termed the appreciation arts. Education for the outdoors consists of the development of the manipulative and creative skills which are expressed in the more active types of outdoor recreation activities.

Outdoor education, therefore, as described above has significant implications for recreation of young Americans. Many significant programs are under way and are examples of education for the worthy use of leisure. Some of the developments in education affecting outdoor recreation are briefly described.

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[3]L. B. Sharp, "Introduction" to AAHPER, *Outdoor Education for American Youth* (Washington, D. C.: The Association, 1957)
[4]AAHPER, *Leisure and the Schools* (Washington, D. C.: The Association, 1961)
[5]Educational Policies Commission, *The Central Purpose of American Education* (Washington, D. C.: National Education Association, 1961) pp. 6-7.

Education in the Outdoors—The use of the outdoors as a laboratory for learning

1. 800 school districts in approximately half the states use camps as "outdoor schools." Classroom groups of teachers and children spend a week on school time as a part of the curriculum of elementary and secondary schools. More than a quarter of a million children have these experiences annually and it is predicted that this pattern of outdoor education will expand rapidly. Upwards of two to three million children may have these experiences annually by the year 1975. In a survey of 1,500 sixth grade children from the Long Beach, California, Public Schools, who participated in this kind of program, over 90 per cent indicated they had acquired new interests in the outdoors.

2. Outdoor settings, other than camps, used by schools as outdoor laboratories include school farms, school gardens, school forests, parks and public lands, zoos, museums, sanctuaries and other areas and facilities. It's probable that one-third of the children in school, which would be approximately 12 million, have some sort of experience in outdoor laboratories.

3. An increasing number of new schools have sites ranging from 20 to 100 acres, which can be used as outdoor laboratories.

Education for the Outdoors—The teaching of outdoor skills and appreciations

Increasing numbers of schools and colleges now provide instruction in outdoor sports and skills. These are usually included in physical education and recreation curricula and are conducted through classes, clubs, intramurals, after-school and recreation programs, or through school and community cooperation. Hundreds of thousands of high school youth now receive some instruction in outdoor activities such as shooting, casting, archery, boating and water activities, winter sports and others.

School Subjects and Outdoor Recreation

Social studies, science, arts and literature have significant implications for outdoor recreation. Outdoor interests and appreciations are developed through these disciplines in which nearly all of the ten million secondary school youth are involved. The study of the subject matter areas, supplemented by field experiences, stimulates travel to parks, historical sites and scenic areas; encourages camping, collecting, outdoor photography, pleasure driving and other outdoor interests and hobbies. Travel will be more extensive in the future and increasing numbers of people will be stimulated by their educational experiences to seek new places of natural beauty and historical significance.

Adult Education

There has been a significant growth in the number of adult education programs in the past few decades. Approximately four million people are enrolled in adult education courses annually. In Flint, Michigan, there are more people in school at night than during the day—37,000 children in the daytime; 52,000 adults and children at night.

Many adult education programs include the teaching of outdoor recreation activities such as casting, boating, shooting and family camping. This stimulates immediate use of outdoor recreation resources. Milwaukee, Wisconsin, has a Family Camping Association of 1,600 family memberships, all of which make use of their instruction in adult education in their camping experiences during the summer months. It is predicted that in the future, adult education and recreation departments, through the teaching of outdoor skills and by providing opportunities for participation in outdoor activities such as family camping, will provide most of the immediate instruction needed by adults who are interested in outdoor recreation.

OTHER DEVELOPMENTS IN EDUCATION RELATING TO OUTDOOR RECREATION

School and college programs on a twelve-month basis. There is a noticeable trend in the extension of school and college programs to a twelve-month basis. Florida is the first state to enact legislation establishing an enrichment program for the eleventh and twelfth months. The program, which includes a wide variety of outdoor activities, such as day camping, field trips, teaching of outdoor skills, nature crafts and others, is partially subsidized by state funds. In the summer of 1957, more than 45 per cent—300,000 in number—voluntarily returned to school to participate in learning activities, many of which lead to outdoor recreation.

It is predicted that other states and individual school districts will develop longer school years, which will have most significant implications for outdoor recreation. It is estimated that the twelve-month school year would double the opportunities for acquiring outdoor recreation skills and interests. An increasing number of colleges and universities are establishing a three-semester or four-term plan which provides additional time and opportunity for outdoor recreation, particularly during the summer months.

Mass communications and new instructional devices. Radio, television and the press are being used more extensively by schools and colleges to disseminate information and instruction. Science, conservation, social studies and outdoor recreation are among the offerings that reach millions of listeners and readers of all ages. Newly stimulated interests in the outdoors through mass media give impetus to participation in many outdoor activities.

A sensational development in education is the Midwest Airborne Television program beamed to thousands of students and it appears likely that this type of education, as well as teaching machines, radio and the press, will develop rapidly in the next decade. The classroom subjects in science, social studies, literature and arts described previously will create interest in outdoor recreation for greater numbers of children, youth and adults, through the media of mass communications.

TEACHER AND LEADERSHIP PREPARATION

Since outdoor education is an integral part of general education and outdoor recreation is the responsibility of many agencies, adequate teacher and leadership preparation must be interdisciplinary in character. Much is being done now by colleges and universities in both pre-service and in-service education for outdoor education. Some of the promising developments include:

1. In-service education
   a. Local in-service activities in outdoor settings conducted by boards of education in cooperation with colleges, universities, state departments of education and conservation, and professional education organizations.
   b. College and university sponsored workshops and off-campus courses at both graduate and undergraduate levels.
   c. Workshops and conferences sponsored by national education associations, such as the American Association for Health, Physical Education and Recreation through the Outdoor Education Project.
   d. Preparation and distribution of instructional materials and audio-visual resources by professional education organizations, colleges and universities, state departments of education, and agencies concerned with outdoor education.

2. Pre-service education
   a. Broader offerings in science and conservation, with emphasis on outdoor interpretation and accompanied by more field experiences.
   b. Educational methods that stress learning techniques and approaches to teaching in informal outdoor settings.
   c. Skill courses and activities that include a wider variety of outdoor activities and sports.

d. Student teaching and field experiences in locations where there are outdoor programs with children involved.
e. Additional preparation, particularly at the graduate level, for those who plan to administer or coordinate outdoor education activities in schools. This more specialized preparation, tailored to the candidate's experience and previous training, may include child development, psychology, outdoor interpretation, conservation, guidance, sociology, arts and crafts, administration and other special subjects as needed.

An increasing number of colleges and universities are acquiring camps and outdoor areas which serve as laboratories for the development of leadership in outdoor education and recreation. These facilities also serve as centers for teaching outdoor skills and conducting workshops and conferences. Another important function of a college-owned camp facility is to serve as an outdoor center for the use of schools in the area that conduct programs in camp settings. This arrangement provides a laboratory situation involving children. Three specific examples of teacher and leadership preparation for outdoor education are briefly described.

1. Northern Illinois University owns a camp, which is known as a field campus. All prospective elementary teachers have three types of field experiences in the camp as a part of their undergraduate education.

2. Michigan State University conducts a two-week summer workshop in graduate education at the Kellogg Gull Lake Biological Station. Fifty leaders from 20 or more states each summer participate in this intensive graduate program.

3. Colorado State College, Greeley, has set an excellent pattern for coordination among the appropriate disciplines and activities in both the preparation of classroom teachers and specialists in outdoor education. A full-time staff member serves as coordinator for the college outdoor education committee.

SPECIAL PROJECTS IN LEADERSHIP PREPARATION—THE OUTDOOR EDUCATION PROJECT OF THE AAHPER

While outdoor activities have been recognized in good health, physical education and recreation programs for many years, they have not occupied the position of importance they deserve in the school and college curriculums in the country as a whole. Prompted by the need for leadership preparation and program development in outdoor education, the American Association for Health, Physical Education and Recreation initiated the Outdoor Education Project, a cooperative venture of business, industry and education. The American Fishing

Tackle Manufacturers Association, the Daisy Manufacturing Company and the Sporting Arms and Ammunition Manufacturers' Institute have been involved in the venture for a number of years. The Outboard Boating Club of America made possible a survey of boating instruction in a list of selected schools and colleges in the United States. More recently, through the cooperation of the Shakespeare Company, archery was added to the Project activities. Other phases of outdoor education are being emphasized by the Project, such as camping and survival, boating, outdoor living and family camping.

Like other important educational programs, a great need is for dynamic leadership in schools and colleges in order that the 37 million boys and girls in schools and the three million in colleges may acquire the necessary skills, attitudes and appreciations for the intelligent use of our resources and for the constructive use of leisure time. It is evident that people cannot fully enjoy and appreciate outdoor activities such as camping, casting and angling, shooting and hunting, boating, winter sports and others, unless they have adequate education. These activities in outdoor living are related, with conservation and safety being integral parts. The Project program, therefore, is designed to intensify and speed up outdoor education programs in schools, colleges, recreation departments and community agencies through in-service education of leaders, interpretation of the need for and nature of outdoor education activities, program development and the preparation of instructional materials.

The AAHPER, through its staff and other resources and in co-operation with the departments of the National Education Association, the National Rifle Association, the American Casting Association, state departments of education, conservation agencies, representatives of the cooperating industries and schools and colleges, is carrying forward the Project program. The Project encompasses the following activities.

1. *Leadership preparation.* Regional, state and local workshops and clinics are conducted for school and college staff members and recreation and agency leaders who are interested in developing programs in their own states and communities.

2. *Interpretation and information.* The need for the development of outdoor education programs and the Project's plan of operation are interpreted to school administrators, teachers and other interested groups through programs, exhibits, demonstrations at conventions, and articles in education journals. Many of these are done through the departmental structure of the National Education Association.

3. *Instructional materials.* Needs for additional instructional mate-

rials are being determined, and committees are at work preparing instructional guides and audio-visual aids.

The Outdoor Education Project, with its broad emphasis on a variety of activities, is stimulating much interest in the schools, colleges and recreation agencies of the nation. The venture is particularly significant now in view of the national emphasis on fitness and the work of the Outdoor Recreation Resources Review Commission.

A survey of the schools, colleges and universities, and agencies represented in 55 state and regional outdoor education workshops, indicated that the number of outdoor education activities had doubled during a five-year period.

Mobilization of Leadership and Resources for Outdoor Recreation

If young Americans are to have their rightful heritage of learning and living in the outdoors, the full cooperation and teamwork of all agencies and organizations with the nation's great resources—human and natural—will be required. Those charged with education and with management of outdoor recreation resources have a common goal in solving the problems of both human and soil erosion. Federal and national agencies and their state and local counterparts will need to coordinate efforts with communities in the mobilization of efforts for the creative use of leisure time. Recent developments are heartening in this respect, but much more remains to be done. Much of the energy and funds expended to combat crime and delinquency could be rechanneled into creative action in creating a better environment for the growing up process of children and the maturing of youth. These are not platitudes, for there are now patterns of action that give hope for the future.

A New Image of Youth

Have we lost the image of children and youth of yesteryears, who with their cane poles, guns and dogs, flower baskets and berry pails roamed in the open spaces of rural America? Can children be seen rolling down grassy slopes, climbing trees and digging caves? Are too many of them wandering in aimless groups on paved streets and in alleys playing Cops and Robbers? Do they get their thrills from watching unreal Westerns on television? Thanks to good programs of schools, recreation departments and youth agencies, and to good homes and churches, large numbers of them are participating in educational and recreational activities superior to those of days gone by.

It is safe to say, however, that too many of today's children and youth are not in an environment where they have opportunities to develop good patterns of recreational behavior. Those who are more favored often lack the opportunities for learning and living in the open spaces. Basically children and youth are the same, but their environment is changed. The present image is often that of delinquent or pre-delinquent youth, far removed from the land, in conflict with laws and regulations and often in trouble.

We can change the image of our children and youth. One effective way is to provide for adventuresome and wholesome play and recreation, part of which is to insure their heritage of experiences in the outdoors. Some of those who know the most about human growth and the nature of learning say that close contact with the land is an important part of the growing up process of children and in the successful transition from youth into adulthood. Upon these premises and the reasons presented in this paper, let us make possible the "great good places"[6] for the physical, mental and spiritual fitness of young America.

DISCUSSION

MR. HENRY SCHAEFFER [Newark *News*]: Where can we get these booklets?

DR. SMITH: These particular publications that I held up were published by the Department of the National Education Association which I represent, the American Association of Health, Physical Education, and Recreation in Washington, D. C., 1201 Sixteenth Street, N. W. I would like to point out that many of the sporting organizations, camping organizations, national recreation associations, and others, are now putting out publications of this kind.

CHAIRMAN NEWTON: Are there any other questions or comments from the audience? If not, I regret very much to announce that the next speaker on your program, Dr. Paul Dudley White, has not arrived and we are very sorry about this. He went on a special medical mission to Asia and has been away for a number of weeks. He returned very recently, and we are sorry to learn that he is unable to be here. We are especially sorry because Dr. White has so much to contribute in this whole field.

The next speaker is well known to all of you. I asked Mr. Gutermuth for a little biography on our next speaker, thinking perhaps that I needed to use it for this audience. But he told me that I did not need any biography for Dr. Gabrielson. In fact, he is "Mr. Conservation" himself. So I present to you an old friend of yours, Dr. Gabrielson.

[6]From a fable by Henry James.

GETTING ON WITH THE JOB

IRA N. GABRIELSON
President, Wildlife Management Institute, Washington, D. C.

Outdoor recreation is one of the most imperiled commodities in the natural resources market place. Its fate rests largely on the outcome of two of man's more noble aspirations—imaginative land use planning and the intensification of essential programs for forestry, range, wildlife, water and other resources. To hope that demands for outdoor recreation can be met is to believe that a balance can be struck between housing and commerce and land and water resources.

Coordinated long-range planning and the proper management of renewable natural resources are the keys to outdoor recreation opportunity. Community and regional planning is of little purpose recreationally if there are few expanses of forests, clear streams, or crystal lakes to enjoy. And even the best husbandry of our resources makes little contribution to mass recreation if natural areas are not accessible for a wide range of uses within reasonable limits of time and expense.

Recreation becomes more expensive daily. Prices always soar for commodities of relatively fixed supply and mounting demand. The millions of Americans who are insisting on more recreational opportunities must realize and accept this unyielding economic consideration. The acquisition and dedication of sufficient lands and waters, their development and continuing administration, and the inclusion of recreation in established programs all cost money. Recreation is never free. It always has a dollar value.

Fortunately, we still have a good land and water resources base upon which to construct necessary recreation programs. We must act swiftly, however, and initiate short-range programs to accommodate sports near metropolitan centers, where deplorable shortages already exist and where problems are becoming extremely acute. We must encourage long-range planning on all levels of private and public endeavor, and promote those essential day-to-day programs of the federal and state agencies responsible for natural resources management. Stable programs go hand-in-hand with outdoor recreation objectives.

The excellent report of the Outdoor Recreation Resources Review Commission shows clearly the obligations and challenges that lie ahead. Its timely recommendations should serve as a rallying point for public information, thinking, and support. This momentum must not be wasted or misdirected. We should not ignore the fact that special commissions, appointed in past years to study major problems, also have submitted good reports. Nothing much was done with their findings, however. Congress and the executive agencies rarely have shown an eagerness to implement commission suggestions. The splendid Paley Commission report is a prime example of this pathetic situation.

Fortunately, some moves already are being made to meet massive recreation demands. Voters in New York, in 1960, authorized a $75 million bond issue for the immediate purchase of all sorts of recreation lands, stream easements, forest preserve inholdings and additions, upland hunting and camping areas, boat launching sites and access strips. That program, solidly endorsed by the state's voters, was prompted by one inescapable fact—suitable recreation lands daily become more scarce and more costly.

The New York program was conceived and accepted because of the absolute necessity to acquire lands now, while they are available. A few people question the wisdom and propriety of securing land now for outdoor recreation without its immediate development. Some state and federal agencies voice similar apprehension. To my mind, those who share this view fail to grasp the scope of the recreation problem, to recognize the challenge as it actually exists. Money cannot be deposited if there are no banks. Quality recreation cannot exist without land.

Last year Wisconsin levied a cent-a-package cigarette tax to finance a 10-year, $50 million outdoor recreation program. Its aim to benefit residents and to capitalize on returns from the tourist trade. You will hear more about that excellent program from Governor Nelson on Wednesday.

New Jersey has a $60 million Green Acres program, based on a bond issue, also dedicated to immediate action. All three of these going programs provide assistance to local units of government to help acquire and develop recreation facilities.

Other states also seek to move forward. Pennsylvania's Governor David L. Lawrence has handed the State Legislature a program involving a $70-million bond issue. It envisions $40 million for regional parks and reservoirs in 43 recreation-short counties; $20 million for matching grants to regional, county, and municipal authorities for park, recreation, and open spaces acquisitions; and $10 million to the Pennsylvania Game and Fish Commissions to purchase wildlife, fish, and boating areas threatened by imminent destruction.

The Michigan Conservation Commission is studying a cigarette tax proposal similar to Wisconsin's. It is estimated that a penny-a-pack tax would produce from $9 to $10 million annually for a broad program covering the purchase and capital improvement of state parks, forests, fishing sites, and game areas.

California is considering a $100 million bond issue to finance beach and park purchases during the next five years. Additional appropriations also are being proposed for construction and improvements at existing state properties.

Recreation problems are not identical in all states. Situations vary widely in accordance with population distribution and the extent and accessibility of private, state, and federal lands and waters that can be used for recreational purposes. Silence gives no clue to preparedness. We fail to hear the welcome sounds of preparation and action, especially in the coastal and Lake States where there is an urgent need to meet burgeoning demands.

The Federal Government's role in attempting to ease the recreation crisis undoubtedly will follow along conventional lines. A good record is likely to be attained through programs of existing agencies already responsible for the administration of forests, parks, wildlife refuges, water developments, pollution abatement, and the national land reserve. Plans for this are in evidence in "Operation Outdoors," "Mission 66" and "Project Twenty-Twelve."

Good planning also is revealed in policy changes such as the recent revision of the widely denounced rule that has been preventing the acquisition of lands around federal reservoirs for recreation and fish and wildlife. That old policy was an unbelievable document. It gave a high percentage of the recreation values created by the spending of millions of dollars of public funds for reservoirs to a handful of people. The new policy, signed by the Interior and Army Departments recently, means that the Federal Government again recognizes the need to obtain sufficient land around new reservoirs, and possibly some old ones, for public access and for present and future requirements for outdoor recreation, fish, and wildlife.

The recreation programs that have been developed by the principal federal land management agencies have been publicized widely. The public must guard against complacency, however, because no chart of action is final. It must be evaluated and revised periodically in response to new trends and new information. It must receive necessary authorizations and appropriations, two prime requisites that the mere issuance of program outlines will not guarantee.

Another opportunity for extraordinary expansion of recreation rests on the millions of acres of land administered by service agencies of the Department of Defense. That department has just issued a new directive, in response to a 1960 law, setting forth specific objectives and instructions for all base commanders. It espouses many of the suggestions of conservationists, and holds out the prospect for full cooperation with state and federal agencies.

The open space program, authorized in the Housing Act of 1961, provides $50 million over a five-year period for assistance grants to states and local governments for acquiring and preserving open space in urban areas. The President has asked for another $50 million in his natural resources message. As large as it sounds, and as welcome as it is, this is a relatively insignificant start on a monstrously large task. Open space needs in the New York metropolitan region alone are estimated at $1.9 billion based on 1960 prices. The cost of acquiring land in the vicinity of Washington, D. C., to meet the needs of the year 2000 is estimated at $2 billion.

Recreation is diverse, a conglomeration of activities requiring much more than a single plan or program. Vigorous leadership, new ideas, new programs, new authorizations, new appropriations—all are sorely needed.

President Kennedy mentioned a number of them in his recent agricultural message to Congress. He asked for reasonable amendment of basic authorizations which, if implemented, would offer the prospect of lessening rural poverty and improving recreational opportunity. Nearly one-third of our people live in rural areas. More than half of our poverty is found there. About 60 per cent of the nation's farms are producing only 13 per cent of the agricultural output. Recreation, the President said, is one way of limiting overproduction and assisting rural economic adjustment.

Conservationists have been asking for a long time why farmers should not be helped to improve their lands for recreation. Public funds have been allocated to farmers for crop-production purposes for years, even in face of surpluses. The government pays to put land into production that is not needed, and stimulates erosion and loss of soil fertility. Why not initiate constructive programs and help interested farmers improve their incomes by raising the recreation potential of their lands? Why not invest public funds, which have been going into wasteful production, in production of another kind, for recreation? Why not provide an additional incentive, perhaps as a bonus, to participating farmers to assure public access to these recreational developments and to indemnify landowners for wear and possible loss of property? Are these not reasonable uses of public funds?

Agriculture Department experts estimate that 51 million acres now in cropland will not be needed by 1980. Technology and increasing farm productivity enable farmers to feed more people from fewer acres. Conservationists should not dismiss the prospect of getting some of that 51 million acres devoted to recreation.

The Administration's viewpoint was voiced by Agriculture Secretary Freeman who earlier this year testified before the House Agriculture

Committee on H.R. 10010 which, like companion bill S. 2786, would put the 1962 agricultural program into action. "I might say to you," the Secretary said, "that it does not make sense to use lands to produce something that we do not need, that we have to store and on which we must pay heavy charges to store and to handle. It is highly inefficient and improper and has put us in the position we are in today.

"But as I said our goal is not to idle land. There is today a great unmet need for land for purposes of outdoor recreation, for wildlife habitat, for green spaces around our cities. The ORRRC report . . . indicated that resources for wholesome outdoor recreation is one of our greatest needs for the future . . . Outdoor recreation also brings about many desirable economic benefits. Its provisions enhance community values by creating a better place to live and increasing land values. In some undeveloped areas it can be a mainstay of the economy.

"Activities of watersheds and other agricultural conservation programs should be oriented toward greater recreational benefits to the public."

The Administration recommends amendment of the Soil Conservation and Domestic Allotment Act to expand the ACP program. These would include cost sharing agreements under long-term contracts to permit changes in cropping systems and land use for the conservation and development of soil, water, forests, wildlife, and recreation. Another would amend the Bankhead-Jones Farm Tenant Act to authorize the use of acquired land for recreational development and wildlife protection. A third would amend the Watershed Protection and Flood Prevention Act, Public Law 556, to permit the Federal Government to share the cost of land acquired by local organizations for recreation and fish and wildlife developments. The Federal Government's inability to do this at present is shown by the fact that not more than 50 of the 1900 reservoirs constructed so far under Public Law 566 are publicly owned and available for recreation.

In his second message to Congress on natural resources, the President outlined a program which he believes will meet still more of the Federal Government's responsibilities. He wants an Outdoor Recreation Advisory Council to represent appropriate federal departments, and a Bureau of Outdoor Recreation in the Department of the Interior to staff the Council and to administer a proposed program of recreation assistance grants to the states.

The cost of the expanded land acquisition program would be financed through a "Land Conservation Fund," which would receive receipts from federal areas user-fees, charges for recreational boating, unclaimed refunds on marine gasoline taxes, and from the sale of surplus federal nonmilitary lands. "To prevent costly delay in beginning an acquisition program," the President asked Congress to authorize advances from the Treasury not to exceed $500 million over an 8-year period, which would be repaid from the fund.

Congress also was asked to enact legislation establishing a national wilderness system along the lines of S. 174, authored by Senator Clinton P. Anderson of New Mexico. Wilderness preservation was called a "key element of our conservation program" that should have priority consideration. He also asked that Congress give favorable attention to proposals for ten national parks, sea and lake shores, and similar areas. Purchase of these park lands, he indicated, would be financed through the "Land Acquisition Fund," apparently a reference to the previously named "Land Conservation Fund."

A disappointing feature about the Presidential message was its failure to mention the tremendous recreation potentials of the national land reserve. The Bureau of Land Management is the nation's greatest landlord. It administers 180 million acres in the western states and nearly another 300 million in Alaska. The BLM has no money for a recreation program, and it apparently is not supposed to have any. The House Appropriations Committee eliminated $200,000 from the budget last year that was supposed to initiate a minimum BLM recreation program. The administration went one step further this year and refused to ask for a penny for recreation on all of those millions of acres of public land.

The President's message said that "we must take action to assure that the full potential is realized from the vacant unused areas in the public domain." Conservationists heartily agreed. There is a tremendous opportunity for better management of those lands. Some necessary steps already have been taken, and others are planned that will amend or eliminate archaic laws and give all of the people a greater voice in the management of the lands. The Administration should be supported in these efforts to correct the things that always have prevented proper management of the national land reserve. But nowhere in all of the suggestions that have been advanced is there any firm plan to develop the vast, untapped recreational potential of the public domain.

This is an unfortunate and shortsighted situation. Unlike the national parks, national monuments, wildlife refuges and other special-purpose areas, the public domain and the national forests are spread throughout much of the country, convenient to millions of people. These lands also are available for many more kinds of outdoor recreation than can be accommodated at special-purpose reservations. The making of more of the public domain suitable for recreation has the sound objective of dispersing public use, not concentrating it and compounding already impossible situations.

I realize that for publicity purposes it is not as impressive to say that only a few thousands of dollars were made available for campgrounds, picnic areas, sanitary facilities, wildlife habitat, lakes, and stream improvements, and other recreational developments on so many millions of acres of public lands. It always is more appealing to be able to name specific areas that have been acquired and developed.

The fact remains, however, that infinitely more recreation can be provided, to more people at less cost on the national forests, public domain, and military installations than on any other lands administered by the Federal Government. We must not lose sight of the fact that the national parks, national monuments, and wildlife refuges are not playgrounds. That was never their purpose. They were established and developed to protect valuable assets, and to intimate that they are playgrounds, capable of taking care of high volume public recreation without destruction of their primary purpose is to misrepresent the facts. I do not infer that parks and other special-purpose areas should not provide some recreation. They do furnish a lot of enjoyment of certain types. What I mean is, if we are going to realize some of the national recreation objectives that have been outlined, then we better begin to make a more realistic appraisal of the opportunities on the vast areas of land already in public ownership. Of course a few more national parks and special-use areas should be created wherever lands are found that meet the rigid standards that have been established for such preserves. I seriously doubt, however, that we should be directing all our efforts and money to only those kinds of areas, when so many of the recreation needs will have to be met through enlightened management of the millions of acres of land already in public ownership.

The recreation potentials of the national land reserve and of the national forests should receive the recognition they deserve. The BLM never has been given enough money to finance even the minimum level of operation. That agency has been harassed for years by a diffidence that extends also through the Executive and Legislative branches of the government. How many people know that the BLM returns $7 to the United States Treasury for every $1 it receives in appropriations? The people have the right to insist that some of this money be reinvested in the national land reserve.

I am generally optimistic about the outlook for outdoor recreation. The incessant clamor for more facilities shows that a tremendous need exists in every part of the nation. How quickly we respond, and how well these needs are met depends largely upon the willingness of each of us to do his part and to encourage others to do theirs.

The bulk of the people in this country are crowding into the large population centers. The trend still is from rural to urban areas, and it is in and around the metropolitan complexes that the people must be served.

The opportunities are there, and it is up to the cities, townships, counties, and states to meet the needs. The greatest opportunity for accomplishment lies with the people themselves. The job is too large and diverse for either the Federal or State Governments. The real corps of the outdoor recreation effort is the innumerable county groups and local communities all over the nation. Many are busying themselves with such things as zoning, deferred taxes, conservation easements, bond issues, and special tax levies. Those groups can count on some financial and technical assistance from the State and Federal Governments, but they should make no mistake. The States and the Federal Government never will have enough money and staff to come anywhere near doing ther job that must be done. Much of the leadership and most of the money must come from the local citizenry. Those who get their programs going first will get the most help.

DISCUSSION

MR. WALTER E. SCOTT [Administrative Assistant to the Director, Wisconsin Conservation Department]: I am not going to ask a question, but I thought I could add to the report on what Wisconsin is doing inasmuch as our program was mentioned by Dr. Gabrielson this morning.

Since Wisconsin's $50 million ten-year program started six months ago on September 1, the Conservation Department has purchased about 19,000 acres of land control for a cost of about $1¼ million on almost fifty different areas. This was in addition to our regular budget for land acquisition and included the first six parcels in our new conservation easement program for partial land control which costs less than making fee-simple purchases.

In our entire acquisition program, in the last eight months since July 1, 1961, our Conservation Commission has encumbered approximately $1¾ million for acquisition of 34,500 acres of land, all dedicated to wildlife and outdoor recreation uses for the future. Thank you very much.

CHAIRMAN NEWTON: Very interesting. Are there other comments or questions? If not, I should turn the meeting back to Mr. Gutermuth who has some announcements.

MR. GUTERMUTH: Thank you very, very much, Dr. Newton. I want to thank you and Mr. Smith, and, Dr. Cottam for pinch-hitting for us.

Walter, in connection with your statement, I want to urge the people to get in to hear the remarks of Governor Nelson of Wisconsin, on this splendid program in Wisconsin on Wednesday. I had the pleasure of hearing Governor Nelson at a meeting in Washington not too long ago, and I am going to say to you that you are going to get an outline for an outstanding program by hearing what they are doing in Wisconsin. So be sure to get in and hear the Governor on Wednesday.

Thanks very, very much for your patience and attention here this morning.

GENERAL SESSIONS

Wednesday Afternoon — March 14

Chairman: ARTHUR S. FLEMMING
President, University of Oregon, Eugene, Oregon

Vice-Chairman: DEWITT NELSON
Director, California Department of Natural Resources, Sacramento, California

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RECREATION'S FUTURE—WHOSE RESPONSIBILITY?

REMARKS OF THE VICE-CHAIRMAN

DEWITT NELSON

Unfortunately, ladies and gentlemen, your regular program chairman for the afternoon is unable to be with us. Dr. Arthur S. Flemming, President of the University of Oregon, at the last moment was required to stay in Oregon and miss the delightful climate here and the wonderful association at this Conference. This is certainly to be regretted, for I know he would have added a great deal to the session this afternoon. So it is now my pleasant duty to assume the chairmanship of this afternoon's panel as a substitute for Dr. Flemming. I guess that's why they have vice-chairmen.

First I should introduce myself. I am DeWitt Nelson. Probably some of you don't know my first name. I get most of my mail by the name of "Swede" Nelson. I am the Director of the Department of Conservation for the State of California.

In following through on the theme of the Conference, "New Horizons for Outdoor Recreation," this panel has been assigned the subject "Recreation's Future—Whose Responsibility?" This and related questions are being asked across the country today. I think we should break this question down and see what some of its component parts are, and I will try to do that if I may.

How do we develop compatibility between the service type of use, recreation, and the commodity production type of use over wild land areas and resources? Many of these are highly competitive for both land and resources, and they are also important to our total economy. There is also competition between the recreation groups. So we have a compatibility to develop in that area.

But who is responsible? I am sure that we all share in this responsibility, but how do we divide it up? Who is willing and able to do what? Where does the money come from? How do you support it once you have it, for each acquisition that develops creates a continuing financial obligation. Will the user pay his fair share of this obligation? How do we secure a coordination of planning in the integration of management, development, utilization, and protection of these resources? Who has the opportunities as well as the responsibilities to meet this growing problem of the acquisition, the development and the operation of the great variety of recreational facilities that are needed by our growing population?

These are only a few of the questions to which we are all seeking answers. This afternoon we shall discuss some of these questions from the points of view of the public role and the private role.

When we speak of the public role, we are obviously referring to some level of government—Federal, state, county, city, district, or regional group. In this area, the Lord only knows how many agencies and units of government exist that have an interest and a responsibility for outdoor recreation. Using California as an example, we have 58 counties, 372 cities, 95 recreation districts, 6 major Federal agencies, and 12 major state departments, for a total of 543 units of government charged with certain phases and responsibilities in the field of recreation; and, in addition, most of these agencies also have responsibility for some form of commodity type of use of these resources.

In the private role, there are literally thousands of businesses, industries and organizations of all kinds with interests ranging from the charitable and civic concern to the purely commercial enterprises providing essential services to a wide range of recreational clientele. This is big business.

The recent Outdoor Recreation Resources Review report points out that leisure time spending in 1954 was estimated at $30 billion and that it might be as high as $40 billion today. Surely there must be opportunities as well as responsibilities for private enterprise to tap a market of this size.

After these two subjects have been discussed, we will have a paper on "What People Want for Recreation." That, in itself, is a big problem and one that is constantly changing. In this area, there are multitudes of special interest groups ranging across the spectrum of recreational activities.

We have a panel of three, each an expert in his field. They have each devoted a lot of time and effort to preparing their papers, but obviously time denies them the privilege of giving to you their whole program definitively. Therefore, in order to get maximum value, we will plan a short question and answer period following each panel member's presentation. I realize that sometimes it is difficult to get people in a group of this size to ask questions, but I hope you will, because we are all seeking the answers that this subject poses.

Our first speaker today is a man who is making history in the field of recreation and ceonservation in the State of Wisconsin—Governor Gaylord A. Nelson. I can't help but like the name. He not only talks a good job, but he does a good job.

Governor Nelson, an attorney by profession, is now serving his second term as Governor of that great state following ten years in the State Senate. Obviously, his legislative experience has aided him in effectively carrying out his duties and functions as the chief executive.

The Governor—and God bless him—got his early education in California at San Jose State College, but he was one who did not stay. He went out for greener fields. After that, he took his degree in law at the University of Wisconsin at Madison, graduating in 1942. From 1942 to 1946, he served in the Quartermaster Corps as an officer, lieutenant grade. While he was on overseas duty in Okinawa, he met the nurse whom he later married. The Governor was elected to the Senate in 1948, elected to the office of Governor in 1958, and reelected in 1960.

Here is a man we are hearing about today, and here is a man we shall hear more of in the future.

THE PUBLIC ROLE IN RECREATION

THE HONORABLE GAYLORD A. NELSON
Governor of Wisconsin, Madison

Mr. Chairman and delegates to the Wildlife Conference: I had a prepared text when I came here, but I decided not to use it. I hope that I haven't confused the press too much, although it isn't new for the press to be confused. But I decided to speak instead from some notes.

This isn't the first time I have had this experience. I don't always use a prepared text. Early in my first term somebody on my staff prepared a text for me. I was speaking on something or other in Milwaukee, and, after I had read about two pages, I discovered that I didn't agree with what I was saying. So I told my audience that they and I were hearing it for the first time and I thought I'd put it aside.

Well, that's the way I felt about my speech today after looking it over. I suppose it is somewhat dangerous to speak to people with the professional qualifications represented here without using a prepared text, but I'll have to take that chance.

A few months ago I was speaking to about 700 college professors in La Crosse, Wisconsin. My wife was a little nervous about my speaking to professors—all those intellectuals! She was at the door, and my eight-year-old son was with her. She asked me, "Are you speaking from a prepared text?" I said, "No, I am just speaking off the top of my head." This seemed to impress my son. A week later I was getting off to give another speech, and he said, "Dad, do you have a prepared speech or are you going to talk out of your head again?"

I enjoy speaking to non-partisan meetings like this. I get a lot of experience in my state speaking to non-partisan meetings like Chambers of Commerce and Rotary Clubs. I guess they are non-partisan, but I never meet anyone from my party there.

It was difficult when I first got into office to master the technique of speaking to non-partisan groups, because I wasn't raised in that tradition. In my home town, Clear Lake, up in Polk County, Wisconsin, we were very partisan. There were some 670 people, more or less, and back in 1932 they held the first and last non-partisan meeting in the history of the village.

It was after the election. The mayor of the village, who was a Democrat, had been struggling since Wilson to win an election. There had been a pretty bitter fight. Back in the depression, the farmers didn't have any money, and everyone was unemployed. The mayor thought it would be a good idea to hold what you might call a "Heal the Wounds" meeting in the village hall, because it's a small town where you meet everyone on the street every day when you pick up the mail at the post office, and you can't afford not to be speaking to people.

So they held the meeting in the village hall. The mayor came to the meeting with some home-brew—inside him. He was presiding over the affair, and the high school band played, the quartet sang, and they served hot dogs. He opened up the meeting by saying that in a little town like this, after the campaign was over, in the American way, the Republicans and Democrats should all join hands and march together for a better Clear Lake, and a better Polk Country, and a better Wisconsin. But then he got to remembering the campaign, and got sore all over again, and he departed a bit to say, "However, during the campaign, the Republicans did lie about us—they cheated—and they stole." Then he realized that he had gotten a little out of line, so he added quickly, "However, with God's help, we beat them at their own game."

I consider it a privilege to talk to an audience of professional conservationists who know what a wildlife habitat is—most of my friends think it is a nightclub downtown someplace. I don't have, and make no pretense at having, any special knowledge about resources or recreation or conservation, and I don't suppose it is really necessary for me to have any. I learned the most important lesson I ever learned—about nature, anyway—from a comment made by a famous naturalist who had been studying spiders. A lawyer friend of his was a bit disturbed about all this preoccupation with the spider. One day he said to the naturalist, "What good is a spider?" The naturalist said, "He's interesting, you fool, and what good are you?"

Now as for the *public* role in recreation, I wouldn't pretend to speak definitively about what it is, except to say, *first*, that public financial participation through our government has been insignificant compared with the responsibility that we have and, *secondly*, that our public responsibility is crucial. The federal government and the state governments must assume a much larger role than they have or the cause will be lost, because all the private efforts in the world won't save what needs to be saved unless there are positive, rapid, and massive efforts on the part of the state governments and the federal government. I suppose one of the problems in persuading Congress and the legislatures to move and in persuading the country to support the activities we ought to be engaging in is a consequence of the fact we in this country have never developed an ethical concept of man's part in nature. If we had, we wouldn't be destroying things the way we are now destroying them. This is a failure of education.

What is happening to America? Of course, all of you are here because you are concerned about the problem. It is too bad that those who aren't concerned couldn't be dragged here. The problem we face is that we are destroying our assets at a rate that should alarm every thoughtful person everywhere in this country. Take the most obvious asset we have, the one you would think ought to be the easiest to preserve—scenic beauty. We now see, as we have seen for years, the billboards, honky-tonks, and all the the rest continuing to sprout up at an increasingly accelerated pace all over the nation. The federal government has moved, as late as five years ago, to put $40 billion into an interstate commerce and defense highway, a magnificent highway system with four lanes and limited access at the interchanges — a beautiful piece of work. But there has not been very good planning about where they put it. They followed the shortest distance between all points without adequate regard for resources along the way. But a much more serious problem revolves around the interchanges themselves. Across the country there will be thousands of interchanges. Since this is a limited access highway without any commercial development on it the land adjacent to the interchange has significant commercial value — you must leave the highway to get to motels, hotels, restaurants, filling staions, cities, villages, etc. Because of the high value of location near the access points we see a mad scramble for land near the interchanges. Congress should have had the courage and foresight to set minimum zoning standards at the interchanges. Their failure to do so assures the development of innumerable ugly slums and shoddy eyesores across the countryside. This senseless sacrifice of scenic beauty is unnecessary and inexcusable.

In Wisconsin I attempted to get an interchange zoning law passed, but the legislature refused to go along with it. How much more sensible and effective it would have been if Congress had settled the issue before highway routes were established and economic interest groups developed a stake in it.

We are moving rapidly to pollute everything in sight—our rivers, our streams, our lakes, the ocean, and everything else. We're running raw sewage and every kind of industrial waste into them and destroying these invaluable assets. I don't know under what theory we do this. It is uneconomical and alarmingly destructive. We say it is economical to discharge the sewage into Lake Michigan and Lake Superior and the ocean, but this isn't true. We couldn't build Lake Superior or Lake Michigan for billions of dollars. It would be a whole lot cheaper to build decent sewage systems. We couldn't build a single river or natural lake. There are states that don't have any lakes at all except artificial ones. You can't build a Mississippi, a St. Croix, or a Columbia. They are there, and if we destroy them they are destroyed forever.

Then we see what we are doing to the wetlands. We have a great policy in this country. We are taking all kinds of land out of production and paying the farmers not to produce on it. At the same time, we are draining the wetlands as fast as we can and putting them into production. As I was driving somewhere in Wisconsin one time I found a road which I had known earlier but which I had forgotten. There were beautiful hills, and there had been two and one half miles of beautiful swamp circling around those hills. It had been a beautiful spot. But it wasn't anymore. Some enterprising businessman had drained it. What was he growing? Mint. Mint for mint juleps, I suppose. It would better if people drank something else. I don't believe we need mint so desperately that we must destroy our remaining wetlands to get it. There ought to be some niches in this country which are safe from "improvement" by human hands. We are destroying our wetlands and wilderness as fast as we can. The idea seems to be that if we open up the wilderness it will be easier to walk through it. We have only a precious small amount of it left.

We are also destroying the soil. It takes nature thousands of years to build an inch of soil, and it takes one year of bad conservation practices to destroy it. Go to the mouth of the Mississippi River and you can see America washing away—8,000 acres a day!

Or look at the urban sprawl all over this country, with little planning for growth, green areas, or anything else. As a matter of fact, you can go to California and get a good look at what all of the country is going to be like forty years from now, because they are doing it faster than we are. I have a friend who went out to Los Angeles. When he came back he said, "I've seen the future, and it won't work."

If we keep on the way we are going in this country, I can predict what the future will be like. We will live in a magnificent asphalt paradise where, of all our wildlife, the only ones that will survive and thrive will be the rodents, the rabbits and the sparrows—because they understand our culture best.

What can we do about it? I think, in the first place, we haven't talked enough about spending money. Everyone is afraid to talk about spending some money. The public has a direct stake in our assets. This is a public, not a private affair. You can't expect and shouldn't expect private contributions and license fees for fishing and hunting to support the whole program. There isn't enough money there anyway. It takes public appropriations of general funds. Conservation has to be permanently financed from general tax levies. I don't understand why everyone is afraid to talk about this.

I suppose it is pretty generally accepted, if you give it any thought, that the two most significant responsibilities we have as a society are the education of our youth and the preservation of our resources—the education of our youth because it is they who must provide the leadership to meet and resolve the problems that will confront our country in the future (and the problems won't be resolved at all without good leadership—without a sound education system), and the conservation of our resources because our very survival and our happiness while we are here depend upon it. Recreation is not a luxury—it is a necessity and more important than any other expenditure except education. I wouldn't wish to select between the two. They are both crucial. There isn't any other expenditure of money that is as crucial. We must provide care and assistance for the aging, the mentally ill, and the mentally retarded; we have to build highways and do many other things. But none of them is as significant as education or conservation.

We will spend billions in many other fields, but almost no public moneys for conservation. This appears even more unfortunate when you consider the fact that you can postpone the solution to any other problem except conservation. It may be unfortunate that you do it; it will be unfortunate if we don't move fast enough on the problems of the aging, the problems of the mentally ill, and many other things. But if those programs were postponed, we could still recover and we could still do the job later on. But in conservation we have only a decade or a decade and a half to make a massive investment in the preservation of our capital assets or else they will be lost forever. That is the distinction between the issue of conservation and all the other domestic issues we have, any one of which may be postponed without irreparable damage to the nation in the long run. This one can't be postponed without permanent damage from which this country will never recover.

It baffles me that we have done such a poor job of selling. Have you ever noticed when tax bills are sent out—bills for $300, $500, $700 for property taxes—how almost everyone complains? What do they get for their tax money? They get police and fire protection, street maintenance, garbage collection, city parks, and the whole educational system for several hundred dollars a year. The same taxpayer who complains bitterly about his tax bill goes downtown every year or so and buys himself a new automobile. It costs $75 to $100 a month to maintain an automobile, which is $900 to $1,200 a year. What does he get for the money? He gets the service of transportation—nothing more!

The taxpayer who buys a car calls his neighbors over and pushes the buttons and the windows go up and down and the seat goes forward and backward. Does he say, "Let's go downtown and run the automobile dealer out of business because I'm being taxed $900 a year for transportation"? Of course not.

Can't we make this kind of investment in the conservation of our resources? I think we can, but we won't unless we make strong, positive arguments for it.

The big step is political action. This issue will be settled by effective grass roots political action or not at all. There is something lost between the conclusion of each year's conference and the beginning of the next year's and that is the political implementation of the conclusions of the conference agreed upon. Sometimes when I think about meetings on important problems such as this, I am reminded of the fellow who went into a barbershop and got into the chair. The barber lathered his face, on and on, until the fellow finally said to the barber, "When are you going to shave me?" The barber said, "We don't shave here. We just lather." It's about time we started shaving. We've lathered long enough about this issue.

We have all the scientific and resource knowledge needed to launch a massive conservation program to acquire and preserve our remaining outdoor assets. Further conferences aren't necessary. The problem now is implementation of our program through political action. If you are just holding conferences among the faithful, without political action, you may as well file your reports with the Smithsonian Institution and wait for the historians to read them some day.

What you must do is go home and weld together a good conservation group dedicated to political action. Activate the garden clubs, roadside improvement clubs, fishing and hunting groups, bird lovers and all the rest into one unified driving force for constructive legislation at the state and local levels.

You won't pass anything without opposition, and your opposition will argue, "Don't spend the money." They will be loud. They will be vigorous in their opposition. The heat and pressure on the assemblyman, the state senator, the Congressman, and the United States Senator will be against spending. They will be hearing from back home, and that's where it counts. There have to be people in the district where the politician is elected who support the program or it will fail at the legislative level.

There is nothing that has more political appeal, once you start to develop it, than the issue of conservation of our resources. It baffles me that more governors and more legislators and Congressmen don't speak out on it. It touches everyone in America. You can go to any sensible politician who knows nothing about conservation and sell him on the idea that it is good politics. You don't have to make an expert conservationist out of him. Sell him on the idea that it is good, sound politics, and it will move.

This is where we have failed. We must keep in mind that conservationists are not a single group. Everyone is a conservationist. He may be a bird watcher, a fisherman, a hunter, a lover of scenic beauty, or just somebody sitting in New York looking at one plant outside his window over Fifth Avenue—he is still a conservationist. Political implementation is the only way to solve the problem. You have the broadest political appeal in America—it's time to use it!

How should you proceed in this? We have started in Wisconsin, and I think it shows how far behind we are in this country that a $50 million program attracted any attention at all. It should have been done thirty years ago, when $50 million would have bought a lot more. We knew this was a political problem. I had thought for years about a program to capture and save our capital outdoor assets—and that is what a program should be, I think—a capital assets acquisition program for the next decade. Development of what we buy can be postponed, but acquisition cannot. We decided to tackle it politically. We surveyed the situation in Wisconsin. We felt that we were blessed more abundantly than almost any other state in the nation with fresh water and other assets, being bounded on the north by Lake Superior, on the east by Lake Michigan, and on the west by two great rivers, the St. Croix and the Mississippi, and with 1,500 fresh-water streams and rivers, and 9,000 named lakes, hundreds of thousands of acres of wetlands, half-a-million acres of state forest and two and one-quarter million acres of county forest. We have a lot, but it isn't enough. Even if we had preserved everything we had twenty years ago, it wouldn't be enough for the future.

We put together a package, because you can sell something in a big package with a good explanation of the total picture and what it means. People will pay for it gladly if they understand it. If they can see it and feel it—if they can visualize it, then they will support it. We put together this package and we put it into booklet form and passed it out all over the state. But we also had to sell the idea of the financing: a one-cent tax on cigarettes. Ordinarily, just about every time you propose a tax anywhere in any state in the Union, the letters of protest come in by the thousands. I got only one letter in opposition to the tax on cigarettes, and the reason I didn't get more was that the people of Wisconsin understood the program. We didn't end our publicity with the booklet. We went on, week after week, reproducing maps and writing articles. We sent a map each week to all the weekly newspapers, showing where the wetland acreages and the fish and game habitat were going to be and what the plan was for each area. We had as many as 150 newspapers in a single week reproducing these maps. We wrote stories on what we proposed to acquire in each county, how close the nearest new state park would be, how many thousands of acres of wetland there were in the program, and where the wildlife habitat was. We did this month after month. When it finally came before the legislators, they had the courage to vote the tax and pass the bill. This is the only way to get something like this done. We had the support for it back home, and I am happy to say that this organization helped by supporting our legislation.

One of the unique and significant parts of the program, though a small fraction of the total amount to be spent, is the acquisition of scenic easements. A scenic easement is the purchase of something less than the fee simple title to the land. Let me give you an example. Most of you are familiar with the Great River Road. This is a project in which the states from the Gulf of Mexico to Canada are building a highway along the Mississippi River. When it is completed, it will be the longest, finest scenic drive anywhere in the world. But what good is a scenic drive, if, as you drive along the river, there are billboards, cottages, and all kinds of other developments to the extent that you can't see the scenic beauty. The entire value of the scenic route is destroyed. We now have about sixty miles of scenic easements on both sides of that highway. We will buy another hundred miles or so to complete the acquisition. We go to the landowner and we say, "We want the right to preserve and protect in perpetuity the scenic beauty of your land. You will continue to own the land, but you may not alter it in any way without our consent. You can't cut the trees or build anything on it. It remains on the tax rolls as yours, but we own the right to protect the scenic beauty forever." The cost has been surprisingly low. It has cost us an average of less than $700 a mile to purchase easements. The Wisconsin Department of Conservation manages 90 per cent of the money under our $50 million program and the department is having some very interesting experiences. It has bought scenic and shoreline easements along trout streams where it has never been able to buy before because the owners didn't want to part with their ownership.

Nevertheless they are willing to place conditions on the land that will protect the scenic beauty of the stream after they are gone. The Conservation Department successfully negotiated easements on 300 acres of wetland adjoining 1,600 acres of wildlife refuge land they owned. They had wanted to buy the 300 acres for a long time but couldn't afford to—it would have cost $16,000. With the use of the easement principle, they purchased the drainage and hunting rights for $2,000. The easements will protect the land in perpetuity. You can get property this way that you would never get otherwise, and in most instances you can get it for a fraction of the cost of outright purchase. In many instances, we are better off not owning the land as long as we own what we wish to protect—the drainage rights or hunting rights, the banks of the streams, the areas of scenic beauty. We are going to buy scenic overlooks on many of our lakes and buy scenic easements to preserve the beauty around them. It is a useful and fruitful device that makes it easier to get what we need from the property owners and reduces expenditures from the limited funds we have.

We are going to create three new conservation camps. I think they will be very successful. We haven't even built them yet—we will open two this summer. We already have more applicants than we can accommodate. We will be able to take 600 boys in two different six-week sessions every summer. These will not be disciplinary camps. Any boy in the state between the ages of sixteen and nineteen will be eligible. High School principals will process the applications. We want a mixture of boys who are interested in camping and conservation. We will pay them $18 a week, and they will work under the supervision of the Conservation Department. They will work on projects within fifty miles of their camps, and there are hundreds of them: stream improvement, park development, and all the rest. It will do a magnificent job of conservation education for these young fellows and make a fine contribution to the Conservation Department, which has millions of man-hours of work to be done.

We also plan to create some new lakes. You might wonder why we should want to create more lakes in a state that already has 9,000 named lakes and many more that aren't named. There are two reasons: first, 9,000 aren't too many; and second, we are going to create these lakes in the part of Wisconsin that doesn't have any—the southwest area. We already have several artificial lakes in Wisconsin, very good lakes and heavily used, some created by the Conservation Department and some by private utilities. We are going to work with the Soil Conservation Service under the Federal Small Watersheds Act. Under this act, the Federal Government will match any state appropriation dollar for dollar to extend the head of a flood-control dam high enough to create a permanent lake. It will cost us only $45,000 to $50,000 to create each of these lakes. We will have to buy the submerged land, but this has to be purchased anyway for the flood control project, and the cost is modest. The shorelines will be in public ownership, and we will have these new assets for the additional cost of extending the heads of the dams. In the next ten years, the Soil Conservation Department believes, we can build twenty to twenty-five new lakes.

The next part of the program covers waterways, springheads, and spawning grounds. The Conservation Department has designated the most crucial areas for acquisition. This was important in selling the program, because all the conservation clubs and all the newspapers could see what their areas would gain immediately and directly.

Acquisition of wetlands for game management is a similar part of the program. We will acquire about 350,000 acres of prime game habitat in the next ten years.

Another major phase involves park and forest recreation areas. We plan to create nine new parks and expand present state parks and recreation areas by some 145,000 acres. Three of the parks will be along the Interstate Highway System and will provide recreation for local residents and travelers. The remaining six will be major additions to our park system.

Wisconsin is fortunate in having two and one-quarter million acres of forest croplands and half a million acres of state forest lands. We included matching funds in the program to create recreation areas in the county forests. We have a great potential for recreation there.

Long before the federal government passed the "green areas" bill—a good program, although it appropriates only $50 million and should be four or five times that much—we passed our own "green areas" program with matching funds for cities. Our cities will acquire green areas outside their municipal limits for recreational purposes under this plan. We will match fifty-fifty alongside the federal government's twenty-thirty matching system. Thus we can assist the cities by providing as much as 70 to 80 per cent of the total acquisition cost of green areas outside incorporated limits. That concludes a summary of the program and expenditures under our new resource program.

I think it is a fine program. It is about half as big as it ought to be for the first ten years: I think we really need to spend $100 million, but we don't have it. I'm hopeful that, in another two or three years, the program will receive an additional appropriation. Regular, permanent financing, and more of it, is crucial. It is fine for New Jersey or New York or California to float a bond issue, but a bond issue is a one-shot deal and this isn't a one-shot problem. I hope the bond issues pass. But they are no substitute for permanent financing, because the recreation problem gets bigger and more expensive and more crucial each passing decade. The question is one of spending more money—not less.

We call our program a $50 million program. We didn't want it to sound too big, or we'd have called it a $100 million twenty-year program. Our financing will raise $55 million in the first ten years and $125 million in twenty years. Thus we have a large, permanently financed acquisition program. I can't emphasize too much the need for basic, permanent financing from the general exchequer in order to preserve our outdoor resources. Without that kind of financing we will fail in this crucial responsibility. The federal government and all fifty states must move now with a major investment in our outdoor assets or our cause is lost.

THE PRIVATE ROLE IN OUTDOOR RECREATION

AL BULL

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This subject is so huge, so complex, and so relatively unexplored, let us pass over the philosophy of leisure time, pausing only to note that leisure is the seedbed of culture. Let us dispose of the economics of leisure time with a grateful acknowledgment that we live in a nation rich enough to afford more of this luxury than any other productive nation in all history.

Henry Wriston, in his chapter on the individual, in *Goals for Americans,* the report of the President's Commission on National Goals, writes, "The basic natural resource of the United States is its people. It follows, inescapably, that the first national goal to be pursued—at all levels, federal, state, local, and private—should be the development of each individual to his fullest potential." One does not develop fully without spending some portion of his time in recreation.

Rising incomes, shorter work weeks, and increasing mobility now provide individuals with a wider choice in type and location of recreation. At the same time, the extreme complexity of our industrial and social organization tends to make the worker, the boss, and their wives as nervous as a long-tailed tomcat in a roomful of rocking chairs. Hence, there is a growing desire to seek the great outdoors where nature responds in proportion to the love and understanding she's accorded rather than to social status or business success. Nature provides a new challenge with a new set of rules—recreation in its finest sense.

Let's examine the booming growth in desire for outdoor recreation just long enough to get an idea of its staggering potential.

The chapter on "The Quality of American Culture" in *Goals for Americans* says, "Conservation in its earlier stages was a movement led by men who loved the natural world for its own sake; the new conservation must aim to organize and make available the gifts of nature to satisfy the needs of a growing population remorseless in its leisure time demands and often unwittingly bent on destroying the very boon it seeks. The need for recreation space over the next decades can be charted with reasonable accuracy. A society which puts a value on the quality of its national life will want to act resolutely in the light of such prediction."

Also in *Goals for Americans,* Catherine Bauer Wurster's chapter entitled "Framework for an Urban Society" includes this estimate: "The demand for outdoor recreation is likely to increase ten-fold in 50 years, simply in terms of the expected growth in population, income, leisure, and mobility."

This estimate coincides with one made by Marion Clawson, director of studies in land use and management for Resources for the Future.

The Soil Conservation Society of America recognized the need by appointing an Outdoor Recreation Committee. The opening statement of the charge to this committee reads as follows: "The demand for outdoor recreational opportunities and facilities for this nation's rapidly expanding population threatens to outstrip abilities of government at all levels to provide them, and capabilities of public lands to supply sites and locations."

The voices of numerous other groups and influential individuals echo the same concern in one degree or another.

The private outdoor recreation facilities section of the Outdoor Recreation Resources Review Commission report states, "In a nutshell, the potential demand for opportunities to participate in outdoor recreation will more than double because of population growth alone in the next 40 years. Apparently, other variables will *multiply* the demand further." The emphasis on multiply is my own.

Doubling population means half as much space per person. Then, even more than now, will be felt the need for space, fresh air, a pleasing view, and a place to play, hike, hunt and fish. Obviously, we *must* conserve what we now have and speed the development of additional facilities.

Without exception as far as I know, every person and group making serious projections of demand for outdoor recreation agree on one point: That the largest, politically practical effort of federal, state and local governments will leave us far short of the need.

Let me make it clear that I favor a maximum expansion of government action in developing recreational facilities and, more important, in preserving for the use of all the people, our finest natural land and water recreation resources. And I would emphasize that this responsibility does not fall exclusively on federal and state governments. Local governments also share this obligation.

This is not inconsistent with my agricultural, midwestern, Republican, private enterprise background which says let government do for people only those things which they can do efficiently for themselves.

But such a social and political philosophy does provide a natural division—one that already occurs to a large extent—between the public and private role in providing outdoor recreational opportunities.

This division is not sacred and can be crossed by either government or private enterprise.

Let's look first at the part of the need that private enterprise is now filling to a large extent and probably will continue to fill. These are the facilities that usually make *intensive* use of land and that experts often call user-oriented.

Into this intensive land use classification, go golf courses, baseball diamonds, swimming beaches, ski lodges, boat marinas, and many similar uses including resort hotels, particularly those attracting customers with quality cuisine or plush night clubs. Private enterprise, motivated by profit, can continue to supply these. But you must expect supply to lag a little behind demand—most private development comes after a need has made itself felt. The lag is seldom big enough to justify government action.

It is in the other division, recreation requiring *extensive* use of land, where government's role is some times paramount. Hunting, fishing, hiking, or just looking at scenery often require large areas of land that are too expensive to provide privately—especially near the large population centers where space is at a premium.

Areas with outstanding natural recreational advantages are limited. Too limited for each of us to own a piece of seashore, a private mountain, and a stretch of trout stream. So it is in the public interest to see that all of these desirable spots are not gobbled up by recreation-hungry individuals and private clubs.

Fortunately we live in one of few nations of the world that can afford to set aside desirable areas for recreation even if they fall on our richest farm land or near crowded urban centers. Our transportation system is unequalled. The distance some folks in this country drive to work is a trip of major proportions in many parts of the world. And our farm production is the marvel of the ages.

Dr. M. L. Upchurch, USDA economist, estimated at a recent meeting of agricultural editors, that our increased population of 1980 will be fed an improved diet from about 50 million fewer acres of cropland than we have in production today. And today we are using the fewest acres of space for cropland since records were started back in 1910. This tribute to agricultural technology merely says that we can spare the land for recreation. We need only place the economic forces in motion to divert it to that use.

I commend our president and his secretary of agriculture for that part—and some other parts as well—of the recent Food and Agriculture message to Congress which dealt with diverting some agricultural land to recreational uses. This is one of the few times a political figure has recommended a long range approach to the farm problem in public.

Five steps were included in the message to help meet recreational needs:

1. loans to farmers through FHA for recreational enterprises.
2. ACP payments for changing land use to recreation.
3. authorization of Bankhead-Jones purchase of good—not marginal—land for recreational purposes.
4. federal sharing of small watershed land costs where a reservoir is to be used for public recreation.
5. authorization of loans to local groups for recreation facilities at watershed projects.

Most of this would be government action spurring private enterprise action in the field of recreation. Often, this is the way to get the most from a tax dollar.

Government has done much toward preserving our naturally desirable recreation areas—and must do more. But when practical politics is given its place in the picture, we can be sure that we will be far short of the needs outlined so thoroughly by the Outdoor Recreation Resources Review Commission. So we have another do-it-yourself task on our hands.

This leaves as our real problem: How far can and will private enterprise go in filling the gap that is sure to remain?

Much more can be done with the same technique—government assisting private enterprise—on private lands with natural recreational advantages. Many owners do not realize the potential of their holdings. Some lack credit to develop them. Others need help with techniques of management or promotion.

Existing developments may need some of the same kinds of help. Too many of them are not providing an adequate profit to encourage development of others.

Education of the public toward paying for use of recreation facilities would help, too. If we were nearer to our predominantly European heritage, this would be easier. Most of the hunting and fishing there has been on a user fee basis for some time. But it would be unfortunate if fees were to become so high that people with low to moderate incomes were excluded.

Probably, the greatest opportunity for increasing recreation facilities comes on lands held primarily for purposes other than recreation.

Under this heading, let's look first at large holdings—usually industrial, such as the forest lands of paper companies. A 1960 survey by American Forest Products Industries covered 86 per cent of industry-owned forest land in United States. Of this 86 per cent, 97 per cent was open for fishing and 92 per cent for hunting. Where suitable, most of it was also available for hiking, camping, swimming, winter sports, and other recreation. The survey also indicated some trend away from charging for use of the land for these purposes.

These natural resource-based industries are obviously aware of the public need for recreation. An under the heading of public relations, they are budgeting money for a contribution to this need.

When public use is permitted, there are costs due to vandalism, littering, fire damage, liability risk which someone must assume.

In stite of this, it appears that multiple use of private lands is being worked out with reasonable satisfaction. And that industry can be counted on to continue making much of its lands available for recreational use.

Most of the nation's land is held, however, in much smaller blocks and for purposes other than recreation—usually agricultural. Right here, in our own backyard, lies perhaps the largest opportunity.

First, we must realize that the desirability of a recreation spot is relative. A mudhole with a shade tree may be worth a 50-mile drive for a picnic if there's no better place around. Yet, a similar spot wouldn't rate a second glance in lake-dotted Minnesota. In other words, an area with a recreation deficit can do a lot with a little—at least toward supplying week-end recreation. Regardless of home's attractions, many people will continue going to another area for longer vacations.

Now what are the opportunities at home? Permit me to cite Iowa as an example, but the same approach can be adapted to any recreation-hungry area.

We need more water areas. Small watersheds planned with government help under P.L. 566 frequently include reservoirs which have recreation potential. Here is a place for *cooperation* among the Soil Conservation Service, Fish and Wildlife units, and farmers. Such cooperation is highly desirable, completely within reason, and yet too often missing.

Some Iowa counties have replaced expensive bridges with dams which form the roadbed. These often impound a small body of water which is readily accessible for recreation. And the dam with its special outlet may even cost less than a bridge and require less maintenance.

More than 23,000 farm ponds have been constructed in Iowa with the technical help of the Soil Conservation Service. These can be stocked with fish supplied by the State Conservation Commission if public fishing is permitted. Some of the bass in those ponds grow to braggin' size.

And when a wild goose or duck appears on a farmer's Sunday dinner table, it most likely came from his farm pond.

Streams and rivers cut thru many of these farms, too, with their attendant recreational opportunities. Pollution, largely of city origin, is a frequent problem of the larger streams.

The same ponds, streams, and rivers provide water for game. Crops which provide the livelihood of the farmer also furnish food for the game.

The opportunities are sizable — if we can realize them. Stunted fish due to underfishing of farm ponds attest to the unrealized opportunity. So do these facts: 50 per cent more pheasant roosters could be harvested without decreasing population. Annual quail mortality is about 80 per cent while the hunting harvest accounts for only 14 per cent.

This unharvested opportunity is not because of lack of desire on the part of hunters and fishermen. But part can be laid to lack of skill. The one-Sunday-a-year hunter can never expect to take much game. Even more frustrating, he may not even find a place where he's permitted to hunt. Let's look at hunting because I have some data on that.

Game in Iowa is public property. But farmers own the fences and gates, the crops and livestock. And just holding title to the land saddles them with an indefinite and worrisome liability risk. Littering, fire, and vandalism are a constant concern.

But most farmers are friendly folks. And many of them permit hunting. Here are the results of a Wallaces Farmer Poll taken back in 1954.

The Poll asked a stratified random sample of Iowa farmers the following question:

"The hunting season finds thousands of people tramping thru fields and woods on Iowa farms. How do you feel about hunters using your farm?"

1. I don't care if they hunt on my place. They are welcome 6%
2. I don't mind their hunting. But I want them to ask permission first 76%
3. I would rather people did not hunt on my place. It is too dangerous and they are careless with gates and fences 13%
4. I absolutely forbid hunting on my place 5%

Results from an identical question three years later yielded similar results almost to the percentage point—all within the range of experimental error.

Some of the comments picked up by the interviewers shed additional light on the feelings of the one in five who doesn't permit hunting.

"Too many people are running around with a hunting license but don't know how to handle a gun. How about a test of some kind before they are granted a license?"

"Most hunters are careful. But some still make trouble. And it doesn't all come from city people, either."

"Sometimes I promise hunting privileges to friends. And I'm pretty unhappy when some uninvited groups try to sneak through first."

These are reasonable and astute comments, I think you'll agree. Of course, not all comments were so reasonable or well-founded.

This is the age-old problem of farmer-hunter relations. What can be done about it? I have only a couple ideas. More training in handling firearms. Some of this is done now, but not enough. How about some public relations and education aimed at farmers as well as hunters? Not many farmers realize the need for outdoor recreation. A convincing presentation of this need would be enough to insure added cooperation from many farmers.

How about a voluntary organization of hunters who would be issued a membership card upon completion of a training course and signing a pledge of sportsmanship and cooperation with copies of the card including name and address of the hunter to be left with the farmer whose land the hunter has obtained permission to use? The National Rifle Association has done some excellent work in some of these areas, but this only starts to meet the need.

Farmers are mostly friendly, helpful folks. Surely someone will think of a way to make additional use of the little-tapped recreational resources on farms.

Some folks have suggested that farmers charge a small fee for use of their lands. But this is not likely to develop to a great extent where farming is big business. A good Iowa farmer with in excess of $100,000 in land, livestock and equipment can't afford to spend his Saturdays at the pasture gate collecting a buck a car from folks who come in to fish, hunt or picnic. He'll make far more sitting at his desk studying markets looking for an extra dime on a load of hogs or planning a fertilizer program that'll boost his corn yields.

Sideline recreation fits where demand is particularly great because of population pressure of a large city or where a farmer can't make a good living at his chosen occupation. That's where you will usually find vacation farms, guest ranches, week-end fishing holes, game farms, and the like. Unless returns improve considerably above the present average, such developments can not be counted on for a big immediate contribution to recreational opportunities except in some areas.

In conclusion, I cannot see that government and private roles in outdoor recreation can or should be distinctly separated. Rather, the need is for *cooperation*—and some moves are being made in this direction.

Here are some points where additional effort is needed:

1. Zoning to regulate land use and prevent recreational slums.

2. Expanded public relations and education programs.
3. Technical help for people planning recreational facilities.
4. Perhaps loans where capital limits development of recreational facilities.
5. Special tax consideration for recreational developments requiring extensive land holdings.
6. Clarification of liability laws.

I'm sure you can add items of your own to complete the list. In fact one of the most important roles of the private individual in providing adequate outdoor recreational opportunities may be in helping provide a proper legislative climate in which outdoor recreation can flourish.

Most important, is the crying need for enlightened cooperation between government agencies and between these agencies and private individuals. Too often the soil conservation man looks only at the soil, the forester looks only at the trees, and the wildlife man looks only at wildlife. This, perhaps, is the challenge of the decade for folks interested in outdoor recreation.

WHAT PEOPLE WANT FOR RECREATION

JOSEPH PRENDERGAST

Executive Director, National Recreation Association, 8 West Eighth Street, New York 11, N. Y.

It is a pleasure to be taking part in this 27th North American Wildlife and Natural Resources Conference at this particular moment in the history of our country. Never before has there been such good news about recreation—and especially about outdoor recreation.

As your conference theme underlines, we are really seeing New Horizons for Outdoor Recreation. The report of the Outdoor Recreation Resources Review Commission, the recent National Conference on Land and People held by the Department of Agriculture in Washington, D. C., and President Kennedy's message to Congress on conservation and recreation are landmarks on this horizon.

It is also significant, I believe, that a representative of the National Recreation Association was invited to participate with you in a wildlife and natural resources conference.

It wasn't so long ago, relatively speaking, that the National Recreation Association was known as the Playground Association of America. At that time, its sole concern was the promotion of playgrounds for children and youth in the slum areas of our biggest cities.

Nor was it so long ago that many of you considered the active recreationist as the greatest threat to the nation's wildlife and forests, and to the peace and quiet of the great outdoors.

Today, America is facing something quite new under the sun. In less than a hundred years, the average work week in the industrial establishments of America has been cut from about 70 to 40 hours a week, and most of this change has come in the last fifty years. Today, the average working man in America has far more leisure time, that is, non-working time, time off the job, than he has working time.

Only the other day the electricians in New York City won a 25-hour work week through collective bargaining. A 32-hour week is now under negotiation between the steel union and management. Shorter working days, shorter working weeks, shorter working years are here. Atomic energy and automation are making leisure time the greatest social problem and the greatest social opportunity ever presented to a nation.

What has happened here in America during the last 50 years can only be properly described as a "sociological breakthrough" as great in the field of sociology as the scientific breakthroughs that opened up the space age.

The only comparable sociological breakthrough in the almost 2 million years of human life occurred some 10,000 years ago when man learned to domesticate the animals which provided his meat and dairy products, and learned to sow and reap the grain which provided his daily bread.

Then and only then did civilization begin, because then and only then did man have some free time from the eternal fight for life in a hunting and gathering economy at the mercy of natural forces.

Today, we stand at the beginning of a new period of human history. The sociological breakthrough of our expanding leisure time opens up to us the possibility of a truly Golden Age when every person can reach his fullest individual development.

On the other hand, our expanding leisure has brought some very serious problems for the nation to solve. For example, the President of the New York Academy of Sciences not so long ago pointed out that "a world re-altered by automation and the abundance of cheap nuclear energy will bring about a class of 'leisure-stricken' individuals who would replace the poverty-stricken" as a problem for our society.

Dr. John Gardner, President of the Carnegie Foundation, put it another way in the Rockefeller Report on Education entitled "The Pursuit of Excellence." "What most people, young or old, want is not merely security, or comfort, or luxury—although they are glad enough to have these. They want meaning in their lives. If their era and their culture and their leaders do not or cannot offer them great meanings, great objectives, great convictions, then they will settle for shallow and trivial meanings. . . . People who live aimlessly, who allow the search for meaning in their lives to be satisfied by shallow and meretricious experiences have simply not been stirred by any alternative meanings —religious meanings, ethical values, ideas of social and civic responsibility, high standards of self-realization. This . . . is a failure of home, church, school, government—a failure of all of us."

Only if we understand the extent of our leisure time and some of the problems inherent in it can we understand the potentialities of recreation—including outdoor recreation.

The Greek word for leisure was "schole" and from it has come our English word "school." To the Greek, the purpose of leisure was not to loaf but to learn and he used his leisure to know himself, to develop a sound mind in a sound body by following the basic rule of moderation in all things, including moderation in the use of his leisure.

If then we have all this leisure coming to us—and some of us may think it's taking much too long to get to us personally—what relation does recreation, and particularly outdoor recreation, have to it?

The shortest and, therefore, the best definition of recreation I know is—the creative use of leisure time. Not the wasted use of leisure time, not the destructive use of leisure time, but rather the creative use of leisure time. Recreation is, therefore, re-creation of body, mind and spirit.

Recreation activities are as varied as the varied interests of every man and as varied as the varied interests of all men. From your own personal experience, you could make out quite a list of activities; from your observation of others, you could add many more.

So far as outdoor recreation is concerned, the Report of the Outdoor Recreation Resources Review Commission lists those activities which they found the most popular at the time among the people they happened to interview. Many of these activities will continue to be popular. They will be among the recreation activities people will want but they won't be all the recreation activities people will want outdoors.

Everything that can be done on land, sea and in the air—yes, and under the land and under the sea—which brings a feeling of accomplishment, of satisfaction, of joy, will be among any list of recreation activities because the "pursuit of happiness" is everlasting.

Who would have thought of or even imagined a few years ago a recreation activity which would consist of crawling through deep caves under the most difficult and normally unpleasant circumstances, or would consist of hunting man-eating sharks under water with a spear, or would consist of skydiving and soaring through the air like the birds?

Outdoor recreation activities, which the American people will want, will be all the activities they have now and all the activities they can imagine in the future.

Recreation is also becoming an important factor in the welfare of our national economy. Today, the United States Department of Commerce estimates that the nation's recreation and leisure time budget exceeds $40 billion and is going up every year. Although there are still many, unfortunately, with not much more than the necessities of life provided through private and public support, the great majority of Americans have passed from the fight for the necessities to the choice between luxuries.

If the American economy turned back the clock to the 72- or 84-hour work week of a hundred years ago, if we began again to employ children at the age of six and kept everyone working until they died, the effect on our economy would be greater and more disastrous than if we achieve the universal peace and complete disarmament about which we are now reading so much in our papers.

In fact, it will be the leisure and recreation market, or to use an even broader phase, the amenities of life which will pick up the slack of any cut-back on military expenditures, a possible slack which seems to disturb some economists but should, in my opinion, disturb no one.

For example, we already have some ideas of the billions of dollars that might well be spent right now for the acquisition of recreation areas, parks and open space. We also have some idea of the billions of dollars it would take to open up such areas, to develop them for recreation use, to provide the needed recreation facilities, equipment, supplies and services. We already can imagine the billions of dollars which would then be spent by the users of these areas, spent for equipment such as boats, hunting, fishing, and camping gear, spent on transportation, food and lodging.

There would also be billions of dollars involved in the implementation of river basin studies, and in the national, regional, state, district and local, rural and urban redevelopment projects needed to provide the proper physical surroundings for the Golden Age mankind has dreamed of for so long.

In all this outdoor recreation will have an important part to play.

What people want for recreation is heavily influenced by what is available. As the ORRRC report puts it: "Access promotes use."

For example, with due allowance for age, sex, and other influencing factors, people with more money do more things. The recreation explosion as a whole is closely related to our sharply rising income curve, as well as to our increasing leisure. It is also related to the increasing amount of education we have.

Thus great numbers of people, given the money and the time, will learn new skills, try new sports, visit new places. The ORRRC discovered that more than 90% of all Americans over 12 years of age enjoy some outdoor activities in a year—and most of them say they'd do more if they could. We know that when new water areas, such as reservoirs in the Southwest, are opened, participation in swimming and boating takes a great leap forward. We know, too, that participation in outdoor recreation, as measured in man-days at our parks and beaches, has grown much faster than our population, probably because of increased car ownership and better roads. In fact, the projection is that outdoor recreation activity will triple by the year 2000.

In trying to discover what people want for recreation, we must consider many factors.

First, we know that people tend to choose the kind of recreation with which they are already familiar.

Second, we know that people will choose even a new and untried recreation activity if it somehow captures their imagination. A good illustration of this is the tremendous increase in pleasure boating in recent years. The association of pleasure boating with the good life has attracted many people who don't care a great deal about boats as such. It's the *idea* of having a boat that seems to be the lure.

Third, we know that a certain proportion of our population seeks activities with challenge—the challenge of skill, even of danger. As our daily lives become more routine we can expect that this hunger for challenge in recreation will grow greater.

This need is a very serious matter. It is not to be passed over lightly with the observation that people who want challenge and danger will probably find them. There is much more to it than that.

One thing our great youth organizations in this country have discovered is that apparently normal young people whose lives are too well ordered, too protected, pleasant, and comfortable will find some way to subject themselves to danger and hardship and strange shocks and stresses. They will do it by hot-rodding and playing "chicken"; they will do it by excessive drinking and experimenting with dope even in "nice" families; they will do it in irrational bursts of destructive violence.

The youth organizations, mindful of their responsibilities, say there is a need for "safe adventure," but it is clear that the word "safe" is added by adults, not by the young.

What does this fact say to us about what people want in recreation—and especially the outdoor recreation with which this conference is chiefly concerned?

I think it shows that instead of saying "Give us men to match our mountains" we must demand "Give us mountains to match our men."

We must keep our wilderness areas as well as our pleasant parks; we must devise more and more challenging sports such as water skiing and we must not let even such new and perilous sports as sky diving frighten us into thinking we can kill man's adventurous spirit by banning participation just because it is potentially dangerous. Let us, in short, recognize and reckon with the fact that one thing some people want in recreation is challenge.

We should also note that people in increasing numbers seem to prefer recreation that families can enjoy together.

Our correspondence at the National Recreation Association and reports from community recreation departments have shown this trend for a number of years. Sales of big department stores and mail order houses show growth in the type of purchases that indicate family activities, and the Rockefeller Commission report further confirms this. Let us hope that American men really enjoy their wives' company, because they seem to be getting it whether they like it or not. Not only is there a tremendous amount of family camping, games such as bowling have already become family games and the last citadel of male aloneness is falling—women are going fishing in ever-increasing numbers.

People want the familiar yet they will follow a new fad; they want thrills and challenge yet they will also stay in the bosom of the family. Part of this ambivalence is due, of course, to the diversity of people. There is no such thing as an average American who wants to spend one third of his recreation with his family picnicking at the beach, one third of his recreation mountain climbing, and one third riding around in his car listening to a symphony broadcast. Instead there are some Americans who will do all these things and some who will do none of them.

So we return to the question with which we began: "What do Americans want for recreation?"

We know that they want what they can get, they want what they can dream about, they want what they can be persuaded to want, and they sometimes want things that parents or governors in their wisdom think they shouldn't have.

Yet by almost any standard we can offer, most people, given enough skills and educational background to feel secure among many choices, will choose wisely.

You will notice that I said "given enough skills and educational background to feel secure." This is an increasingly important point and one which is of special concern to all those who have been given or who have assumed any leadership in our use of human or natural resources. It is just as important in outdoor recreation as in any other use of our leisure time.

In outdoor recreation, we cannot expect a man to play tennis if he doesn't know how to hold a racquet; a woman who takes up hiking ought to know something about properly fitted boots; and we certainly don't want any untrained youngsters to go out and drown themselves under the impression that they're skin-diving.

In short, there is a tremendous opportunity and a tremendous responsibility for *leadership* in recreation.

Americans are still a mobile, reasonably vigorous people. They are willing to learn, eager to try attractive new ideas. Many of them are not aware of the great potential of their own leisure but they will begin to recognize it once it is pointed out. They may have to revise old concepts about only paid work being worth while. Instead, they must accept the idea that a man's worth is not measured by his paid job but by what he does with his total allotment of time—his employment of time, paid or unpaid.

Leadership can help Americans realize all that recreation can mean —and thereby change what Americans *want* for recreation.

When Americans realize that recreation can have many new dimensions, they will look for them. And what will they find?

Will they find that it is impossible to draw inspiration from the mountains because the view is blocked by billboards and the ground is covered with gum-wrappers and beer-cans? Will they find "No Swimming" signs posted because the waters are polluted? Will they turn to their neighborhood and community parks only to find them destroyed by highways or used for non-conforming purposes?

Of one thing we can be sure, outdoor recreation has more meaning to Americans than to the people of any other country because we are the descendants of explorers, scouts, frontiermen, pioneers, trappers, miners, woodsmen and farmers. The outdoors is an integral part of our character. Without it we would be less than American.

For this reason your responsibilities and the responsibilities of those of us in the recreation field are joint and common responsibilities.

Here the playground leader, the widllife manager, the forester and the wilderness ranger join hands. Together we must provide the best and most satisfying use of the expanding leisure time of America.

New Horizons for recreation beckon all of us. What people want for recreation is constantly changing and ever expanding. Our objective should not be just to catch up with the demand for outdoor recreation opportunities but to keep ahead of it with space, facilities, leadership. If we do that, no matter what the recreation target may be in the year 2,000, our children and our children's children will find that the launching platform is ready and the new horizons for outdoor recreation will be just ahead.

DISCUSSION

CHAIRMAN NELSON: Thank you, Joe Prendergast. Joe has explored some new areas of responsibility and interest, particularly both for the youth and for the aging as well as for us in the in-between class. He has graphically pointed out that leisure time can be a drug unless we learn how to use it constructively. People living under our present conditions need and want a change of environment as frequently as they can get it. Joe has pointed out that they will get it in one way or another and what we had better do something about it to see that it is channeled in the right direction.

On behalf of the entire conference, I want to thank our panel members for their excellent and stimulating papers. Governor Nelson, Al Bull, and Joe Prendergast, we owe you a debt of gratitude for the contributions that you have made to this wonderful conference. I think because of their contributions, we will all leave here with an enrichment and with some new ideas we can take home and put into practice.

This afternoon we have explored the recreation future and the responsibility for meeting the needs of our growing population with more leisure time, better incomes and greater mobility. These are problems with which we are going to be struggling in the years ahead. But may I make one point? I hope that we will all remember that recreation is only one of the many things that must come from our wilderness lands and resource areas. We need to properly coordinate the recreation programs and problems with those other often competing uses and needs from our resource areas, so that no single interest can warp the whole.

One of the greatest problems confronting all of us today, I think, is that of coordination, and it is one we will not solve simply.

We have seen leadership in action today. Each of you are leaders in your particular activities in your own sphere of orbit, and I think from this we can go home and exercise some of the presentations that have been here presented.

PART II
TECHNICAL SESSIONS

TECHNICAL SESSIONS

Monday Afternoon—March 12

Chairman: Richard K. Yancey
Assistant Director, Louisiana Wild Life and Fisheries Commission, New Orleans

Discussion Leader: Ernest L. Paynter
Director of Wildlife, Department of Natural Resources, Regina, Saskatchewan

WETLANDS AND INLAND WATER RESOURCES

EFFECTS OF DROUGHT AND LAND USE ON PRAIRIE NESTING DUCKS

James W. Salyer
Missouri Cooperative Wildlife Research Unit, Columbia

There is no doubt that drought adversely affects waterfowl production. However, detailed information about the ways in which drought reduces production is noticeably lacking in the literature. The effects of land use on waterfowl production has received more attention than drought-waterfowl relationships because, fortunately, drought is not of annual occurrence.

This paper presents a discussion of specific factors influencing waterfowl production that are altered by severe drought conditions simultaneous with various intensities of grazing by cattle. The data presented here were obtained at Lostwood National Wildlife Refuge, North Dakota, during the drought years of 1959 and 1961. The intervening year of 1960 was a period of more plentiful water areas and normal vegetative production. Comparison of these climatically different breeding seasons has afforded a measure of the effects of drought and land use on waterfowl production.

STUDY AREA

Lostwood Refuge, in northwest North Dakota, is situated in the Coteau du Missouri or "hills of Missouri" (Hainer, 1956). This range of terminal moraines forms an irregular, hilly, and undulating topography that has a gentle northwest to southeast slope without streams or outlets for natural drainage.

The 26,747 acres of the refuge is similar to the Parklands of the southern Canadian Prairie Provinces. Numerous potholes are interspersed in this short grass prairie, some of which are surrounded by aspen and cottonwood groves.

The water depth of most of these potholes ranges from a few inches to about three feet; some are deeper. Snow contributes most substantially to pothole water, but rainfall is necessary to condition the soil for good runoff into the potholes. Maximum runoff is obtained when fall rains afford sufficient moisture for soil saturation and freezing, resulting in rapid spring runoff.

Sampling area. The original sampling area established in 1959 included six square miles in the northern part of the refuge (Figure 1). There were two contiguous sections with light grazing—5 acres per head per month; two with moderate grazing—3 acres per head per month; and two idle with no grazing. Brood counts were made on four square miles of private land near the refuge to obtain a sample from an area of intensive land use. This private land was subject to haying and cropping as well as grazing. Land use categories employed were: heavy, moderate, light, and idle.

Lack of water in the potholes on the study area in 1961 made it necessary for additional areas to be included; consequently, contiguous sections or partial sections were added. These are shaded areas on the map (Figure 1). Only 1961 nesting and brood population data were obtained from the added portion. All other observations were made on the original study area.

WATER CONDITIONS

Bailey (1926) gives evidence that the general decline of water levels in North Dakota is not a recent event. A steamboat landing in use in 1887 on Devil's Lake was two miles from water in 1920; the water level was 18 feet below that of 1879.

Water tables. The relationship of water tables to permanency of potholes is shown by two potholes about 100 yards apart in Section 32. One was completely dry in 1959 while the other held water throughout the season. In 1960 they both held water the entire season, but in 1961 the first was dry by June 15, the other not until mid-July. The second was at a lower elevation and was probably nearer the

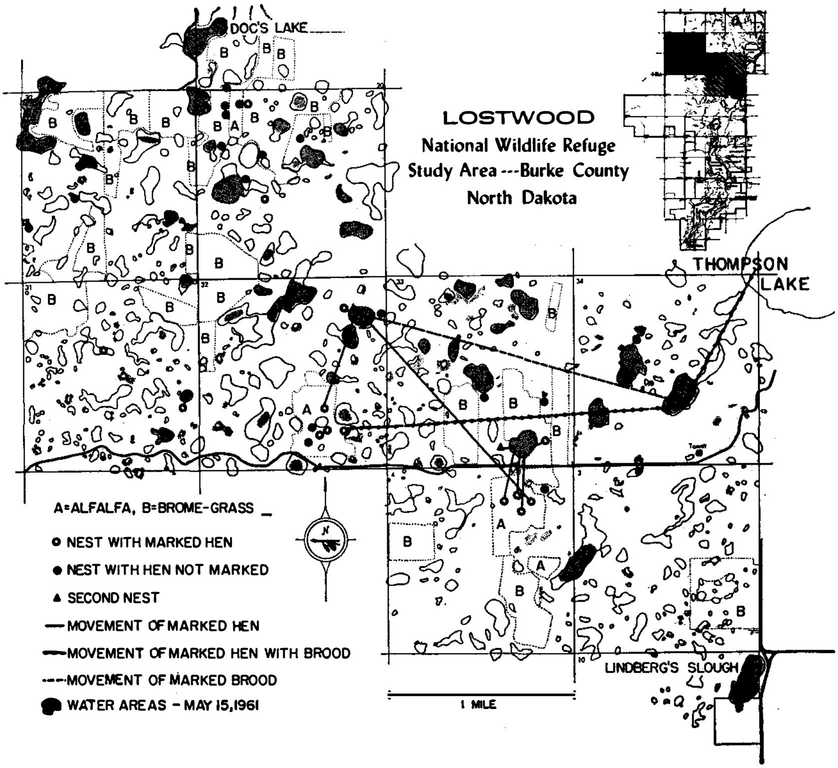

Fig. 1. Map of the study area showing the distribution of potholes, water areas, reseeded plots, and nests.

water table. Although no specific elevations were determined other potholes that were obviously at high elevations dried up first.

The pattern of drying was progressive from the northwest to the southeast, where all the larger and more permanent water areas were found, such as Thompson Lake and Lindberg Slough (Figure 1).

Precipitation. Annual precipitation in the refuge vicinity was less than 12 inches for the period 1958 through 1961, except for 18 inches in 1959. (Bradley, in litt.) The amount of precipitation contributed by snow in this same period was as follows: 1958-'59—1.59 inches; 1959-'60—4.30 inches; and 1960-'61—2.64 inches.

An average of five water areas per square mile of study area was being censused for waterfowl broods in 1959. By August, 56 per cent of these were dry. In 1960, seven potholes were being censused in each square mile of the study area and all still held water in August. In 1961, the drought was so severe that all of the potholes were dry by mid-July on the original six-square-mile study area.

Schroeder (in Crissey 1961) described the conditions in North Dakota in 1961 as the poorest since the waterfowl survey was started in 1948. The average of 0.45 water areas per square mile in North Dakota in 1961 was 91 per cent below the 5.02 water areas per square mile in 1960 and 74 per cent below the 1.63 per square mile in 1959.

The water conditions can be arbitrarily rated as follows: 1959—fair; 1960—good; and 1961—poor. These ratings are based on the number of water areas available in mid-July. In all three years of the study, water areas were more abundant at the time nesting began; however, their stability varied with the amount of fall and winter precipitation preceding each breeding season.

BREEDING POPULATIONS

Smith and Hawkins (1948) have pointed out that censusing of waterfowl during the early breeding season is facilitated by pairing and territorial behavior, seasonal tameness, sparseness of cover, and group dispersion.

A valid census may be obtained from the time prenesting activity begins until males have abandoned their mates and begun to flock. A single count of breeding pairs was made in early June of each year. Hammond (1959) has suggested that this time be set during the period of initiation of the blue-winged teal nesting in late May and early June, thus including both late nesters and renesting by early breeders.

Counts were made in the morning hours from dawn to noon. These hours permitted counting of birds that flew from the larger water areas such as lakes and sloughs to the smaller potholes for morning dispersal.

Any bias resulting from differential use of water areas or land use types by breeding pairs during various parts of the day was avoided by either counting the pairs in the various habitats simultaneously or during the same hours on different days. The distribution of the breeding pairs is presented in Table 1.

Population densities varied between areas with the same grazing rate. Each year Section 33 of the moderate grazing units had larger breeding pair populations than did Section 3. The number of water areas is probably the most influential factor causing this difference. Moderately grazed areas contained 206 breeding pairs in 1959 compared with 159 in lightly grazed and 124 in ungrazed areas. Ungrazed areas were used more by breeding pairs in 1960 and 1961 than were moderate or light grazing areas. Bue et al. (1952) found a direct relationship between pairs and number of water areas in South Da-

TABLE 1. BREEDING PAIR DISTRIBUTION ON AREAS WITH DIFFERENT RATES OF GRAZING

	1959	1960	1961
Water conditions	fair	good	poor
Moderate Grazing (3 acres/head/month			
Section 3	53	57	6
Section 33	153	86	75
Light Grazing (5 acres/head/month)			
Section 30	77	76	77
Section 31	81[1]	80	no water
No Grazing			
Section 29	61	124	89
Section 32	63[1]	136	90
TOTAL PAIRS	488	559	337

[1]No counts were made in these sections in 1959; the figures were extrapolated from 1960 data.

kota and a close relationship with grazing practices; however, their study dealt only with stock ponds. Hammond (in litt.) has found, in extensive studies in the Dakotas and Nebraska, that so many factors are involved with water area selection by breeding pairs that it is difficult to pick a single factor. No direct evidence was found in my study to show that breeding populations were related to grazing rates employed on Lostwood Refuge.

NESTING

Nest hunting and hen trapping were initiated in 1960 to mark hens and broods for movement studies. The nest hunting was conducted in the morning hours when most hens were on the nest (85-90 per cent: Hammond (in litt.).

Cover types and nest density. The cover types dragged were (1) native short prairie grasses, (2) buckbrush (*Symphoricarpos occidentalis*), sometimes mixed with silverberry (*Elaeagnus argentea*), (3) alfalfa, and (4) retired farm ground re-seeded to bromegrass (*Bromus* spp.), crested wheatgrass (*Agropyron cristatum*) and quackgrass (*A. repens*).

More than 70 per cent of the nests in both years were found in the thick cover of buckbrush or alfalfa (Table 2). Ellig (1955) found

TABLE 2. NESTS FOUND IN FOUR COVER TYPES

Cover Type	Alfalfa		Buckbrush		Brome		Native Grass[1]		Total	
Year	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961
Acres Dragged	69	129	217	196	379	271	110	147	775	743
Percent[2]	8.9	17.4	28.0	26.4	48.9	36.5	14.2	19.8	100	100
Species										
Mallard	4	7	4	9	3	0	0	1	11	17
Gadwell	4	0	3	0	2	0	0	0	9	0
Bluewinged teal	6	1	4	0	2	0	1	1	13	2
Pintail	2	0	4	3	1	4	0	1	7	8
Shoveler	2	3	0	0	1	0	1	1	4	4
Baldpate	0	0	1	0	0	0	0	0	1	0
L. Scaup	0	0	0	0	1	0	0	0	1	0
Total Nests	18	11	16	12	10	4	2	4	46	31
Acres/Nest	3.8	11.7	13.6	16.3	37.9	67.8	55.0	36.8	16.8	24.0

[1]Includes grasses in dry pothole basins.
[2]Percent of total acres searched.

that upland nesting ducks in Montana made little use of alfalfa but used greasewood (*Saracobatus vermiculatus*) extensively. Greasewood grows in clumps and patches at heights similar to buckbrush. Even though brome-grass and native grass comprised more than 50 per cent of the total area dragged, less than one-third of the nests were found in these cover types. The nests found were in close association with either buckbrush or slough vegetation.

It is readily apparent that alfalfa supported the greatest nesting densities with 3.8 and 11.7 acres per nest in 1960 and 1961 respectively. Nest densities decreased in the drought conditions in 1961 in all cover types that were adequately sampled.

Nesting conditions. The difference between 24 acres per nest in 1961 and 16.8 acres per nest in 1960 is partly attributable to moisture conditions affecting vegetative growth. In the favorable year 1960, brome-grass stems grew to heights of 36 inches or more. Stems of this species rarely exceeded 24 inches in 1961.

Heavy snows normally mat down old plant stems, so that they are obscured by new growth in the spring. The rank stems of the 1960 season were not forced down by the light snow in the following winter; consequently, the erect dead stems stood up among the sparse green of new growth in 1961 and the vegetation appeared to be dry. The absence of the normal green of new vegetation may have discouraged nesting. Marshall (1957) found the red-billed weaver finch (*Quelea quelea*) of Tanganyika was stimulated to build nests only after rainy periods produced green grass for nesting materials. The absence of safe and traditional nest sites is considered by Marshall and Disney (1952) and Bertram et al. (1934) as being a chief cause of non-nesting among arctic birds.

Nest success. The high rate of nest predation in 1961 as compared with 1960 indicates a lack of safe nest sites. Of the thirty-one nests found in 1961, only five were successful; 24 were destroyed by predators and three were deserted. Skunks accounted for 16 of the destroyed nests, crows for three and foxes for five. Three hens were killed on nests in 1961 and one in 1960. No nests were lost to trampling by cattle. Nest success fell from 65 per cent in 1960 to 16.6 per cent in 1961. In 1960 all species produced broods from 50 per cent or more of their nests. Gadwalls were most successful with seven of nine nests producing broods (78 per cent). No gadwall nests were found in 1961 and neither of two blue-winged teal nests hatched.

Nesting effort. An index expressing the comparative nesting effort was determined from the pair counts and the nests found (Table 3). The pairs per nest for each land use type indicates a different dispersal of the breeding population in the two years. This is probably a

TABLE 3. RELATIONSHIP OF BREEDING PAIRS TO NESTS FOUND

Grazing Rate	No. of Pairs 1960	No. of Pairs 1961	No. Nests 1960	No. Nests 1961	Pairs/Nest 1960	Pairs/Nest 1961
Moderate	143	81	12	3	11.9	27.0
Light	146	77	9	3	16.2	25.6
Idle	360	179	23	17	15.7	10.5
Total	559	337	44	23	12.7	14.7

function of water distribution. However, the total breeding populations in these two years made similar nesting efforts with 12.7 pairs per nest in 1960 and 14.7 pairs per nest in 1961. (No significant difference by chi square test at the 95 per cent confidence level.)

Egg success. Drought was responsible for decreased egg viability and may have indirectly caused increased predation. The per cent of dead embryos left in the nests doubled in 1960 over 1961 (Table 4). Nests found on high ground in both years held most of the dead embryos. The greater success of eggs in nests in slough bottoms was perhaps attributable to more humid conditions there. The increased distance of nests from water in 1961 also reduced the moisture normally carried to the eggs by the hen's feathers.

Predation was three times as great in 1961 as in 1960 because of: (1) apparent increased skunk populations, (2) less suitable cover for nests, and (3) persistence of obvious trails made by the observer in the dry vegetation.

Clutch size. There was no significant difference in clutch sizes between the two years of this study. The 10 mallard nests found in 1960 and 11 in 1961 contained an average clutch of 8.2 eggs each year. When all species are lumped, the average clutch in 1960 was 8.8 and in 1961 was 8.5 (no statistically significant difference).

Nest distance from water. All 1960 nests were within 125 yards of water and the sustained water levels precluded appreciable change at hatching time. The average distance of 1961 nests from water was 385 yards. By the time these broods hatched no nest was closer than one-fourth mile to water and some were as far as one and one-half miles. Some of the nesting hens were trapped and marked and their movements followed. One pintail hen moved her brood three miles and a mallard brood was identified two miles from the nest site.

TABLE 4. FATE OF EGGS

	1960 Number	1960 Per Cent	1961 Number	1961 Per Cent
Eggs laid	361		203	
Eggs hatched	242	67	32	16
Eggs with dead embryos	14	5	21	10
Eggs destroyed or deserted	105	28	152	74

BROOD PRODUCTION

Broods were counted each year at weekly intervals. Counts were made along an established route which sampled each section of the refuge study area and the private land nearby. Counts were begun when the first broods were observed (usually in mid-June) and continued until Class Ia broods were no longer seen (late August). Broods were identified as to species and age according to criteria described by Gollop and Marshall (1954).

Brood counts. On the six-square-mile study area 247 broods were observed in 1959, 331 in 1960 and 47 in 1961.

Water areas were so reduced in 1961 that the brood counts could not be used for comparison with production on the study area in 1959 and 1960. In order to determine production on the entire refuge, a weekly brood count was made on all the water areas remaining (five) in the northern 18 square miles of the refuge. The off-refuge sampling area was similarly affected but some water did remain at the end of the season. Brood counts made on and off the refuge are shown in Table 5.

TABLE 5. TOTAL BROODS OBSERVED BY WEEKS OF THE COUNTING PERIOD

Count Week	1	2	3	4	5	6	7	8	Total
1959	3	7	26	42	77	64	48	21	287
1960	5	11	23	57	51	132	93	59	431
1961	17	42	62	51	36	34	18	9	269

The peak count in 1959 was only one week earlier than in 1960, but the peak count in 1961 was two weeks earlier than in either previous year (Figure 2). This single early peak suggests renesting was minimal in 1961. Renesting tended to maintain higher counts in 1960. The earlier broods (up to mid-July) show similar curves in 1959 and 1960. After this time appearance of new broods declined continually in 1961; peaks in the other years did not occur until early August. Another cause of the earlier peak in 1961 was probably the concentrated use of the only water remaining as compared with the scattered more numerous potholes in the two previous years.

Broods and land use. Low water levels made it impossible to compare land use and brood distributions for 1961. Comparisons for 1959 and 1960 are shown in Table 6.

TABLE 6. COMPARISON OF BROOD COUNTS ON THE VARIOUS LAND USES

Land Use	1959	1960
Intensive	40	100
Moderate	58	134
Light	80	78
Idle	109	118

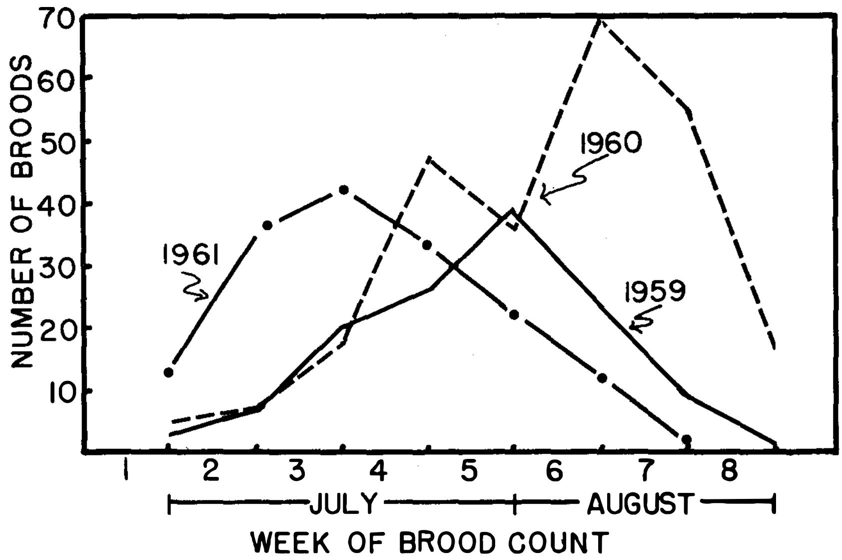

Fig. 2. Chronology of Appearance of Class I Broods

The first year's data suggested that the number of broods was inversely related to the intensity of land utilization. However, in 1960 moderate grazing was the most conducive to brood production.

Brood size. The equal clutch sizes in 1960 and 1961 suggest that nearly equal brood sizes should follow. Brood sizes were smaller in 1961. Although the averages were not significantly different, the frequency distribution showed the mode to be lower in the drought year (Table 7).

TABLE 7. MOST FREQUENT BROOD SIZES OBSERVED

Year	Mallard	Gadwall	Bluewing	Pintail
1959	8	8	6	5
1960	8	8	7	6
1961	6	5	6	5

The difference in brood sizes can be explained by the number of dead embryos found, increased mortality resulting from longer distances from the nest to the water, and possible increased predation rates brought about by extended mud flats exposed by receding water levels. No brood ducks were observed to have met such a fate, but two flightless mallard drakes were found partially eaten. A fox was flushed from the cattails nearby. Trails of fox, raccoon, and skunk were prominent in the mud margins between the vegetation and the water's edge. Probably many ducklings, as well as adults, were destroyed here.

REPRODUCTIVE SUCCESS

The ratio of pairs to broods (corrected for duplicate observations) gives reproductive success of 36 per cent in 1959, 75 per cent in 1960 and only 16.6 per cent in 1961. These figures apply only to dabbling ducks. Although there was no specific concern with diving ducks, it may be of interest to note that reproductive success for this group was 6.5 per cent in 1959, 91 per cent in 1960 and 24.6 per cent in 1961. Actual diving duck broods observed for the three years were 4, 158, and 40, with ruddy ducks and lesser scaup as the most significant producers in 1960.

ACKNOWLEDGMENTS

This study was conducted while the writer was employed by the U. S. Bureau of Sport Fisheries and Wildlife as a Wildlife Aid. I extend my appreciation to Merrill C. Hammond for guidance in the field, to Dr. William H. Elder for advice and direction both in the study and with the preparation of this paper, and to Homer L. Bradley for facilitating the study. I am grateful for the financial assistance of the Missouri Cooperative Wildlife Research Unit and an E. Sydney Stephens Fellowship.

SUMMARY

Lack of precipitation (both rain and snow) caused poor water conditions for waterfowl production in 1959 and 1961. Much better conditions existed in 1960 when good rains and snow the preceding fall and winter filled the potholes. Waterfowl production was evaluated in relation to the effects of drought and grazing intensity.

Breeding pair populations tended to fluctuate with the number of available water areas, but showed no distinct relationship with grazing intensity. The number of suitable breeding territories was reduced during drought; hence, the population declined. There was no decline in the nesting effort or in the clutch size among pairs finding territories. But the success of their reproductive efforts was very low because of increased predation and embryo mortality in the drought year. The size and number of the broods were also much lower, probably due to the greater distance from nest to water.

Diving duck populations responded dramatically, both in numbers and reproductive success, to the changing water levels.

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DISCUSSION

DISCUSSION LEADER PAYNTER: Our speaker certainly has given us something to think about. I thought I was back in Saskatchewan as of last summer. What he has told us about the success under the conditions we have had gives us a lot to think about. I only noticed one difference from what we had in Saskatchewan. We plant a wheat collar around our potholes so that the ducks won't have to go far to feed.

MR. GLENN SMART [Round Lake, Minnesota]: Jim, I have a question. You indicated that some of the nests this year were hatched as far as a mile and a half from open water. Do you have any indication how far these nests might have been from water at the time of initiation?

MR. SALYER: Most of the nests in both years were much closer to water at the time of initiation because in each spring the pothole water that was available was much more abundant. Many of these birds begin nesting before the frost has gone out of the bottom of the potholes, and as long as this frost or seal is maintained the birds have water to use. Then when the season warms up and the water level drops down, the nest is left stranded or away from water. The average distance of the nests established in the spring was never more than 200 yards. Most of them were somewhere within ten to 150 yards.

DISCUSSION LEADER PAYNTER: Jim, there is one question I might ask you. In your talk you mentioned that where there was slight grazing the nesting success was better than on the other two types of area you were serving. Is that right?

MR. SALYER: Yes, this is true. I am reluctant, however, to credit the grazing rates as the sole factor involved here. I also indicated that water distribution was probably more important.

I would like to make this final remark about grazing on this study. The difference wasn't great enough that I could make any specific statement about it except that in 1960, the first year that I studied nests, there was an inverse relationship with grazing rates and duck production. In 1961, when the water was almost completely gone, there was no pattern at all. I found out that light grazing was better than intensive grazing. I found out that moderate grazing was better than idle land, but it wasn't as good as light grazing. So there was no distinct pattern in 1961, and I am not ready to make any gross statements or give anything in detail about drought relationship or grazing relationship.

CHAIRMAN YANCEY: I want to thank you, James Salyer, for a very interesting presentation. I believe all of us got a lot out of your paper.

SOME EFFECTS OF A HEADWATER IMPOUNDMENT UPON WATERFOWL

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Luther Marsh is an impoundment of 4,500 acres situated on one of the headwaters of the Grand River in southern Ontario, at latitude 43° 50′ N, longitude 80° 20′ W. It was established in 1952 at a cost of $233,806, which included the purchase of more than 5,000 acres of land and cost of development. The Grand River Conservation Commission, a body established by provincial legislation in 1932, developed the scheme as one of a series of impoundments with the objectives of downstream flood control and increased summer flow.

The Grand River Valley is 2,600 square miles in area. The main branch of the river rises 125 miles north of Lake Erie, from an extensive, poorly-drained plateau between 1,600 and 1,700 feet in elevation. Luther Marsh is situated toward the southern edge of this plateau. Originally a peat bog containing deposits of moss and peat up to 20 feet in depth, it was drained for agriculture and peat-mining commencing around 1890. Prior to impoundment, water areas had been reduced to two small boggy lakes and several streams and drainage ditches. The original forest had been logged and replaced by second growth stands of white elm (*Ulmus americana* L.), white birch (*Betula alba* L.), trembling aspen (*Populus tremuloides* Michx.), tamarack [*Larix laricina* (DuRoi) Koch] and white cedar (*Thuja occidentalis* L.).

USES OF LUTHER MARSH OTHER THAN WATERFOWL MANAGEMENT

The level of Luther Marsh is controlled by an earthen dam 930 feet long and 15 feet high. Winter precipitation permits a draw-down of two feet annually. This is effected in accordance with downstream requirements, usually between July and September. The Grand River Conservation Commission has reforested most of the open land it owns adjoining the marsh, as a condition of receiving federal aid for a subsequent project. Islands within the marsh have not been reforested. A small amount of angling and picnicking is supported by the area.

INVESTIGATIONS OF WATERFOWL OF LUTHER MARSH

A few months after impoundment, it was obvious that Luther Marsh was going to affect waterfowl populations. Investigations in recognition of this fact commenced in 1953. The Lake Huron District staff of the Ontario Department of Lands and Forests has conducted waterfowl bag checks on opening days since 1953. Since 1960, bags have been checked throughout the season. J. H. Day (1955) of the Canadian Wildlife Service made a ten-day survey of nesting waterfowl of the marsh in 1955. Nesting was studied more intensively from 1958 to 1960 by G. F. Boyer and O. E. Devitt (1961). In 1961 the Department of Lands and Forests carried out a study of nesting and habitat, and the Ontario Waterfowl Research Foundation commenced a study of movements of waterfowl in relation to Luther Marsh.

RESPONSE BY WATERFOWL TO THE IMPOUNDMENT OF LUTHER MARSH

The lake, with its associated complex of bog, marsh, swamp and flooded timber, Fig. 1, created by the Luther Dam is in the centre of

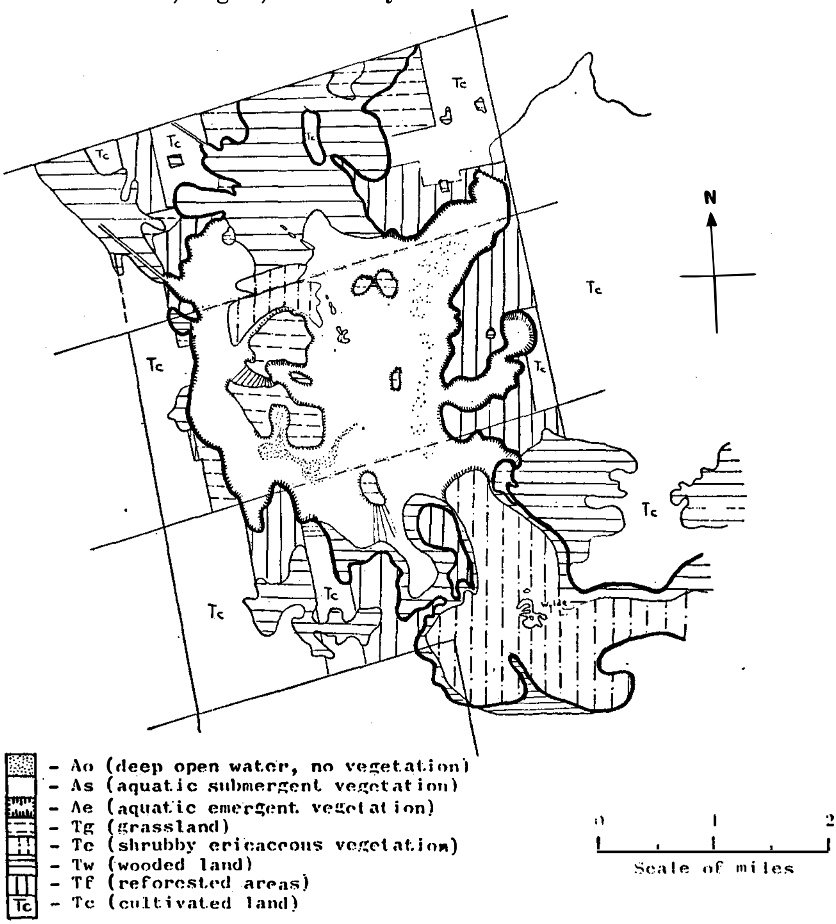

Fig. 1. General Vegetation Types of Luther Marsh. Map by W. A. Creighton.

a large area which is deficient in lakes and marshes. So far as we have been able to determine, the response by waterfowl to the establishment of this area was pronounced and rapid.

Luther Marsh is not used by large numbers of transient waterfowl in the spring, owing to a late break-up, normally in mid-April. At times, a few thousand birds may be present in the spring, including whistling swans [*Olor columbianus* (Ord)], Canada geese [*Branta canadensis* (Linnaeus) (A.O.U., 1957)], and twenty or more species of ducks, of which several species were not previously recorded as occurring in the general area. Eleven species of ducks remain to nest. Large numbers of waterfowl use the marsh during the autumn. The following statement, concerning 1961, provides further details of the general use of Luther Marsh by waterfowl.

During June, 1961, there were about 1,500 to 2,000 ducks at Luther Marsh. In July, this number increased, perhaps doubled, with the addition of new ducklings, plus post-nuptial drakes and unsuccessful hens from other areas that gathered at Luther prior to their flightless period. Flocks of between 50 and 100 redhead [*Aythya americana* (Eyton)], American widgeon [*Mareca americana* (Gmelin)] and green-winged teal (*Anas carolinensis* Gmelin) that appeared to be recent immigrants were seen during July.

During the first week in August, the population began to rise sharply. On the basis of birds counted along transects, there were estimated to be between 10,000 and 13,000 ducks present by the end of August. Information from banding records suggests that this increase was due mainly to an influx of mallards (*Anas platyrhynchos* Linnaeus) and black ducks (*Anas rubripes* Brewster). The population continued to increase until it reached an estimated 15,000-25,000 in the first week of October.

RESPONSE BY NESTING WATERFOWL

Estimates of the nesting population of waterfowl at Luther Marsh made at various times are summarized in Table 1. No information concerning the nesting of waterfowl in what is now Luther Marsh prior to its impoundment has been recorded. It seems certain that the pre-impoundment nesting population was low, because few habitats in southern Ontario are highly productive of waterfowl, and since conditions to support a high nesting population probably would have supported a large fall population and would have attracted many hunters. An original breeding population of 1 to 5 pairs per square mile is assumed.

Published reports for nearby areas (Klugh, 1905; Calvert, 1909; Soper, 1923) and general descriptions of breeding ranges (Baillie

TABLE 1. ESTIMATES OF NESTING POPULATIONS OF DUCKS, LUTHER MARSH, ONTARIO

Year	Pre-1952	1955	1958	1959	1961	1961
Authority	This paper	Day, 1955	Boyer and Devitt, 1961	Boyer and Devitt, 1961	Mason This paper	Palmer This paper
Basis of Estimate	By inference	General reconnaissance	General reconnaissance	General reconnaissance	Sample plots	General reconnaissance
Species			Estimated Number of Pairs Present			
Mallard	Possibly present	"High Production"	60	60	91(81-102)	200
Black Duck	Principal species	"High Production"	40	40	8(7-9)[3]	50
Gadwall		"Nests"	2-3	2-3	8(7-9)[4]	15
Pintail		"Nests"	"Present"	15		20
Green-winged Teal		"Suspected of nesting"	10	10		10
Blue-winged Teal	Possibly present	160	200	200	249(220-227)	225
American Widgeon			"Present"	15	33(29-37)	25
Shoveler[1]		"Present"	1	2		not seen
Wood Duck[1]	Possibly present					5
Redhead		"Present"	"Present"	7	17(15-18)	50
Ring-necked Duck		"Suspected of nesting"	25	25	58(51-65)	75
Lesser Scaup[2]		"Present"		1		present
Ruddy Duck		"Suspected of nesting"	"Present"	12	[4]	25
Total	10-35	—	—	389-390	464(412-517)	700

[1]No proof of nesting by Wood Duck and Shoveler has been found.
[2]A Lesser Scaup nest was found by Boyer in 1960.
[3]Range given in brackets is estimated nesting population ± 2 standard errors.
[4]Considered present as nesting species because of nests or broods seen outside sample plots.

and Harrington, 1936; Kortright, 1943; Lumsden, 1951; Baillie, 1958 and 1960; Mendall, 1958) suggest that the black duck was the main nesting species in the area prior to 1952, and that mallard, blue-winged teal (*Anas discors* Linnaeus), wood duck [*Aix sponsa* (Linnaeus)] and hooded merganser [*Lophodytes culcullatus* (Linnaeus)] might have been rare nesting species; lesser scaup [*Aythya affinis* (Eyton)], common goldeneye [*Bucephala clangula* (Linnaeus)], common merganser (*Mergus merganser* Linnaeus), pintail (*Anas acuta* Linnaeus), shoveler [*Spatula clypeata* (Linnaeus)], American widgeon, redhead, ring-necked duck [*Aythya collaris* (Donovan)] and ruddy duck [*Oxypura jamaicensis* (Gmelin)] had been known to nest occasionally within 150 miles of the area.

Day (1955) estimated high production of mallards and black ducks, and a breeding population of 160 pairs of blue-winged teal, and he found nests of pintail and gadwall (*Anas strepera* Linnaeus). Several other species, described as present, or suspected of nesting in 1955, were found nesting by 1959.

Boyer and Devitt (1961) established proof of nesting at Luther Marsh for green-winged teal, ring-necked duck and ruddy duck in 1958, American widgeon and redhead in 1959, and lesser scaup in 1960. This increased the number of species of ducks known to nest at Luther Marsh to eleven, and for eight of these, the records constitute extension of the known and published nesting distributions within Ontario.

Shoveler, wood duck and hooded merganser likely nest at Luther Marsh, but no nest or brood has been observed yet.

These nesting populations established themselves at Luther Marsh in the absence of stocking or any other artificial measure. A high degree of pioneering, in the accepted sense of the term (Hochbaum, 1946) was shown. The record of nesting species from 1952 to 1955 is incomplete, but it seems likely that by 1955 all pioneering species, with the possible exception of the American widgeon, had established themselves. The rate and extent of pioneering by redhead, ring-necked duck and ruddy duck appear to be unusually high.

Bases of estimating the total population of nesting waterfowl of Luther Marsh, summarized in Table 1, have ranged from inference through general reconnaissance and breeding stock counts to plot sampling. It seems clear that a high nesting population had been reached by 1955. This substantiates many earlier reports of rapid response by nesting waterfowl to new impoundments (Hartman, 1949; Sowls, 1955; Davenport, 1959). The gross nesting population may have remained fairly stable until 1959. Some changes in species composition likely occurred during this period. The nesting population apparently increased between 1959 and 1961.

Two estimates are given for 1961. Mason's is based on 57 nests found in 86 plots sampled, and Palmer's is based on totalling of breeding stock counts in different parts of the marsh. The differences between the two estimates can be explained by the following: plot sampling commenced May 23rd, too late for early nests of mallard and black duck, and breeding stock counts commenced in April; several habitats, including one large bog, flooded timber and the cattail fringe are not represented in the plot sample; efficiency of methods used in searching for nests on the plots has not been measured. Palmer's estimate of 700 nesting pairs is thought to be a conservative one. Several hundred pairs of American coot (*Fulica americana* Gmelin) nested at Luther Marsh in 1961.

Nesting densities varied considerably with habitat. Mason recorded the highest densities, of about 1 nest per acre, in a leatherleaf bog. There was an average of about 1 nest per 2.5 acres on grassland islands. Nest densities in mainland habitats were much lower.

These records show that Luther Marsh still was highly productive in its ninth year after impoundment. Other studies have indicated that productivity of small impoundments may decline in the third year after flooding (Benson and Foley, 1956). Larger flowages may remain productive longer (Hartman, 1949, Davenport, 1959) but Luther's productivity appears to be holding up unusually well. One possible explanation is that the key nesting habitats, including floating leatherleaf bogs and grassland islands, have changed little. The amount of cattail fringe, used by ruddy duck, mallard and redhead, has increased. The over-all nesting habitat is probably as good as it was in 1952.

Information was collected on nesting success and brood size in 1961, but these data will not be presented here.

MOVEMENTS OF WATERFOWL USING LUTHER MARSH

A study of movements of local and non-resident waterfowl in the upper Grand River Valley was begun in 1961. Although this study is incomplete, certain features of the movements of waterfowl using Luther Marsh were ascertained. Most of this information has been gathered from band recoveries, and re-traps, but some is based on observations made in the study area.

There is no information about the wintering range of the ducks that nest at Luther. Post-breeding movement results in the gathering of many adult and juvenile birds at the marsh. Banding data indicate that some come from other areas in the upper Grand River Valley. The population build-up that occurred between August and October possibly could be explained altogether by movements of birds from this area to Luther, but present evidence indicates that some birds come from more distant places. Retrapping of previously banded birds showed direct summer movement to Luther Marsh of birds from eastern Ontario and Massachusetts.

From July 16 to September 14, some 421 mallards, 191 black ducks, 7 mallard × black duck hybrids, 7 wood ducks, 6 pintails and 15 blue-winged teal were banded at Luther. Repeat trappings, and band recoveries from the opening day of hunting season, October 7, indicate a low rate of turnover up to this date. Recoveries of banded birds, are summarized in Table 2. Late season recoveries have not been reported yet.

The past hunting season produced one direct and two indirect recoveries of birds banded in New York.

HUNTING AT LUTHER MARSH

There was little waterfowl hunting in what is now Luther Marsh before it was impounded. According to Passmore (*pers. comm.*), only about six parties hunted in the area regularly in 1939 and 1940, and total amount of hunting approximated 300 hours per year. More people hunted there from 1945 to 1947, although the total number of hours of hunting was unchanged.

Reports indicate that hunting pressure increased a little in 1952, was heavy in 1953, and very heavy from 1954 to 1960, although estimates

TABLE 2. DISTRIBUTION OF DIRECT RECOVERIES OF DUCKS BANDED AT LUTHER MARSH FROM JULY 16 TO SEPTEMBER 14, 1961.

Species	No. Banded	Total Recoveries[1]	Recoveries from Luther Marsh	Recoveries from Elsewhere in Ontario	Recoveries from U.S.A.
Mallard:					
Number	421	45	30	10	5
% of no. banded	100%	10.7%	7.1%	2.4%	1.2%
Mallard x Black Duck Hybrid:					
Number	7	0	0	0	0
% of no. banded	100%	0	0	0	0
Black Duck:					
Number	191	28	15[2]	12	1
% of no. banded	100%	14.7%	7.9%	6.3%	0.5%
Pintail:					
Number	6	0	0	0	0
% of no. banded	100%	0	0	0	0
Blue-winged Teal:					
Number	15	0	0	0	0
% of no. banded	100%	0	0	0	0
Wood Duck:					
Number	7	1	1	0	0
% of no. banded	100%	14.3%	14.3%	0	0
Total: Number	647	74	46	22	6
% of no. banded	100%	11.4%	7.1%	3.4%	0.9%

[1]Based on recoveries reported up to February 28, 1962.
[2]Includes one predated bird.

based on counts of cars and average number of hunters per car were not made for opening day until 1959, and for the balance of the season until 1960.

Greatest estimated number of hunters on one day was 1,970 on opening day in 1959. Maximum seasonal pressure estimated was 4,892 hunter-days in 1960. Numbers of hunters dropped sharply in 1961, to 1,256 on opening day and 3,016 for the season.

Luther Marsh sustained between 15,000 and 25,000 hours of waterfowl hunting per year in 1960 and 1961, some 50 to 80 times the amount supported prior to impoundment.

THE HARVEST

Opening day harvest, shown in Table 3, has ranged between 0.42 and 2.05 ducks per hunter since 1953, and between 0.59 and 1.59 for the past four years, measurements which are probably more reliable than those for earlier years, owing to more intensive sampling.

The greatest daily kill was on opening day in 1959, when an estimated 2,165 ducks were bagged.

Total kill for 1960 and 1961 has been computed by applying the average number of ducks bagged per hunter checked each day to the estimated number of hunters that day. In 1960, some 4,892 hunters bagged 2,409 ducks. 42% of the hunting was on the first two days, when 49% of the kill occurred. In 1961, 3,016 hunters took 3,355 ducks, and 64% of the hunting was on the first two days of the season when 62% of the kill occurred. The second day of the season was a holiday in 1961, but not in 1960.

The four most important species of ducks on opening day have consistently been mallard, black duck, green-winged teal and blue-winged teal, with a good deal of variation in rank between years. During the past few years, pintail, American widgeon, redhead, ring-necked and ruddy ducks have made up increasing proportions of the opening day bag. Canvasback [*Aythya valisineria* (Wlson)], bufflehead [*Bucephala albeola* (Linnaeus)] and red-breasted merganser (*Mergus serrator* Linnaeus) are transients and among the less important species bagged, whose status at Luther Marsh has not otherwise been established in this paper.

Bag checks in 1960 and 1961 revealed that more than 75% of all blue-winged teal, wood duck, ring-necked duck, redhead (1961 only) and ruddy duck bagged were taken during the first two days of the season. The possible effects of this harvest situation upon the nesting populations are being examined.

After the first two days of the season, mallard, black duck, scaups [including greater scaup, *Aythya marila* (Linnaeus)] and green-

TABLE 3. SPECIES COMPOSITION OF DUCKS BAGGED ON OPENING DAY AT LUTHER MARSH, ONTARIO, 1953–1961

	1953	1954	1955	1956	1957	1958	1959	1960	1961
No. of hunters checked	207	729	639	589	426	918	1564	1566	1214
Estimated no. of hunters		1500–2000	1500–2000	1500–2000	1500–2000	1500–2000	1970	1875	1256
No. of ducks checked	423	422	501	568	180	1463	1723	931	1464
No. of ducks identified	344	422	501	568	180	1463	1572	912	1447
No. of American Coots checked[1]		64		35	54	67	294	189	89
No. of Canada Geese checked							5	3	2
No. of ducks per hunter	2.05	0.58	0.78	0.97	0.42	1.59	1.10	0.59	1.21
	Number of ducks bagged and checked, by species								
Mallard	74	53	89	155	57	492	478	294	322
Black Duck	148	49	136	163	55	386	420	94	160
Gadwall				5		32	9	10	12
Pintail	10	2	8	22	1	48	34	22	68
Green-winged Teal	33	148	104	100	8	265	116	125	333
Blue-winged Teal	79	125	91	64	24	130	348	172	192
American Widgeon		1	17	10	3	15	28	53	35
Shoveler		2				3	3	6	5
Wood Duck		17	3	5		6	20	9	22
Redhead			9	6	7	21	17	9	34
Ring-necked Duck		9	10	9	7	13	33	11	144
Canvasback				1		2		1	
Scaups		2	11	12	3	29	14	35	41
Common Goldeneye		2							3
Bufflehead					1	1	3	2	3
Mergansers		4	10	3	3	14	15	4	29
Ruddy Duck		8	13	13	11	6	34	65	44
Total	344	422	501	568	180	1463	1572	912	1447

[1]Reporting of coots checked has been inconsistent.

winged teal are the principal species taken, and make up more than 80% of the late season kill.

Species composition of total kill in 1960 and 1961 was more similar to what within the Mississippi Flyway than that within the Atlantic Flyway.

WATERFOWL MANAGEMENT AT LUTHER MARSH

Certain waterfowl management measures based on the results of investigations have been carried out at Luther Marsh by the Ontario Department of Lands and Forests.

In 1954, an 800-acre Crown Game Preserve was established at the north end of the marsh, in order to provide sanctuary and to induce waterfowl to remain at Luther Marsh throughout the fall. It has been successful.

Moonlight shooting on opening day in 1955 led to a departure from the traditional opening time of a half-hour before sunrise, both at Luther Marsh and through much of southern Ontario. Several different opening day hours were tried, and for the last four years, shooting has commenced at noon on opening day.

In 1960, the Grand Valley Conservation Authority purchased 300 acres of land within the Crown Game Preserve which has been turned over to the Department of Lands and Forests for management. Part of this land was planted to grain crops for duck food in 1961. The crops were not used by ducks, even though there is extensive field-feeding by mallards and black ducks in agricultural areas within five miles of the marsh.

The Department of Lands and Forests established a feeding refuge at the south end of Luther Marsh in 1961. This feeding area attracted ducks, mostly mallards and black ducks. There is little evidence that it affected the kill, because the total kill of all species increased by 39% in 1961, while that of mallard and black duck increased only 18% and 21% respectively.

This has been the record of waterfowl management activities at Luther Marsh to date. It is obvious that there are many opportunities for research and management at Luther Marsh.

SUMMARY

1. The 4500-acre Luther Marsh impoundment was established in 1952 at a cost of less than a quarter million dollars.
2. Eleven species of ducks nest at Luther Marsh, including eight which pioneered between 1952 and 1960. Western species are strongly represented.
3. The estimated nesting population in 1961 was 700 or more pairs.

Blue-winged teal, mallard, ring-necked duck, redhead, and black duck were the most abundant nesting species in 1961.

4. Luther Marsh sustained between 15,000 and 25,000 hours of hunting in 1960 and 1961. Mallard, black duck, green-winged teal, blue-winged teal, scaups and ring-necked duck are the principal species bagged.

5. Little waterfowl management has been done at Luther Marsh to date.

ACKNOWLEDGMENTS

The authors wish to express their sincere thanks to W. A. Creighton and M. R. Wolfe, who assisted in field work in 1961; to E. R. Meadows and the dozens of officers of the Department of Lands and Forests, along with students and staff of the Ontario Agricultural College, who have taken part in bag check studies through the years; and to Antoon de Vos for reviewing the manuscript. The hard work, records and advice of these men has been of great assistance in preparing this paper.

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DISCUSSION

MR. ANTOON DEVOS [Ontario Agricultural College]: I would like to ask Mr. Palmer whether we could get some more information about field feeding and also about his artificial feeding that he referred to in the southern part of the marsh.

MR. PALMER: Artificial feeding in the southern part of the marsh was undertaken by the Department of Lands and Forests. They have that data. I haven't seen it at present.

As part of my own thesis work, I am doing studies of the field feeding at Luther Marsh. In the past year of 1961, between 5,000 and 10,000 birds were field feeding at Luther Marsh over an area of approximately 100 square miles. Most of the feeding occurred within five miles of the marsh and was well scattered. This might be of interest to some of our friends in the western provinces. There were very few damage complaints by farmers of waterfowl depredations. Black ducks and mallards account for 90 percent of the field-feeding birds.

DISCUSSION LEADER PAYNTER: Mr. Palmer, I am wondering how widespread developments such as this are in your Province.

MR. PALMER: There are three other impoundments within a fifty-mile radius of Luther that I can think of offhand, none of which, to my knowledge, has been studied extensively. But, for various reasons, usually due to their physical structure or to the fact that the water level is controlled entirely for the purpose of regulating stream flows and with no thought to waterfowl, these areas are not used highly as breeding areas or as gathering areas in the fall.

MANAGED GOOSE HUNTING AT HORICON MARSH

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In recent years, goose hunting activities on and in the vicinity of the Horicon National Wildlife Refuge, located in southeastern Wisconsin, have attracted the attention of hunters, wildlife managers and conservationists. The principal objective of this paper is to trace developments in goose hunting at Horicon Marsh and review some of the management practices involved. In describing developments, we will concentrate on two aspects, (1) hunting opportunities and (2) goose harvest.

As a state agency, the Wisconsin Conservation Department has the basic obligation of providing an adequate and flexible system for the protection, development and use of the outdoor resources of the state. With respect to the Canada goose (*Branta canadensis interior*) resource, the challenge to meet this obligation has increased in magnitude during the last 10 years. Canada geese have always been a much sought-after species and a highly-prized game bird. The species has

[1]Formerly Wisconsin Waterfowl Research Project Leader stationed at Horicon from 1950 through 1959.

always been a common spring and fall migrant. Its relative unimportance, prior to 1950, was due to the limited numbers attracted to refuge areas during hunting seasons. At the time of their publication, "Canada Geese of the Mississippi Flyway," Hanson and Smith (1950) considered only two fall concentration sites of importance in Wisconsin, (1) the Rock Prairie Refuge in the extreme south-central area and (2) the Greenwood Farms Refuge in the central area. While several thousand geese used these state-controlled refuges each fall, hunters harvested only a few hundred birds at each area. The Horicon National Wildlife Refuge, which was established in 1940, was not mentioned. Rapid development of the Horicon Refuge as a fall goose concentration site in 1949 resulted in the Wisconsin Conservation Department taking greater interest in goose management and research.

DESCRIPTION OF AREA

Horicon Marsh lies immediately north of the City of Horicon in Dodge and Fond du Lac counties. The marsh is 14 miles long, averages 3.5 miles in width, and totals 31,653 acres. As the goose flies, it is approximately 800 miles south of the breeding range along the Hudson Bay coast and about 475 miles due north of the principle winter range in the Horseshoe Lake, Illinois area. The southern one-third (10,857 acres) of Horicon Marsh is state-owned and serves primarily as a public hunting and fishing grounds. The northern two-thirds (20,796 acres) is federally owned and is known as the Horicon National Wildlife Refuge. Because of high public use of the state-owned portion and the emphasis on duck management, relatively few geese concentrate there in fall. This paper deals with fall populations of Canada geese on the federally owned portion, unless otherwise specified.

Within the federal refuge, approximately two-thirds of the area is covered by 1-2 feet of water and is highly productive aquatic habitat. Emergent aquatic vegetation is dominant, but does not completely cover the flooded area. A variety of management practices are used to maintain or manipulate the aquatic vegetation for duck and coot use, and in some years for muskrat populations. Geese use the aquatic areas for watering, roosting and loafing, and some feeding. Most of the feeding activities are concentrated on the 1,500 acres of agricultural land located along the periphery of the refuge.

Some of Wisconsin's best agricultural lands surround the Marsh. Dairying is the principle form of farming. Hay and corn are the important crops. Canada geese and dairy farming are highly compatible. Geese make feeding flights to farm lands as far as 15 miles from the refuge. Most off-refuge flights are west and north. Contributing importantly to the northern flight pattern is the Thornton Closed Area, a privately developed refuge of about 900 acres located 8 miles northeast of the marsh. In some years, daily feeding flights between the Thornton Area and Horicon Marsh contribute significantly to goose hunting opportunities.

GOOSE POPULATIONS

Basically, the Canada geese using Horicon Marsh are part of the Mississippi Valley population. A major portion of the Canada goose band recoveries occurring at Horicon Marsh are primarily from unpublished Illinois studies conducted on the winter range. A few recoveries also occur from the work at Jack Miner Sanctuary in Kingsville, Ontario, and from the large banding program being carried out at the Swan Lake National Wildlife Refuge in Missouri. Our own banding work in the early 1950s yielded recoveries well within the limits of the Mississippi Valley population (Hanson and Smith, 1950: 76).

Although part of Horicon Marsh was established as a federal refuge in 1940, Canada geese did not start concentrating on the area in large numbers until the late 1940's. A peak fall population of over 10,000 Canadas occurred for the first time in 1949. Almost every year since then has seen a continuing increase, with 1961 being the highest when over 100,000 Canadas used the refuge (Table 1). Increased numbers of Canada geese at Horicon Marsh have resulted from a combination of factors. Development of the refuge has created greatly improved food and water conditions, as well as furnishing protection to the birds. Refuge farming operations have stressed increasing acreages of alfalfa and fall-planted greens for browse and increasing corn acreages and yields. Other important factors include: (1) a greater availability of geese due to the increased flyway populations, (2) manipulation of

TABLE 1. FALL CANADA GOOSE POPULATION DATA
HORICON NATIONAL WILDLIFE REFUGE 1949–1961

Year	Date Geese Arrived	Number Geese Oct. 1	Opening of Goose Hunting: Date	Opening of Goose Hunting: No. Geese	Peak Goose Pop.: Date	Peak Goose Pop.: Number	Close of Goose Hunting: Date	Close of Goose Hunting: No. Geese	Average Fall Goose Population[1]
1949	Sept. 12	1,600	Oct. 14	3,900	Nov. 1	12,000	Nov. 22	100	5,600
1950	Sept. 22	1,000	Oct. 14	8,000	Nov. 14	20,500	Nov. 16	20,000	12,100
1951	Sept. 18	5,000	Oct. 13	12,500	Oct. 25	24,000	Nov. 25	1,000	12,000
1952	Sept. 18	4,000	Oct. 4	5,000	Oct. 21	17,500	Nov. 27	13,000	14,000
1953	Sept. 16	3,000	Oct. 3	3,000	Nov. 1	30,000	Nov. 26	15,000	21,500
1954	Sept. 16	5,000	Oct. 2	5,000	Nov. 3	47,000	Nov. 25	30,000	37,800
1955	Sept. 15	20,000	Oct. 1	20,000	Nov. 1	31,200	Dec. 9	1,000	23,400
1956	Sept. 16	3,000	Oct. 1	3,000	Oct. 31	67,300	Dec. 9	1,000	40,200
1957	Sept. 20	5,000	Oct. 15	32,000	Oct. 21	37,400	Dec. 9	700	22,900
1958	Sept. 16	4,000	Oct. 15	47,100	Oct. 20	50,300	Nov. 16	28,000	48,200
1959	Sept. 15	14,200	Oct. 15	75,000	Oct. 15	75,000	Dec. 2	6,000	47,500
1960	Sept. 12	12,000	Oct. 7	40,000	Nov. 2	73,300	Oct. 16	70,000	62,300
1961	Sept. 12	41,000	Oct. 7	57,000	Nov. 1	100,200	Oct. 25	92,000	83,500

[1]The average number of Canada geese present between October 10 and November 15.

hunting regulations to permit an early build-up of fall goose-use on the refuge and surrounding areas and (3) gradual changes in farming operations on private lands around the refuge aimed at providing feeding areas to attract geese.

DEVELOPMENT OF GOOSE HUNTING

Goose hunting interest began to develop in the years immediately after World War II, when a few thousand geese started using the refuge each fall. Road-side hunter checks were established in 1949 and continued through 1952. During that period, free-lance goose hunting was largely eliminated. Peripheral farms offering good hunting were leased, and daily fee shooting developed on many other farms. Establishing the actual status of hunting privileges (*i.e.*, lease, daily fee, hunting by permission, etc.) was complicated by lack of any licensing system or special regulation of such hunting areas. By 1952 many hunters had only two places to hunt geese. They either stood on the roads or railroad tracks around the refuge, or they hunted along the south boundary of the refuge on the state-owned portion of the marsh. Under such conditions, poor sportsmanship, wild shooting, high crippling loss, and trespassing on private or refuge lands were common occurrences.

In recognizing the need for improving the goose hunting situation at Horicon Marsh, the Wisconsin Conservation Department considered the purchase of a strip of land completely around the periphery of the federal refuge. Estimated cost of these farm lands in 1952 was about 1½ million dollars. An expenditure of this magnitude for goose hunting was considered impractical. Nor could such lands be leased at the $0.20 per acre rate the Conservation Department was authorized to pay under its public hunting and fishing grounds program.

Fortunately, federal officials also recognized the need for improving hunting conditions, and in 1953 permitted the state to establish a managed hunting unit along the north and west boundary of the refuge. Since 1953, efforts have been concentrated on developing this unit in the best interest of the hunting public and the geese.

From a physical standpoint, the managed hunting unit in 1953 had 114 blinds in an 8-mile long strip averaging 125 yards in width. Blinds were spaced 125 yards apart. Experience quickly showed that goose hunters need much more space. Hunters in adjoining blinds frequently fired at geese passing between blinds and often claimed any geese knocked down. The 125-yard width for retrieving downed birds also proved inadequate. These conditions led to three changes in 1954: (1) an extension of the managed hunting unit along the entire east boundary, which increased the total length to 17 miles, (2) an increase in maximum width of the hunting unit to 440 yards, and (3) retention of the 114 blinds, with a minimal spacing of 200 yards between blinds. The managed hunting unit now totals 1,485 upland acres, or 7 per cent of the refuge area. While the managed unit has remained essentially constant since 1954, hunting regulations for the area have varied considerably (Table 2). The effects of these regulations on goose hunting opportunities and harvest are considered in the balance of this paper.

TABLE 2. CHRONOLOGY OF GOOSE HUNTING REGULATIONS AT HORICON MARSH 1949–1961[1]

1949–1952	Canada goose hunting developed on private lands surrounding the refuge. Only statewide waterfowl hunting regulations in effect. Leasing and daily fee shooting dominated the area by 1952. Shot size limited to BB and smaller in 1952.
1953	Limited public hunting permitted in state managed hunting unit on periphery of federal refuge. First-come, first-serve system used for 114 blinds on a 8-mile strip 125 yards wide. Blinds 125 yards apart; limit of 3 hunters per blind; blinds refilled at any time; $1.00 hunter fee. Season limit of two Canada geese per hunter for the managed unit. No dogs allowed; duck hunting permitted.
1954	Managed hunting unit increased to 17 miles in length, 440 yards in width and blinds were spaced 200 yards apart. Guns must be enclosed in case when hunters are not in blind.
1955	Managed hunting unit blinds were closed every Monday of season at request of private-land hunters (only in 1955).
1956	Hunting in managed unit limited to 3 trips per season rather than 2 Canada geese per hunter. Blinds were refilled only during the period from noon to 1:00 p.m. (only in 1956). Duck shooting was prohibited (continuous since 1956).
1957	Opening of waterfowl hunting delayed to October 15 (continuous through 1959). Daily hunting hours curtailed to 2:00 p.m. closing in zone around refuge (continuous, with minor alterations, through 1961). A mail-type blind reservation system was initiated, based on earliest post mark. Fee changed to $3.00 per reservation. Blinds not used by reservations filled from waiting line. Limit of 3 reservations, but no limit on number of trips per hunter if blinds are available.
1958	Reservation system changed to permit random selection of applicants. Limit of one reservation per hunter. Blinds reduced to 110. Goose hunting stopped in 2-county area around Horicon Marsh after 33 days of 70-day season and harvest of 11,500 Canadas.
1959	Daily bag limit reduced in mid-season from 2 Canadas to 1 to reduce goose kill. Goose hunting stopped in 2-county area after 49 days of 70-day season and harvest of 25,000 Canadas.
1960	Kill quota of 7,000 established for Horicon and Necedah refuge areas in Wisconsin. No delayed opening. Blinds reduced to 106. Reservations assigned only through October 31 in anticipation of short season due to quota. Waterfowl hunting eliminated from road and railroad right-of-ways. Daily bag limit set at 1 goose of any species in the managed unit and 2:00 p.m. zone. Daily bag limit set at 1 Canada goose for entire state. Blinds on private lands moved back 75 yards from refuge boundary. Goose hunting stopped in 2-county area after 10 days of 60-day season and harvest of 13,000 Canadas.
1961	Applicants for blind reservation required to possess current hunting license. Kill quota of 10,000 Canada geese set for Horicon marsh area. When total kill reaches 8,500 hunting stops in 2:00 p.m. zone. No delayed opening. Bag limit set at 1 goose of any species in managed hunting unit and 1 Canada goose in the 2-county area surrounding the refuge. Hunting on private lands limited to blinds spaced 200 yard apart, 100 yards from property boundary, and 75 yards from refuge. Hunters limited to three per blind. Hunting stopped in 2:00 p.m. zone after 11 days and a kill of 8,500 Canada geese. Complete closure after 18 days, when total kill reached 11,000.

[1]Regulations continue from year to year unless changes are indicated. Statewide waterfowl regulations prevail unless otherwise indicated.

DISTRIBUTION OF HUNTING OPPORTUNITIES

From 1950 through 1952 estimates of goose hunting trips to the immediate Horicon area increased from 15,900 to 24,300. The estimated Canada goose harvest was 1,800, 2,800 and 2,400 for the respective years in this period. Much of the increase in hunters occurred on roads and railroad track right-of-ways. By 1952, approximately 60 per cent of the hunting trips and 32 per cent of the goose kill occurred in this limited zone, an acreage representing no more than a few per cent of the total hunting territory. Approximately half of the hunting trips were made by hunters living within 10 miles of the marsh. Hunters contacted averaged 0.08 geese per trip, fired 27 shots per goose bagged, averaged 6.5 trips per season, and hunted slightly more than 2 hours per trip.

Canada geese at Horicon are on the wing shortly after daylight and are moving from aquatic roosting sites to feeding areas on and around the refuge. These natural feeding activities, which last for two to three hours in the morning and occur again in the late afternoon, limit the amount of time large numbers of hunters will wait along refuge boundaries for a chance to shoot at geese. When geese establish flight patterns out of the refuge, hunters concentrate along the flight lanes. The harvest is limited by highly competitive shooting and the geese soon learn to confine their movements to the refuge. As a consequence, most goose hunting activities terminate by 9 :00 a.m. in the entire area.

With the establishment of the managed hunting unit on federal lands in 1953, a considerable change occurred in the distribution of hunting pressure along the refuge boundary. From 1953 through 1959, when hunting seasons were unaffected by kill quotas, there was an average of 31,700 hunter trips to the immediate refuge area, and a peak of 55,300 in 1959 (Table 3). The managed hunting unit accounted for 46 per cent of the trips during that 7-year period, and hunters averaged about 5 hours per trip. From 1958 through 1961, hunters averaged 0.52 geese per trip.

It is not our intent to imply that the managed hunting unit is providing one-half of the goose hunting opportunities at Horicon Marsh. In the first few years of its operation, most of the goose hunting occurred on the farms on the immediate periphery of the refuge and the managed unit played a very important role. While hunting pressure on private lands was unaffected for some years, there was a visible reduction in hunter use of the roads and railroad tracks. However, with continuing increase in popularity of goose hunting, hunting pressure increased, and subsequently public hunting had to be regulated by other means. In later years, changes in hunting regulations resulted in more hunting occurring in outlying areas and a shift in hunters to these areas. In terms of the total estimated hunting effort in 1961, the managed unit accounted for a little more than 10 per cent of the hunter trips (C. W. Lemke, personal communication, 1962).

TABLE 3. HORICON MARSH GOOSE HUNTING STATISTICS, 1953-1961

Item	Year 1953	1954	1955	1956	1957	1958	1959	1960	1961
Statewide Season Length (Days)	55	55	70	70	70	70	70	70	60
Days Hunted Horicon Marsh Area	55	55	70	70	56[1]	33[1]	49[1]	10	18
Hunter Trips to Area[2]	28,900	26,400	28,100	34,100	23,900	25,100	55,300	16,900	15,100
Total Harvest in Area[3]	2,000	2,300	6,000	7,400	11,500	16,000	25,000	13,000	13,300
Managed Hunting Unit									
Hunter Trips	16,713	17,685	16,254	11,746	13,318	11,158	15,299	4,921	5,118
Canada Geese Bagged	655	1,115	2,302	2,159	3,308	5,401	8,664	3,002	2,453
Crippling Loss (%)[4]	42	22	23	15	17	18	14	16	14
Geese Per Trip	0.04	0.06	0.14	0.18	0.25	0.48	0.57	0.48	0.61
Hours Per Trip	4.5	4.9	5.4	5.1	5.1	5.3	....	....	....
Shots Per Goose Bagged	40	25	22	13	15	....	....	....	....

[1]Federal regulations permitted a 70-day statewide season. The delayed opening in the Horicon Marsh Area—1959, subtracted 14 days. In 1958 and 1959 the goose season was also closed when a large kill occurred.

[2]Based on car counts around the periphery of the refuge. All yearly totals rounded to the nearest 100.

[3]Includes estimated kill and crippling loss.

[4]Calculated by dividing the number of geese reported knocked down and lost by the sum of the geese bagged and lost.

For several years, we determined the number of individual hunters using the managed unit. This ranged from a low of 7,019 in 1956 to a high of 10,008 in 1958. When considering that Wisconsin averages approximately 100,000 waterfowl hunters, the 1,485-acre managed hunting unit makes a significant contribution by providing goose hunting opportunities for 7.0 to 10.5 per cent of the hunters. Admittedly, opportunities to hunt are limited to one or two trips per year. But we consider the system good for this very reason. Our regulations have been designed to spread hunting opportunities.

In view of the trend toward controlled goose hunting, a brief review is presented of experiences with various regulations used to spread hunting opportunities in the managed hunting unit.

(1) From 1953 through 1955, a season bag limit of 2 Canada geese was in effect. In that period, only 2 per cent of the hunters bagged the limit. This regulation probably would have had a considerably greater effect with higher goose populations and regulations employed since 1957.

(2) In 1956, a 3-trip limit was established as a more equitable means of distributing hunting opportunities. Only 13 per cent of the hunters actually made three trips that year. The 3-trip limit remained in effect in 1957 but was modified to allow more trips per individual if blinds were available. This procedure has been used through 1961. With other changes in obtaining a chance to hunt, hunters making three or more trips decreased to 2 per cent in 1959.

(3) A mail-type reservation system was established in 1957 to replace the first-come, first-served system of obtaining blinds. In 1957 reservations were selected on the basis of earliest postmark. Unequal chances occurred due to variations in time of stamping mail at different classes of post offices. Beginning in 1958, applications were accepted during a specified period and a random selection of applications was made. Unlimited reservation requests were permitted in 1957. In subsequent years only one request was permitted. Until 1961, a reservation could be obtained without possession of a current hunting license. Requiring a person to possess a license before applying for a reservation probably reduced applications received by 35 per cent, from 25,879 in 1960 to 16,731 in 1961. Use of reservations was lowest in 1957, when only 52 per cent were honored. A long hunting season and low goose populations were responsible for the limited use of reservations. Blind reservation use increased after 1957 and reached a high of 92.5 per cent in 1961. The reservation system's major effect was to reduce the number of trips made by hunters of the city of Milwaukee from 45 to 30 per cent and to permit a corresponding increase from other sources. Local hunters were unaffected by the reservation system and continued to

contribute about 8 to 10 per cent of the hunter trips. Apparently a major portion of the local hunters have access to private lands in the area.

(4) Two restrictions considered desirable, but which have been difficult to evaluate, are (1) a ban on duck shooting since 1956 and (2) a daily bag limit of 1 goose, regardless of species, since 1960. In 1955 over 3,700 ducks were killed in the managed unit. Prohibiting duck hunting reduces the amount of shooting and increases turnover of blinds after hunters have killed their geese. In 1959 over 380 blue and snow geese were killed, with some hunters bagging limits of 5 geese. Establishing a 1 goose limit was aimed at preventing hunters from waiting for blue and snow geese after killing their limits of Canadas, and also at distributing the goose harvest among the greatest number of hunters.

Since 1957 the distribution of hunting opportunities outside the managed hunting unit has improved. In 1957 a delayed opening and a 2:00 p.m. closing zone were established for the first time. The delayed opening zone was an area around the marsh that included most of the daily off-refuge feeding flights of geese. The 2:00 p.m. closing zone was smaller in area and was designed to encourage some geese to leave the refuge in the afternoon feeding periods. Early migrant Canada geese arriving at Horicon Marsh readily adapted to the protected area offered, and established extensive feeding flights to the surrounding countryside. Hunters naturally took advantage of the hunting opportunities created by these feeding activities. Estimates indicate that over 3,000 geese were bagged in the first 3 days of hunting in 1957. About one-third of the kill was made by hunters on outlying farms.

While the above techniques were successful in spreading hunters over a bigger area, the increased kill also attracted more goose hunters. Many of these hunters had only roads and railroad tracks from which to shoot at geese. Increasing hunting pressure resulted in poor quality hunting on easily accessible areas. For example, late in the 1959 season, hunters standing almost shoulder to shoulder on a ¼-mile stretch of road along the west boundary bagged 160 and 136 Canada geese on successive days. In 1960, hunting from roads and railroad track right-of-ways was prohibited. Now goose hunting must occur on private lands or in the managed hunting unit.

Where did the hundreds of goose hunters who used the roads and railroad tracks go to hunt geese in 1960? Many were forced to shift to the more outlying areas. Generally, a hunting fee of some sort was charged, but this imposed no great burden. Geese used these areas and hunters were willing to pay for the hunting opportunities. A majority of landowners on the periphery of the refuge also provided more blinds as a result of the road hunting restriction. With the competition that existed for goose hunting space along the refuge, hunters readily made use of these added blinds. To cite an extreme example, on one farm of 140 acres along the eastern edge of the refuge there were 55 blinds, or 1 blind per 2.5 acres. Most of these blinds were used throughout the 1960 season.

The logical solution to discourage crowded conditions was to encourage adequate spacing of blinds on private land. Regulations for this purpose were established in 1961. These regulations immediately reduced daily hunting pressure. For example, in the same length of refuge boundry behind 106 state-operated blinds, private blinds were reduced from 495 to 194, or 61 per cent.

The question of where the evicted hunters on private land hunted in 1961 is also pertinent. We have no data to answer this question. We know from personal contact that the effect of blind spacing in the immediate refuge area was not as great in reducing the number of individuals who hunted as it was in reducing the number of trips per season per hunter.

As yet, there has been no indication that the regulations employed are actually reducing the opportunity to hunt geese. Increasing goose populations, along with changes in regulations, have spread hunting efforts over a much larger area. This greater space has absorbed many hunters who previously used the peripheral areas, both public and private.

HARVEST ASPECTS

One of the principle objectives at Horicon Marsh has been to increase the harvest of Canada geese within the limits of their annual production. In the early 1950's, heavy hunting pressure in the area appeared to be the most important factor holding down the kill. The early October hunting-season openings, daylight-to-dark shooting hours, and the ring of blinds around the marsh quickly confined geese to the refuge. Perhaps of equal importance was the fact that a great many of the hunters had little or no goose hunting experience. Many hunters simply did not know when a goose was in killing range. As a consequence, shooting "too soon" was as common as shooting at geese which were really out of range.

Several techniques for increasing the goose kill became apparent. While there was no way to control shooting by hunters, regulations could be established to permit more access to the geese. Recommendations following the 1954 season were: (1) to delay opening the hunting season until mid-October in a large area around the marsh and (2) to stop hunting at 2:00 p.m. each day within this zone. While these two regulations were not adopted until 1957, they were the two principle techniques which resulted in a significant increase in the harvest.

The geese themselves aided in increasing the kill in 1955 and 1956. Many Canada geese migrated early in 1955, with the result that a natural delayed opening effect occurred. Approximately 20,000 geese were present and feeding in the general refuge area when the hunting season opened on October 1. A large number of geese were bagged in the early part of the season and the total kill increased to 6,000. In 1956 the migration was more on schedule, but the refuge goose population reached a peak of 67,300. Sheer numbers of geese accounted for a continuing increase in the kill.

In 1957, when the delayed opening and 2:00 p.m. daily closing zone were established, the kill increased to 11,500 despite a drop in peak goose numbers to about half the 1956 level. These regulations were used again in 1958 and 1959, but with considerably more geese present than in 1957. In 1958 the kill rose to 16,000 and goose hunting was closed by the Wisconsin Conservation Department after 33 days of a 70-day season. In 1959, the kill increased to 25,000 and hunting was stopped after 49 days of a 70-day season. The important point to note in the years of rapidly increasing kill was the number of geese in the area when the hunting season opened (Table 1). Without constant harassment, near-peak numbers of geese were present and off-refuge feeding flights were well established when the hunting season opened.

Local hunters were, of course, enthused over the increased goose harvest. They were now getting "their fair share of geese." However, criticism developed from some people because they feared a "slaughter" was occurring. The early closing of the hunting seasons in 1958 and 1959 demonstrated the intent of the Wisconsin Conservation Department to protect the goose resource.

As it turned out, the increased kill near Horicon Marsh in 1959 was important to Illinois as well as Wisconsin hunters. For the first time, the Mississippi Valley goose population was being subjected to heavy harvests in two states. Previously, Illinois had taken the major share of the kill, averaging over 30,000 geese for the 10-year period 1950-1959 (Arthur, 1960). Horicon's greatly increased kill caused a decline in the Illinois kill, and the combined harvest from all states resulted in a decline in the annual mid-winter goose inventory to its lowest level since 1952. As a result of these developments, a Canada goose harvest-quota system was established in 1960 through joint efforts of the U. S. Bureau of Sports Fisheries and Wildlife and the states in the upper Mississippi Flyway.

HARVEST QUOTA SYSTEM

Nelson (1961) has presented the most recent review of this important step in species management of waterfowl. The immediate objective of the quota system is to hold the kill on the Mississippi Valley population below the annual reproductive gains. Current thinking is that both the wintering and breeding ranges can support many more geese. Harvesting fewer geese than are produced should permit an increase in the population to take advantage of the carrying capacity of the range. In brief, the system involves (1) determining the age structure of the wintering population, (2) estimating the production gains and mortality, (3) calculating the population available for harvest in the next hunting season, and (4) determining how the harvest will be divided between states. Distribution of the available harvest is worked out to the mutual satisfaction of the Bureau of Sport Fisheries and Wildlife and the states in the upper Mississippi Flyway. Specific quotas have been set only in the major harvest areas in the states of Illinois and Wisconsin.

Establishment of the harvest-quota system created a new challenge at Horicon Marsh. The problems were to decrease the total kill and slow down the daily kill. In 1960 a quota of 7,000 Canada geese was set for two areas in Wisconsin: (1) the Horicon National Wildlife Refuge and (2) the Necedah National Wildlife Refuge, located in the central part of the state.

In view of increasing goose use in the Horicon area, some changes were needed in regulations to decrease the daily kill. With the objective of prolonging the 1960 season, goose hunting was permitted as early as possible and a daily bag limit of 1 goose of any species was established. As it developed, an early migration occurred and over 40,000 geese were in the area on opening day October 7, 1960. Hunters killed geese at a rate of about 1,000 per day. Kill surveys (Lemke, 1960; Green, 1960) revealed the need to stop hunting within a week, but administrative action to close the season required an additional 3 days. Consequently, the season lasted 10 days and the harvest reached 13,000, including crippling loss. Controlling the kill in 1960 was further complicated by the rapidly expanding refuge goose population, which increased from 40,000 to 70,000 during the 10-day period of hunting. An unfortunate result of the rapid kill at Horicon Marsh was the early closing at the Necedah area, where only 300 geese were bagged.

A somewhat similar pattern followed in the 1961 hunting season. The quota was somewhat higher, 12,000 for Wisconsin, of which 10,000 were actually assigned to the Horicon area. Horicon's 10,000 quota was further divided to permit closing the 2:00 p.m. zone after the kill had reached 8,500 in the entire area. The remaining 1,500 geese were allotted to an area outside the 2:00 p.m. zone. Regulations were comparable to 1960, except that (1) daily shooting started at sunrise instead of one-half hour before and (2) blind spacing on private lands was established for the first time. When the hunting season opened on October 7, over 57,000 geese were present and many geese had well developed feeding flights outside the refuge. Despite intensive hunting, the refuge goose population increased to 92,000 by October 15. Containing this large population inside the refuge appears to be impossible. Hunting was over in 11 days in the 2:00 p.m. zone. An additional 7 days were required to take 1,500 geese in outlying areas.

One important objective in the short 1961 season was accomplished. A considerably greater portion of the kill was taken in outlying areas than in any previous year (Table 4). Contributing most importantly to the wider distribution of kill, was the sunrise opening of daily shooting hours. A major part of the geese making morning feeding flights out of the refuge were well beyond the immediate periphery of the refuge when shooting started.

Limitations on hunting imposed by the quota have had some important side effects. Goose-use at Horicon Marsh has developed to the point where the refuge in 1961 held approximately one-half of the entire Mississippi Valley Canada goose population, and two-thirds of the population that eventually reached the Illinois winter range. Much of this increased use is due to the effectiveness of the federal refuge management program. Perhaps of equal importance has been the early and rapid kill that has occurred in the area. Some geese arriving at Horicon Marsh in the latter part of the normal migration period never

TABLE 4. DISTRIBUTION OF CANADA GOOSE HARVEST HORICON MARSH AREA 1953-1961

Item	1953	1954	1955	1956	Year 1957[1]	1958	1959	1960[2]	1961[2]
Number of Geese Bagged[3]	1,211	1,862	5,072	6,237	9,503	13,746	22,035	10,900	11,141
Percentage Distribution of Total Bag									
Managed Hunting Unit	50	60	45	33	35	39	33	28	22
Peripheral Farms[4]	42	35	53	65	63	59	33	48	24
Outlying Areas							33	21	49
State End of Horicon Marsh	8	5	2	2	2	2	1	3	5
Total in 2:00 p.m. Zone[5]							66	76	46

[1]Established 2:00 p.m. closing zone around Horicon Marsh and continued it through 1961.
[2]Established harvest quotas of 7,000 Canada geese in 1960 and 10,000 in 1961.
[3]Excludes crippling loss.
[4]Includes percentages in outlying areas for years 1953 through 1958.
[5]Data from unpublished report on "1961 Goose Harvest, Horicon National Wildlife Refuge," by W. F. Green.

were subjected to hunting. In the absence of continuous shooting and an abundance of food and water, migration from Horicon Marsh was delayed. Consequently, fewer geese were present in Illinois, where hunting pressure declined in both 1960 and 1961. Whether or not additional goose-use should be encouraged at Horicon Marsh is a question needing carefully study.

FUTURE MANAGEMENT

In our estimation, Canada goose harvest quotas should be a continuing practice. No better method is known to help maintain both satisfactory goose hunting and an optimum-sized Mississippi Valley Canada goose population. Management and hunting regulations should be aimed not only at spreading the available kill among as many hunters as possible, but also at providing the maximum hunting opportunities. Since the 1962 mid-winter inventory revealed no increase in Canada geese, despite restrictive quotas in Illinois and Wisconsin, another very limited harvest appears necessary. As yet, regulations have not been established for 1962. However, the main concern will be to design regulations to prolong hunting opportunities. Three other regulations should be considered:

1. A compulsory form of goose-hunter and goose-kill registration.
2. A season bag limit of 4 or 5 Canada geese.
3. A shell limit for individual hunters in the managed hunting unit.

To some people, our use of the terms "managed" and "hunting" are probably misnomers. We frankly admit that goose "shooting" is a more descriptive term. We also admit that much of the hunting is not of high quality. However, by standards in other goose hunting areas, management of hunters and control of harvest are considered good. Distribution of hunting effort and harvest are also good. While the quality of goose hunting in the vicinity of Horicon Marsh is not ideal, it is considerably better than it would be if only statewide waterfowl regulations applied.

The unfortunate part of the goose hunting picture in the past few years is that too much emphasis has been placed on the actual killing of geese and not enough on the opportunity to hunt geese. The bird is no longer considered a trophy by many hunters. Possibly too many geese have been attracted to Horicon Marsh, especially during the past few years. Hunting regulations have also made it too easy to bag geese. Changing the major emphasis from killing geese to that of increasing opportunities to hunt geese is now the foremost challenge.

ACKNOWLEDGMENTS

Many individuals of the Wisconsin Conservation Department and the U. S. Bureau of Sport Fisheries and Wildlife contributed to the development and improvement of goose hunting at Horicon Marsh. We are particularly indebted to Lloyd Gunther, Robert F. Russell and Lester H. Dundas, who were refuge managers at the Horicon National Wildlife Refuge from 1950 through 1961.

A note of special appreciation is due Wisconsin sportsmen for their support and cooperation in the goose hunting program. They are to be commended for their acceptance of the restrictions on Canada goose hunting imposed by harvest quotas. They have helped advance an essential part of a basic goose management program.

SUMMARY

This paper traces developments in goose hunting opportunities and regulation of goose harvest in the vicinity of the Horicon National Wildlife Refuge from 1949 through 1961. Peak Canada goose populations on the refuge increased in that period from 12,000 in 1949 to 100,000 in 1961. Basically the Canada geese using Horicon Marsh are part of the Mississippi Valley population.

By 1952, 60 per cent of the hunter trips and 32 per cent of the goose kill occurred on the limited space provided by roads and railroad right-of-ways. Hunters averaged 6.5 trips per year, 2 hours per trip, 0.08 geese per trip, and fired 27 shots per goose bagged.

In 1953 a state-operated managed hunting unit was established on the periphery of the federal refuge to improve the distribution of hunting opportunities. From 1953 through 1959 the managed unit accounted for 46 per cent of the hunter trips to the area. From 1958 through 1961 hunters in the managed unit averaged 0.52 geese per trip. Regulations used to increase hunting opportunities in the managed unit included (1) a season bag limit of 2 Canada geese (1953-55), (2) a season limit of 3 trips per hunter, (3) a mail-type reservation system, and (4) restricting the daily bag limit to 1 goose of any species (1960-61).

Regulations to improve hunting conditions on private lands around the refuge included (1) prohibiting hunting on roads and railroad tracks, (2) moving blinds 75 yards back from the refuge boundary, and (3) requiring a 200-yard spacing of blinds on private lands.

Two regulations were very effective in increasing the goose harvest at Horicon Marsh in the years 1957 through 1959: (1) a delayed opening to mid-October, and (2) a 2:00 p.m. daily closing in a zone around the refuge.

As a result of the increased harvest at Horicon Marsh and a continuing heavy kill in Illinois, a Canada goose harvest-quota system was developed in 1960. In both 1960 and 1961, the quota was instrumental in preventing excessive harvests of the Mississippi Valley Canada

goose population in Wisconsin and Illinois. In the future, regulations in Wisconsin will have to be designed to contain the allowable kill within quota limits and at the same time provide maximum hunting opportunities.

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DISCUSSION

DISCUSSION LEADER PAYNTER: We have just heard from Dick Hunt how they hunt geese at Horicon.

MR. H. M. WEANER [Retired from the Forest Service]: Will you tell us of the development of the refuge from the time the farmers own it and the time they drain it and before the drainage was put in some years ago? How does he develop the refuge up to this extent?

MR. HUNT: I think that this subject is probably worthy of a paper in itself because there have been so many developments. The State Conservation Department, operates the goose hunting program, but doesn't do any other work there at all. Land management is solely a function of the Federal program and we consider ourselves fortunate that this is the case. Primarily the work that has been done has been directed at improving the feed program on the refuge. They have about 1,500 acres of farm land, and this has been managed primarily for alfalfa browse, winter wheat, and other greens and improving the corn acreage and yield on the refuge. So out of the 1,500 acres used for farm land and which the geese use primarily, there are perhaps 600 acres of corn.

MR. HAROLD EDWARDS [Nebraska Game Commission]: Do you have any figures on crippling loss in relation to the total kill, in relation to the blinds and also to the refuge?

MR. HUNT: We have expressed the crippling losses based on what the hunter reports to us. This has changed considerably in the past few years. In 1953, we had reports of a crippling loss of 40 percent, and we only harvested 655 birds. In the last few years, the reported crippling loss has dropped to about 14 or 15 percent. We made some observations in the field to check this because there are so many geese in our area. A hunter may shoot one goose and cripple it, but we like to have them expressed as birds knocked down. If he doesn't watch this bird, it may still sail out to the marsh and fall. There are so many birds moving around that he may take a shot, not get it down, and forget to watch the bird. So the crippling loss is probably in the neighborhood of 20 to 25 percent.

BIOLOGICAL CONTROLS FOR WATERWEEDS

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Many waterweeds and certain species of filamentous algae are of major concern to landowners who manage ponds for fish and wildlife. These plants are troublesome because they interfere with fishing, limit the better foods of fish and wild ducks, and cause unbalanced fish populations by providing hiding places for too many small fish.

Animals have been successfully used in other parts of the world to control waterweeds. Allsopp (1960) reports manatees successfully cleared weeds in a canal. Van der Lingen (1960) reported aquatic weeds controlled by *Tilapia* and by Pekin and Rouen ducks.

All farm ponds contain species of single-celled algae. The microscopic algae are desirable, but the stringy filamentous kinds are not.

Single-filament algae such as *Spirogyra* grow principally during the cool and colder seasons of the year. This type of algae presents no serious problem unless barnyard manure, hay, tree leaves, or other decaying organic matter is decomposing in the water (Davison, Lawrence and Compton, 1962).

The two more troublesome algae, *Pithophora* and *Cladophora*, have branched filaments. Their branched filaments are seen easily when viewed under magnification. When masses of these algae are squeezed dry, they form wads like wet cotton. Both grow principally in summer. *Pithophora* grows in fresh-water ponds. *Cladophora* competes with widgeongrass, *Ruppia maritima*, in brackish water duck ponds. There is no satisfactory chemical control for either.

PITHOPHORA

When *Pithophora* invades a pond, the water becomes clear because of competition with the phytoplankton for plant nutrients. Fertilization of the pond only hastens the growth. The algae forms a thick blanket across the pond bottom which interferes with bluegill feeding and fishing. Fish production may be reduced 50 per cent. Masses of *Pithophora* also break loose and float to the surface, forming a heavy scum that makes fishing difficult. Even if suitable chemicals were available, treatment would be complicated by the summer stratifaction of water in the pond. Swingle (1957) reported the possibilities of biological control of *Pithophora* by means of the Israeli strain of mirror carp, *Cyprinus carpio.*

From 1957 to 1961 field trials were conducted in Georgia and Arkansas to determine the suitability of Israeli carp to control *Pithophora* in heavily infested ponds. With Swingle's cooperation enough carp were obtained to stock the ponds reported here.

Israeli carp were stocked in infested ponds at rates of 55, 61, 64, 100, and 102 per acre. Fish used ranged in size from 2 inches to 14 inches. Periodic checks were made to determine growth rate of fish and the extent to which the algae had either increased or decreased. Table 1 shows the different stocking rates, the original, and final conditions.

Good results in reducing or eliminating *Pithophora* were obtained in six of the seven field trials. The Israel pond had more branched algae than any other observed. The infestation was reduced by 50 per cent at one time. Removal of the carp in the pond by fishing and natural losses apparently reduced the number of fish below that necessary to eliminate the algae.

All ponds, except those at Fish Lake Farms, contained other fish,

TABLE 1. STOCKING RATES, SIZE OF FISH, ORIGINAL AND FINAL CONDITION OF ALGAE

Pond	Size (Acres)	Stocking Rate per Acre	Size of Fish (Inches)	Date Original Condition	Date Condition at End of Field Trial
Stone Pond Warren County, Georgia	3	110	3 to 4	12-17-57 Bottom—90% covered. Surface—60% covered.	9-26-58 Bottom—No algae present. Surface—No algae present.
Israel Pond Calhoun County, Georgia	1	100	3 to 4	12-17-57 Bottom—90% covered. Surface—70% covered.	9-3-59 Bottom—80% covered. Surface—50% covered.
Weems Pond Whitfield County, Georgia	3	100	4 to 6	4-2-59 Bottom—90% covered. Surface—65% covered.	7-8-60 Bottom—5% covered. Surface—1% covered.
Lake Frances, Whitfield County, Georgia	1½	75 25	2 to 6 6 to 12	7-6-59 Bottom—90% covered. Surface—25% covered.	7-8-60 Bottom—5% covered. Surface—1% covered.
Fish Lake Farms, Jefferson County, Arkansas	Two ⅛-Acre Ponds	64	14	June 1960 Bottom—100% covered. Surface—85% covered.	July 1961 Bottom—No algae present. Surface—No algae present.
McGraw Canal, Lincoln County, Arkansas	3	46 15	2 to 4 8	1-28-60 Bottom—80% covered. Surface—70% covered.	7- -61 Bottom—No algae present. Surface—No algae present.
Lovett Canal, Lincoln County, Arkansas	3	40 15	5 8	1-28-60 Bottom—85% covered. Surface—65% covered.	7- -61 Bottom—2% covered. Surface—1% covered.

principally largemouth bass, *Micropterus salmoides,* and bluegills, *Lepomis macrochirus.* Spawning of Israeli carp was not observed in ponds having bass-bluegill populations. A high percentage of loss of the carp was noted where 12 inch or larger bass were present and the carp stocked were less than 5 inches. In one pond the loss was 75 per cent of the original stocking.

On the basis of our experience, we are now recommending a stocking of 5 to 6 inch Israeli carp at the rate of 50 per acre where *Pithophora* is a pest and bass are present. Where the infestation is especially heavy or fast reduction of the algae is desired more fish per acre will be recommended. Field observations indicate that the larger the fish the faster the reduction.

No recurrence of *Pithophora* was noted in the Stone Pond two years after it was drained and restocked with bass and bluegills.

Numerous obeservations were made of the carp actually eating the algae. Examination of 10 stomachs was made. Each stomach was full of algae. We conclude, therefore, that the principal reduction of the plant is by eating. Carp, in feeding along the bottom, also stir up enough sediment to reduce favorable growing conditions for the algae.

CLADOPHORA

A good use for brackish marshes in coastal sections is to dike them into ponds and grow widgeongrass as food for wild ducks. However, some of these widgeongrass ponds become infested with *Cladophora.* This algae drapes the widgeongrass heavily, either smothering it out or making it unattractive to ducks. Floating masses of *Cladophora* may cover large portions of the ponds.

The Soil Conservation Service began field trials in 1955 in coastal South Carolina to determine (1) a method for controlling *Cladophora* and (2) the reason why *Cladophora* appears in some widgeongrass ponds and not in others, even when ponds are adjacent.

Brays Island Plantation provided a good location for beginning the trials. This plantation had three widgeongrass ponds which had not been bothered with *Cladophora* the first five years. Then suddenly, they became infested with this algae and were seldom used by ducks. Previously these ponds had good stands of widgeongrass, and were used heavily by wild ducks. Pond 1 ("House Pond") and Pond 2 ("Shop Pond") presented a sanitation problem because of the foul odor of decaying masses of *Cladophora* near the dwellings. Pond 1 was 27 acres, Pond 2 was 14 acres, and Pond 3 was 18 acres in size.

The first attempt to reduce or eliminate the algae was by drying. The ponds were drained the summer of 1955. They were refilled in early fall and a fair stand of widgeongrass developed before the open duck season, with little *Cladophora.* It was realized from the outset that this type of management could not be continued over a period of years without exhausting the residual supply of widgeongrass seed. Drying only temporarily diminished the *Cladophora* and it was back as heavy as ever the next spring.

A lead on *Cladophora* control was suggested when the manager of Good Hope Plantation, Ridgeland, South Carolina, requested information on how to kill mullet, *Mugil cephalus,* in his widgeongrass ponds. He thought that the many large mullet in the ponds might be interfering with the growth of widgeongrass. These widgeongrass ponds were among the oldest in the State (built in 1931) and yet they had never had *Cladophora.* Could the mullet be the answer?

Queries at Brays Island Plantation revealed that the widgeongrass ponds there had mullet in them up to the year before the *Cladophora* appeared. An airplane spraying with DDT for mosquito control had killed all the mullet and other fish in the ponds.

Visits were made to several widgeongrass ponds with and without *Cladophora* infestations. By watching for the jumping and schooling of mullet near the surface, it is relatively easy to determine whether this fish is in a pond in any appreciable numbers. Mullet were detected in the ponds with little or no *Cladophora.* No mullet were seen in the infested ponds.

It then remained to demonstrate the control of *Cladophora* by mullet. For these trials, mullet were introduced into Brays Island Ponds 1 and 2 during June 1958 from brackish water creeks adjacent to the ponds via the connecting water control structures. Pond 3 was left without mullet as a control.

The ponds were examined two months later. Although there were many floating masses of *Cladophora* in the stocked ponds, the infestation was less than in previous years. By November 1958, the *Cladophora* had almost disappeared. The previous November there had been almost complete coverage of the ponds with floating masses of algae. On February 12, 1959, no *Cladophora* was seen in Ponds 1 and 2 and they were being used regularly by wild ducks. The mullet were about 10 inches in length at that time.

The control pond (Pond 3) remained infested with *Cladophora.* It was, of course, a failure as a wild duck pond during the 1958-59 season.

Field observations and examination of stomach contents of mullet indicate that reduction of the algae is accomplished by eating. The number of mullet per acre required to control *Cladophora* is unknown. However, since fingerlings are naturally available in adjacent waters, most widgeongrass ponds can be stocked by manipulating the water to let in more mullet.

DUCKWEEDS

The surface of some freshwater ponds becomes covered with duckweeds *Lemna, Wolffia,* and *Spirodela* which are detrimental to fish and fishing. These misnamed weeds are not important duck foods—except for wood ducks (Davison and Neely 1959).

Phytoplankton growth is seriously inhibited by the shading effect of these floating plants. Fertilization of such ponds only encourages further growth of the duckweeds.

Duckweeds usually grow in ponds that are in some way protected from prevailing winds. The protection may be from cliffs, embankments, trees, brush, or shrubs surrounding the pond; from large amounts of floating debris; or from submersed waterweeds. If these obstructions are removed, either in whole or in part, wind usually solves the problem by blowing the duckweeds onto the shore, where they die. Chemical and mechanical controls of duckweeds have not been generally successful.

Wild ducks occasionally eat duckweeds. We have no evidence that wild ducks have reduced or eliminated these tiny floating plants. Tame Muscovy ducks were observed eating duckweeds in Georgia in 1956. This species was therefore used in field trials to determine: (1) if reduction could be effected; (2) the number of ducks needed per acre; and (3) length of time necessary to eliminate the weed. Results of treatment are outlined in Table 2.

TABLE 2. RESULTS OF MUSCOVY DUCK TRIALS TO CONTROL DUCKWEEDS IN GEORGIA

Pond	Ducks Stocked	Number	Percentage of Surface Orig. Covered by Duckweed	Per Cent Reduction of Duckweed and Date
Garvin, Bulloch County ¾ Acre	June 1, 1958 June 20, 1958 Aug. 15, 1958	2 2 12 (ducklings)	90	100 April 14, 1959
Broxton, Coffee County 1 Acre	Sept. 13, 1956	6	85-90	100 August 9, 1957
Sellers, Jeff Davis County 1 Acre	July 19, 1959 Sept. 1, 1959 Sept. 10, 1959	3 14 10	95-100	100 October 1, 1959
Gin, Stewart County 3 Acres	Jan. 29, 1959	8	95	60 April 8, 1960

Note that on the 3-acre Gin Pond, 8 ducks gave only partial control. As a result of these field trials, six or more Muscovy ducks per acre are recommended. The more per acre, the quicker the control. Other species of ducks have not been tried.

This technique works best on ponds located near human habitation, where predation is not serious. In all cases, to reduce losses from predation, it is recommended that a platform be erected over the water, with the top slightly above the normal water level. For several days after the ducks are placed on the pond, feed should be put on the platform so the ducks will learn to use it.

SUBMERSED WATERWEEDS

Swingle and Smith (1947) demonstrated the practical eradication of submersed aquatic weeds by enveloping them with filamentous algae, produced by heavy applications of fertilizer in January and February. H. R. Bissland, Soil Conservation Service Biologist, (unpublished report) has shown that in the warmer waters of central Florida and southward, submersed pondweeds can be controlled by year-around fertilization. Cold-water overflow systems designed by the Soil Conservation Service now make both summer and winter fertilization more practical in control of weeds. The systems take cold water from the bottom of ponds and pass it through the dam and downstream, resulting in warmer water in the spring and fall. Controlling submersed vegetation by fertilization is not effective in ponds having extensive shallow water—less than 18 inches in depth.

SUMMARY

Two genera of algae often are serious problems in Southeastern ponds. *Pithophora* grows in freshwater fish ponds, and *Cladophora* in brackish-water duck ponds. No suitable chemical has been found to control either one.

Field trials in Georgia and Arkansas confirm research at Auburn, Alabama, that it is practical to establish effective biological reduction of *Pithophora* in bass-bluegill ponds by using Israeli carp. It was necessary to stock with 5- to 6-inch fish, rather than smaller fingerlings, to prevent largemouth bass from depleting the stocking. Indications are that 50 carp per acre is sufficient.

Field trials in coastal South Carolina proved that *Cladophora* can be effectively controlled in widgeongrass duck ponds by introducing mullet. Stocking is accomplished by opening the control gates to take water into the ponds on high tides, at seasons when schools of fingerling mullet are observed in adjacent creeks. The fingerling mullet thus come in with the water. The rate of stocking is not known.

Duckweeds occur in farm ponds that are protected too well from wind and wave action. Chemical and mechanical control measures are but temporarily effective. It was found that six or more Muscovy ducks per acre will control duckweeds in ponds. A method of protecting these ducks from predation is described.

Adequate winter and summer fertilization will control submersed waterweeds in ponds not having extensive shallow edges.

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DISCUSSION

DISCUSSION LEADER PAYNTER: I think the men who got out these studies certainly have a lot of credit coming to them. Nowadays, it seems that we have to use the insecticides or herbicides to do everything, and I am wondering, in view of the bad grasshopper problem that we anticipate in Saskatchewan this summer, if you boys can dig me up a flying fish to handle it.

MR. DAVE HOOPER [Iowa State University]: Once the *Pithophora* is controlled, what do you do with the carp? Do they create any problem? Are people happy to have them down there?

DR. GRIZZEL: You can do several things. We drained one of the ponds and restocked it with bass and bluegills and did not get a reinfestation of the *Pithophora* for two years. The fishermen were very happy with the Israeli carp. They grow very fast. I was astounded at their rate of growth; in some cases, a pound a month. In that case, they stocked rather lightly, but it shows the potential growth of these fish. We have found that they are very good to eat and that a lot of people enjoy them. The rib case is especially good. If you know how to filet them, they make a delicious meal.

MR. VERNE DAVISON: Roy, you should remind them that bass and bluegills will control the water so that carp will not reproduce and we do not have them in sufficient numbers to muddy the water. So there is really no difficulty in these types of ponds.

MR. GRIZZELL: Yes, that is certainly true. The only case we have had of spawning was where we put in a half a dozen adults in very fresh water like we do the buffalo to get them to spawn. Where the bass and bluegills were present, they did not spawn, and where the other species were well situated the carp did not spawn either.

I might mention that I recently observed some irrigation canals in Arkansas in which Israeli carp had done a 100 percent job of controlling *Pithophora* and *Chara*, and the water was not muddy. It had a pretty good bloom on it and you could see them swimming around in there. The Israeli carp does not cause the muddy type of disturbance, since they don't disturb the bottom to the extent that the German carp does.

A QUANTITATIVE STUDY OF THE NUTRIENT CONTENT OF FOOD REMOVED FROM THE CROPS OF WILD MALLARDS IN LOUISIANA[1]

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Although a large amount of information is available on foods eaten by wild waterfowl, little is known concerning the nutritional requirements of these birds or the nutrient composition of their foods. Also, little is known regarding the physical and physiological condition of birds on the wintering grounds prior to their spring migration. Since physical condition may influence their reproductive potential, the nutrition which they receive during the winter and prior to the breeding season may be a critical factor affecting productivity and, thus indirectly, the size of the fall flight of waterfowl.

The objectives of the present study were: (1) to determine the nutrient content of food removed from the crops of wild mallards (*Anas platyrhynchos*) by proximate analyses, (2) to identify these foods, (3) to compare the results of the nutrient analyses with the dietary recommendations for semi-domestic ducks and (4) to determine the condition of ducks from which crops were removed by checking the amount of fat in the body cavity.

LOCATION AND DESCRIPTION OF COLLECTION AREA

Mallard crops were collected from the Prairie Marshes of Southwest Louisiana. These marshes are quite different from the delta and subdelta marshes which lie to the east in that they are older geologically and therefore slightly higher and much firmer. In general, the prairie marshes support higher plant types that include several grasses.

The area can be divided into three major marsh types: (1) Salt marshes parallel the coast line and extend inward three to five miles, depending on tidal action. They support a salt marsh grass-wiregrass (*Distichlis-Spartina*) type. (2) Brackish marshes occupy a zone two to three miles in width and extend inward to the nearest stranded beach ridges. Wire grasses and three corner grasses (*Scirpus*) are predominate. A transition zone occurs near the ridges and contains cutgrass (*Zizaniopsis*), millets (*Echinochloa*) and arrowhead (*Sagittaria*). (3) Fresh marshes lie between the ridges and high ground. They support many grasses such as millets, paspalums, panicums, sprangletop (*Leptochloa*) and bagscale grass (*Sacciolepis*).

[1]A contribution of Louisiana State University and The Louisiana Wildlife and Fisheries Commission.
[2]Graduate Student, School of Forestry and Wildlife Management.
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[4]Associate Professor Game Management, School of Forestry and Wildlife Management.

Collections were made in the fall of 1961 at Creole, Pecan Island and Gueydan. Creole represented a salty to fresh area, Pecan Island a brackish to fresh area and Gueydan a fresh marsh area.

STUDY METHODS

Field Procedure

Duck crops were obtained through the cooperation of biologists, hunters, and professional duck pickers. Professional duck pickers were the greatest source of crops.

Cooperators were supplied with envelopes that were labelled as follows: species of duck, sex, date, location shot, collector and condition of duck (rated as good, fair or poor, according to the amount of fat observed). Cooperators were instructed to place each crop in a separate envelope; to label envelope completely, and to freeze as quickly as possible. Crops were collected from the cooperators at the end of each half of the split season and stored in a deep-freeze until processed.

Laboratory Procedure

To satisfy the minimum requirement of three grams of material for chemical analysis and to reduce the number of chemical analyses, the contents of five crops were combined to form one composite sample. Crops were combined according to location and date collected. Five crops were randomly selected from these groupings to form a sample.

Samples from each half of the split waterfowl season were to be examined separately and compared; but because there was no appreciable difference in the food items and the nutrient analyses from each area, and since there was an insufficient number of crops collected in the first half of the season, all samples were analyzed as one collection period.

In processing crop contents, the vegetative material from the five crops was dried, separated, identified and measured. The contents were again combined, finely ground, thoroughly mixed and chemically analyzed.

Animal matter was placed in a petri dish in a one per cent solution of boric acid in order to eliminate loss of nitrogen (Richardson, Watts, Wilkinson and Dixon, 1960). It was dried in a forced-air oven at 68°C. for 48 hours, then identified and measured. Because of the small quantity found in each crop, it was necessary to combine all the animal matter from each collection area to meet the three gram minimum required for chemical analysis. Therefore, there was a total of only three samples of animal material analyzed.

All analyses were made by chemists of the Feeds and Fertilizer

TABLE 1. FOODS CONTAINED IN MALLARD CROPS

	Creole	Pecan Island	Gueydan
No. Samples	13	18	12
No. Crops	65	90	60
Food in Per Cent by Weight			
Grass	81.7	71.0	90.3
Sedge	0.1	0.5	5.0
Polygonum	16.2	22.9	2.2
Other Plants	0.1	3.6	0.9
Animal Matter	1.5	1.6	0.9
Grit	0.1	Tr.	0.2
Total Food	99.7	99.6	99.5

[1]Assistance in seed identification was given by Neil Hotchkiss, Patuxent Research Center, Laurel, Maryland.

Laboratory at Louisiana State University. Analyses were made in accordance with recommendations contained in the eighth edition of "Official Methods of Analysis—Association of Agricultural Chemists, 1955."

CROP CONTENTS

As shown in Table 1, the seeds of grasses and smartweeds made up the bulk of the food eaten by ducks in all areas. The seeds of other plants, animal material, and grit were found in small amounts.

Five grasses, barnyard millet, Walter's millet, fall panicum, brown seeded paspalum and domestic rice made up 78 per cent of the food eaten in the Creole area (Table 2). The three important grasses making up 64 per cent of the food in the Pecan Island area were: fall panicum, bagscale grass and giant foxtail. Domestic rice made up slightly over 50 per cent of the food consumed at Gueydan. Smartweed (*Polygonum hydropiperoides*) was important at Creole and Pecan Island.

Although grit occurred in 42 per cent of the samples, it made up less than 0.1 per cent of the crop contents. Forty-two lead pellets were found but it is believed all had been shot into the ducks.

TABLE 2. GRASS SEEDS CONTAINED IN MALLARD CROPS (IN PER CENT BY WEIGHT)

	Creole	Pecan Island	Gueydan
Brachiaria extensa (Signalgrass)	1.2	....	1.7
Digitaria sanguinalis (Crabgrass)	....	....	1.3
Distichlis spicata (Salt marsh grass)	0.7	0.4	....
Echinochloa crusgalli (Barnyard millet)	13.2	....	4.8
Echinochloa walteri (Walter's millet)	18.2	3.2	4.3
Leptochloa fascicularis (Sprangletop)	1.3	1.6	0.1
Oryza sativa (Domestic rice)	12.6	....	50.9
Panicum dichotomiflorum (Fall panicum)	11.5	39.0	4.6
Paspalum acuminatum	0.3	....	....
Paspalum plicatulum (Brownseeded paspalum)	22.7	....	13.5
Paspalum sp.	....	....	7.9
Sacciolepis striata (Bagscale grass)	....	9.5	0.2
Setaria magna (Giant Foxtail)	....	15.8	....
Sorghum sp.	....	1.5	....

RESULTS AND DISCUSSION OF NUTRIENT ANALYSES

Table 3 contains the results of the proximate analyses of samples from each collection area. Since waterfowl undoubtedly utilize minerals contained in grit, it was included with the animal matter.

The results of all analyses are presented on a "dry weight basis." An analysis of variance and "t" tests were used to detect significant differences in areas and in nutrients.

Crude Protein

In the Creole area crude protein in seeds ranged from 10.4 to 18.1 with an average of 14.6 per cent (Table 3). Animal matter averaged 27.9 but contributed only 1.0 per cent to the total protein. Millets, brownseed paspalum, smartweed, fall panicum and domestic rice were important seeds. As shown in Table 4, the per cent crude protein of these species is approximately 16.3, 7.4, 9.5, 15.2 and 9.1 respectively. Since seeds having a low protein content contributed heavily to the samples, the average per cent protein is rather low.

Crude protein in the Pecan Island crops ranged from 13.4 to 20.5 and averaged 17.1 per cent. Animal material contained 24.9 per cent protein but contributed only 0.4 per cent to the total protein. Important seeds were fall panicum, bagscale grass and giant foxtail; grasses having a high protein level. This high level is reflected in the high average protein per cent for this area.

TABLE 3. PROXIMATE ANALYSES OF FOOD CONTAINED IN MALLARD SAMPLES (PERCENTAGES ON A MOISTURE FREE BASIS)

	Crude Protein	Ether Extract	Carbohydrates: Crude Fiber	Carbohydrates: N-Free Extract	Ash	Calcium	Phosphorus
			Creole (13 Samples—65 Crops)				
Minimum	10.4	2.5	14.9	31.9	13.0	0.22	0.233
Maximum	18.1	3.6	21.2	54.0	31.1	1.35	0.969
Average	14.6	3.1	17.7	43.2	21.2	0.42	0.669
Animal Matter	27.9	1.8	6.9	14.6	48.8	12.39	0.621
Total Average	15.6	3.0	16.9	41.1	23.1	1.28	0.666
			Pecan Island (18 Samples—90 Crops)				
Minimum	13.4	1.4	9.9	51.8	3.5	0.13	0.332
Maximum	20.5	4.1	17.1	64.6	6.8	0.63	0.576
Average	17.1	2.8	13.8	61.4	4.8	0.34	0.473
Animal Matter	24.9	2.6	7.4	10.5	54.4	13.38	0.547
Total Average	17.5	2.8	13.4	58.8	7.4	1.02	0.477
			Gueydan (12 Samples—60 Crops)				
Minimum	8.9	2.1	9.3	42.1	6.5	0.25	0.175
Maximum	13.6	5.2	19.4	66.2	12.1	0.42	0.668
Average	10.9	2.9	14.4	60.6	9.2	0.32	0.354
Animal Matter	18.2	1.1	5.2	17.5	58.1	12.85	0.333
Total Average	11.4	2.8	13.8	57.3	12.9	1.28	0.352
Grand Average	14.8	2.9	14.7	52.4	14.5	1.19	0.498

In the samples analyzed from the Gueydan area, crude protein ranged from 10.9 to 18.1 and averaged 10.9 per cent. Animal matter averaged 18.2 and contributed 0.5 per cent to the total protein. Domestic rice and brownseed paspalum were the two most important grasses. Since both are low in protein, they depressed the average for the area.

There was no significant difference in protein from Gueydan and Creole; however, protein in the Pecan Island samples was significantly higher at the one per cent level of probability.

When protein averages for all crops from each area are considered, they reflect the protein level of the seeds making up the bulk of the diet. Exceptions are noted when individual crops are examined.

Ether Extract (fat)

An analysis of variance showed that there was no significant difference in ether extract among the areas. The average for Creole, Pecan Island and Gueydan was 3.1, 2.8 and 2.9 respectively. Most grass seeds are low in fat. The animal material in the samples was also low in fat. Most commercial feeds have some type of oil added to increase the fat content.

Crude Fiber

The averages of crude fiber for Creole, Pecan Island and Gueydan were 17.7, 13.8 and 14.4 respectively. There was a significant difference at the one per cent level among areas, Pecan Island being the lowest. The relative crude fiber content of most wild grass seeds is rather high (Table 4) when compared to the amount in domestic feeds. Crude fiber is very high in seed coats; therefore, there is a higher fiber content in an equal amount of small seeds than in large ones.

Nitrogen Free Extract

Tests showed that there was a significant difference in NFE and that it was significantly lower in the Creole area. The average per cent of NFE in samples from Creole was 43.2 as compared to 60.6 for Gueydan and 61.4 for Pecan Island. The nitrogen free extract includes the more soluble carbohydrates such as starch, sugars and hemicelluloses. They are the chief sources of energy for animals. Since the NFE in wild grass seeds is relatively high (Table 4), they may provide ducks with nutrients for muscular work such as flight.

Ash

The average percentage of ash for the Creole, Pecan Island and Gueydan areas was 21.2, 4.8 and 9.2. Each area was significantly

TABLE 4. PROXIMATE ANALYSES OF SOME SEEDS OCCURRING IN MALLARD CROPS* (PERCENTAGES ON MOISTURE-FREE BASIS)

Plant	Crude Protein	Ether Extract	Carbohydrates Crude Fiber	Carbohydrates N-free Extract	Ash	Calcium	Phosphorus
Graminae							
Digitaria sanguinalis	14.0	2.4	14.1	63.0	6.5	0.10	0.356
Brachiaria extensa	10.7	6.4	21.1	55.5	6.2	1.44	0.381
Paspalum plicatulum	7.4	2.3	18.9	65.1	6.1	0.11	0.273
***Panicum dichotomiflorum*	15.2	4.1	19.9	51.7	9.4	0.13	0.340
Sacciolepis striata	21.9	3.5	7.2	62.5	4.9	0.04	0.461
Echinochloa crusgalli	9.7	1.4	22.2	40.5	6.2	0.06	0.325
Echinochloa walteri	16.3	3.6	14.2	61.4	4.4	0.05	0.413
Setaria magna	14.2	1.5	17.1	64.2	3.9	0.06	0.271
****Oryza sativa*	9.1	2.0	1.1	74.5	1.1	0.04	0.250
Cyperaceae							
Cyperus albomarginatus	8.2	3.5	19.2	61.1	7.9	0.16	0.436
Cyperus esculentus	4.1	4.3	11.1	68.5	11.9	0.18	0.274
Cyperus iria	8.9	3.9	14.5	65.0	7.6	0.13	0.357
Fimbristyles miliacea	13.3	0.8	36.9	25.7	23.2	0.09	0.671
Polygonaceae							
Polygonum sp.	9.5	2.2	18.3	66.5	3.5	0.09	0.310
Amaranthaceae							
Amaranthus sp.	17.9	18.7	8.1	50.3	4.6	0.45	0.670
Buettneriaceae							
Melochia corchorifolia	17.1	7.3	18.6	53.0	4.0	0.20	0.544

*Feed and Fertilizer Laboratory and L.S.U. School of Forestry and Wildlife Management except where noted.
**King and McClure, 1944.
***Morrison, 1957.

different from the others. The high level in samples from Creole is unexplainable. There is a possibility that seeds in this area had a higher salt content resulting in greater amounts of ash. Salt marsh grass and other brackish plant seeds were present in crops from this area.

Calcium

There was no significant difference in calcium between areas. The average per cent was .42 for Creole, .34 for Pecan Island and .32 for Gueydan. The addition of animal matter, largely gastropods, increased the calcium percentage to 1.28, 1.02 and 1.28 respectively.

It is apparent from these results that the calcium intake of wild ducks was low during the winter. Calcium in many wild seeds is low. Duck undoubtedly derive considerable amounts from animal foods and may have a greater intake during the spring. Wild ducks lay only a limited number of eggs and may not require a high calcium diet.

Phosphorus

Tests revealed that there was a significant difference in phosphorus and that the Creole area was responsible for the difference. The Creole area had an average of .666 and the Pecan Island and Gueydan area had an average of .354 and .473 per cent respectively.

TABLE 5. PER CENT NUTRIENTS IN THE DIETS OF WILD DUCKS

	Breeder Ducks (Scott & Holm)	Mallard (This Study)	Teal Bardwell (1962)	Pintail[1] Bardwell (1962)
Protein	19.0	14.8	19.0	15.8
Fat	6.0	2.9	3.6	2.5
Fiber	3.8	14.7	18.3	14.5
Calcium	2.7	1.19	0.36	0.94
Phosphorus	0.79	0.498	0.460	0.426

[1]Does not include animal matter; quantity too small to analyze.

COMPARISON OF NUTRIENTS IN THE DIETS OF WILD DUCKS

Scott and Holm (1961) determined the nutrient composition of rations that were suitable for wild breeder ducks held in captivity under game farm conditions. Data in Tables 5 and 6 indicate that the diet of wild mallards in Louisiana is below the levels recommended. Bardwell (1962) also found this to be true for pintail and teal in Louisiana.

Based on Scott and Holm's recommendation, crude protein for mallards was deficient by 22 per cent, fat by 52 per cent, calcium by 56 per cent and phosphorus by 37 per cent while fiber was over by 400 per cent. Uncontrollable factors may partially account for the low levels. A slight amount of digestion may have occurred in the crop of ducks and there may have been a little bacterial action in the crops. The amount is believed to be negligible. Stage of maturity, age, length of time in water, storage and processing may have altered the chemical composition of seeds.

TABLE 6. PERCENTAGE OF NUTRITIONAL REQUIREMENTS (RECOMMENDED BY SCOTT AND HOLM, 1961) MET BY FOODS CONTAINED IN MALLARD CROPS

	Crude Protein	Fat	Calcium	Phosphorus
	Creole (13 Samples—65 Crops)			
Minimum	54.7	41.6	8.1	29.4
Maximum	95.2	60.0	50.0	122.6
Average	81.9	51.9	15.5	84.7
Animal Matter	146.8	30.0	458.8	78.6
	Pecan Island (18 Samples—90 Crops)			
Minimum	70.5	23.3	4.8	42.0
Maximum	107.8	68.3	23.3	72.9
Average	92.2	46.0	12.4	59.8
Animal Matter	131.0	43.3		
	Gueydan (12 Samples—60 Crops)			
Minimum	46.8	35.0	9.2	22.1
Maximum	71.5	86.6	15.5	84.5
Average	60.4	47.3	11.6	44.8
Animal Matter	95.7	18.3	475.9	42.1
Average of All Areas	77.9	48.3	44.0	63.0

The quality of nutrients was not determined in this study. For example, all proteins are not of equal value. Some are synthesized in the body more easily and more completely than others. It is possible that the foods consumed by wild mallards contained proteins of a high quality and that a smaller protein intake was required. It may be possible for ducks to eat large quantities of foods having a low protein per cent and thus meet the required level.

Because of the careful conduction of the work and because of the large number of samples analyzed, it is believed the results obtained are accurate.

Of the 215 mallards examined 174 (80.9%) were observed to be in good condition, 21 (8.9%) in fair condition, 4 (1.9%) in poor condition and 16 (7.4%) in an undetermined condition.

It is concluded that mallards under true wild conditions thrive on a diet having smaller quantities of nutrients than do wild mallards in captivity.

SUMMARY

Two-hundred-fifteen crops containing food were removed from wild mallards in Southwest Louisiana during the 1961 hunting season. Grass seeds made up the bulk of the food eaten. The most important grasses were millets, paspalums, fall panicum, giant foxtail, bagscale grass and domestic rice. Smartweed was important at two collection areas. Animal matter and grit were present in small quantities.

Proximate analyses of crop contents revealed that the foods had the following nutrient percentages: protein 14.8, either extract 2.9, fiber 14.7, NFE 52.4, ash 14.5, calcium 1.19 and phosphorus 0.498. When compared with a diet for breeder ducks recommended by Scott and Holm (1961), crude protein was deficient by 22 per cent, fat by 52 per cent, calcium by 56 per cent and phosphorus by 37 per cent.

Since approximately 81 per cent of the ducks were in good condition and two per cent in poor condition, it was concluded that wild mallards thrive on a diet having smaller quantities of nutrients than do wild mallards in captivity.

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MULTIPLE PURPOSE DEVELOPMENTS IN SMALL WATERSHEDS

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The small watershed program, authorized by Public Law 566 and administered by the U. S. Department of Agriculture, is basically a program for the protection of life and property from flood damages; for the conservation of soil resources in watersheds; and for the management of agricultural waters. Through amendments and interpretations of the basic legislation, it has also become a program of expanded opportunity for resource development. It is a program in which there is opportunity for the merging of rural and urban interests; opportunity for the development of recreation areas, for the preservation of wild plant and animal resources and the enhancement of their habitats; opportunity to develop water resources for industry and municipalities; for irrigation and other water management. It is our purpose to call attention specifically to some of these opportunities; to indicate how advantage may be taken of them; and to cite examples of what is being done. We propose to show how an integrated program of small watershed projects will serve a variety of public and private interests; how such a program may be coordinated with existing land and water uses, and thus provide new opportunities to the people of a particular portion of Pennsylvania.

We shall touch rather lightly on such matters as water storage for municipal water supplies, industry, and irrigation in order to emphasize opportunities and accomplishments in fish and wildlife enhancement. And, even though our topic deals with multiple-use developments, we want to mention those having single purpose.

In order to orient the reader on what a watershed program may encompass, we have listed ten items:

A watershed work plan may include

1. Land Treatment.
2. Flood Prevention.
3. Agricultural Water Management.
4. Municipal Water Supply.
5. Water for Industry.
6. Water for Power.
7. Water for Recreation.
8. Water for Fish and Wildlife.

9. Water for Pollution Abatement.
10. Salt Water Intrusion Control.

FISH AND WILDLIFE ENHANCEMENTS

Since we plan to discuss in detail the fish and wildlife opportunities in small watersheds, we have selected Item 8 from the list above for particular emphasis.

Federal technical and financial aid are both available for the enhancement of fish and wildlife resources in connection with small watershed programs. Enhancement measures are those that create, increase, or improve fish and wildlife habitat. The measures, to qualify for cost-sharing, must be related to water-management; must significantly benefit fish or wildlife; must significantly benefit the public; and must be accessible to the public. Preferably, such measures should be of a multi-purpose nature but most of them can be installed for single purposes. The benefits, incidentally, of these enhancement measures are considered at least equal to the costs. Enhancement developments are not limited to game species of fish or wildlife.

The following is a list, more or less complete, of measures eligible for the installation for the enhancement of fish and wildlife resources:

FISH AND WILDLIFE OPPORTUNITIES

1. Water Storage.
   a. On-site (fish or wildlife).
   b. Off-site (wildlife).
   c. Stream flow stabilization (fish).
   d. Pollution abatement (fish).
2. Water Control.
   a. Regulated level release (fish).
   b. On-site fluctuations (fish or wildlife).
   c. Salt water exclusion (wildlife).
3. Stream Improvement.
   a. Habitat devices (fish).
   b. Channel improvement (fish).
   c. Streambank planting (fish).
4. Habitat Renovation.
   a. Sediment removal (fish).
5. Fish Passage.
   a. Dry ponds.
   b. Fishways.
6. Wetland Habitat Improvement.
   a. Level ditches, islands, potholes (wildlife).
   b. Planting (wildlife).

FINANCING FISH AND WILDLIFE ENHANCEMENTS

In calling attention to the opportunities for enhancement of fish and wildlife resources, we believe that it is important to consider ways through which local cost-shares can be provided. These are listed below:

1. *Local financing.* Federal cost-sharing is available only to qualified State agencies and local organizations as specified by Public Law 566, as amended. Examples of ways to arrange local financing:
   a. State wildlife agency may provide cost-sharing funds. The local share of the cost may include purchase of the land, easements, and construction costs.
   b. An individual, private club, or sportsman's organization may give funds or lands to the local sponsoring organization, which may then be credited as part of the local share of the cost.
   c. County governments or municipalities may provide cost-sharing funds to establish public fish and wildlife waters.
   d. Self-liquidating developments. A district or any other legal sponsoring organization that sees fit to finance 50 per cent or more of a fish and wildlife development may collect use fees that permit reasonably equitable access to cover amortization and other operation and maintenance costs.
2. *Private financing.* Private groups or individuals desiring to provide the fish and wildlife enhancement measures for their own use may arrange with the local sponsoring organization to pay in full the expense allocated to the fish and wildlife purposes. *This is applicable where public access is not provided.*

RECREATIONAL OPPORTUNITIES

Water is a lodestone to the recreation seeker. Flood prevention structures offer numerous opportunities for the development of recreation areas. State, county, and municipal parks are being developed in connection with water storage areas throughout the Northeast. We shall show by example not only the opportunities for such public recreation developments but also indicate how private recreation developments may be stimulated by an integrated watershed program. At present, water supplies for recreation must be financed entirely by non-Federal funds.

REGIONAL SUMMARY

Approved Northeastern watershed work plans in which cost-shared fish and wildlife enhancements are included are presently located in New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, and West Virginia. In stages preliminary to definite planning are enhancements in watersheds in Maine, Vermont, and Connecticut.

Table 1 presents an up-to-date summary of fish and wildlife, recreational and other developments in Northeastern small watersheds.

TABLE 1. STRUCTURAL DEVELOPMENTS IN NORTHEASTERN SMALL WATERSHEDS (PL-566)

Type of Structures Planned	No.	Total Planned Surface[1] Area, Acres	Dry Ponds[2]	No.	Total Built Surface[1] Area, Acres	Dry Pond[2]
Single Purpose:						
Flood Prevention	186	2,013	25	49	376	5
Desilting Basin	8	1,073	....	4	39	....
Fish and Wildlife	2	244	....	....	....	....
Total	196	3,330	25	53	415	5
Multi-purpose:						
Flood Prevention Fish and Wildlife	16	1,453	....	6	891	....
Recreation	4	205	....	....	....	....
Municipal Water	8	684	....	3	124	....
Industrial Water	1	3	....	....	....	....
Irrigation	2	36	....	2	36	....
Total	31	2,381	....	11	1,051	....
Grand Total	227	5,711	25	64	1,466	5
Stream Improvement Fish	2	10.3 mile	....	....	....	....

[1]Acreage figures rounded to nearest whole acre.
[2]Standard conduits having no special features for fish passage.

We should like at this point to discuss with you more specifically the progress of Public Law 566 watershed projects in Pennsylvania. To date the Soil Conservation Service has received sixty-three applications from local sponsors covering approximately 3,000,000 acres or about 10 per cent of the land area of the Commonwealth. Thirty-three of these applications are active. Plans have been completed on ten of the watersheds and six more are in the planning stage (Figure 1).

The applications have been sponsored in all cases by Soil Conservation Districts and Boards of County Commissioners. In Pennsylvania the Board of County Commissioners is the governing body of County Government with full taxing power. Many watershed projects are also co-opsonsored by Departments of State Government, townships, and/or municipalities.

The securing of land rights has been the most difficult and time-consuming of the responsibilities in carrying out Public Law 566 projects. In most cases, easements have been donated. In other cases, interested individuals have purchased the sites and donated easements. County Governments, Township Governments, or Boroughs have, on occasion, used the right of eminent domain in order to secure land rights.

The Northwestern section of Pennsylvania provides an excellent op-

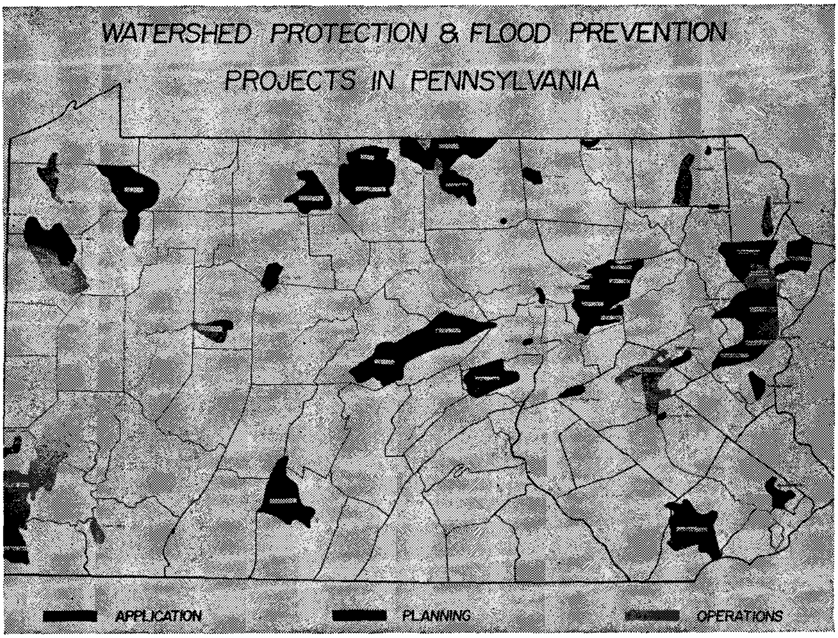

Fig. 1

Fig. 1. A map of Pennsylvania showing the good distribution of watershed protection and flood prevention projects in the Commonwealth. A number of the projects include multiple purpose use of the flood prevention structures to provide both flood prevention and storage of water for other uses.

portunity to illustrate the use of Public Law 566 projects, with fish and wildlife features. This area, bordering on Lake Erie and Lake Pymatuning, is part of the Eastern flyway for waterfowl. The number of watersheld applications from this area indicates that the local people are fully cognizant of how Public Law 566 can help them not only in flood prevention, but in the development of their land and water resources for their best use (Figure 2).

The pattern of land and water resources in this area shows that the program on one watershed should be closely associated with programs on nearby watersheds. It is recognized, also, that the programs developed for the watersheds as a whole will affect the type of programs developed for individual farms and other properties.

In each of six Public Law 566 watersheds under consideration in the locality, maximum attention is being given to developing the fish and wildlife opportunities. The watershed programs will tie in nicely with the work of the Pennsylvania Game Commission in its development of the waterfowl refuge on the shores of Lake Pymatuning. The six

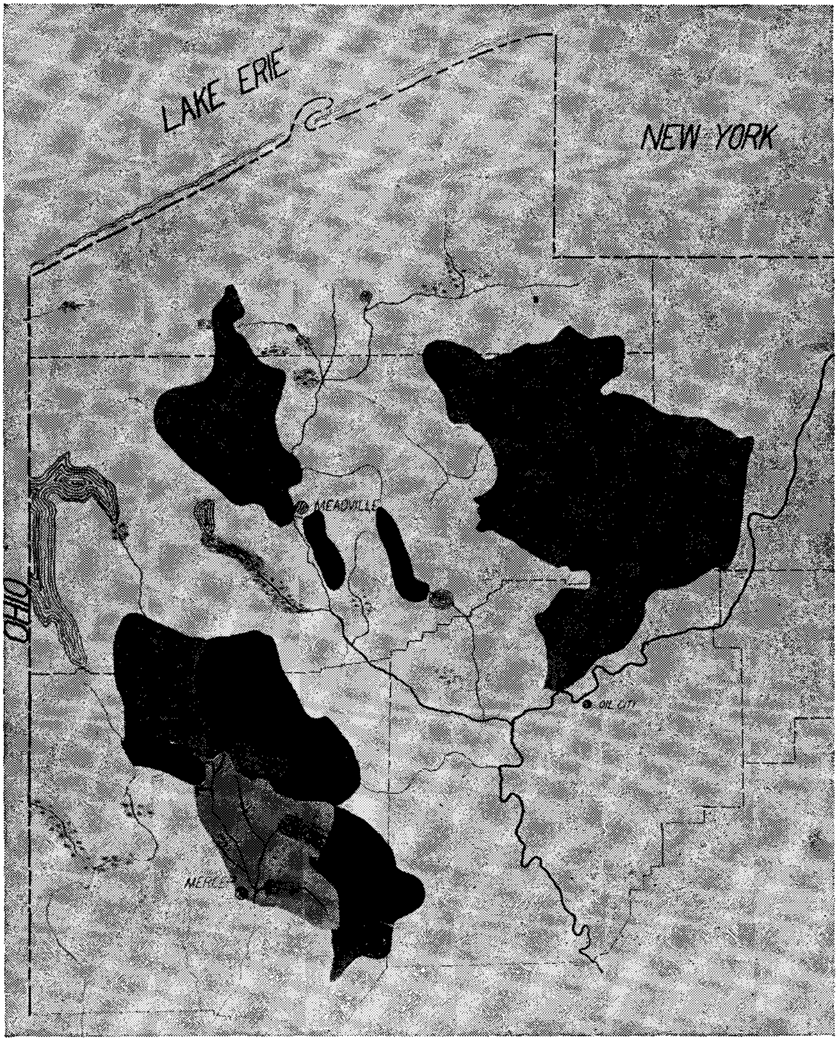

Fig. 2

Fig. 2. Resource Area map of northwestern Pennsylvania showing the location of eight watersheds under application for watershed protection and flood prevention planning. Other water management projects included in the area make it an ideal recreational center for the nearby cities.

watersheds also will make a contribution to the wildlife refuge being purchased and developed in close proximity by the U. S. Fish and Wildlife Service. A large State Park, which involves Lake Pymatuning and much surrounding area, is a related factor in fully developing the land and water resources of this area.

The long-range plans for the Mercer and Crawford County Soil Conservation Districts now being developed, based on their Conservation Needs Inventory, are taking into full consideration the land and water resources as well as the problems and opportunities involved. Farming in the two counties has been on the decline. This entire area involves much wet and imperfectly drained land. The imperfectly drained land, once it is drained, still requires large amounts of lime and fertilizer for good crop production. These limitations in the land resources for farming have resulted in a definite land use trend. More land is going out of production as farm land; better farms are being developed on the best land and are becoming larger units. The future use of farms not being so developed will, undoubtedly, be influenced by the long range plans and programs now under way in these two districts. Soil Conservation District Directors recognize that all landowners should fully consider the possibilities of using their land and water resources to develop wildlife and recreational features.

A look at the map quickly convinces one of the recreational opportunities that do exist in this generally undeveloped area. The area is surrounded by cities such as Buffalo, Erie, Cleveland, Youngstown, Pittsburgh, Altoona, and other populous areas. All of these concentrations of population are within one and one-half hours drive from the center of the area. The people in these metropolitan areas, like people elsewhere, are anxious to find fishing waters, hunting areas, camping sites, and other opportunities for outdoor recreation.

One of the watershed projects now under construction is the Mill Run Watershed in Crawford County. It not only is typical of the specific area under consideration, but it is also typical of all of the watershed work now going on in Pennsylvania. Mill Run is a small watershed of approximately 6,000 acres above Meadville. The stream channel is very constricted in the City of Meadville just before the confluence of Mill Run with French Creek. The program, when completed, will control 97 per cent of the annual flood damages and will consist principally of two main structures. In order to provide maximum protection, one of the structures will be on the headwaters and the second one within the Meadville city limits. The upper one of these structures will spread water over 600 acres of swampland. This area, known as Tamarack Swamp, now has only limited benefit for wildlife according to local game technicians. It has served no benefit for other purposes. The dam will come under the ownership of the Pennsylvania Fish Commission. Public ownership under the Fish Commission will also include a minimum of 200 additional feet beyond the top of dam elevation bordering the pool. The 600 acres of water will vary between 4 feet and 14 feet deep. Adequate land area will be developed for boat launching, picnicking, and other recreational features.

The second watershed we should like to call to your attention is the Sandy Creek watershed in Mercer County. This watershed consists of approximately 42,000 acres. The land area has a large percentage of swamp and other wet land. There are a number of farms, but only a small percentage of them are prosperous operating units (Figure 3).

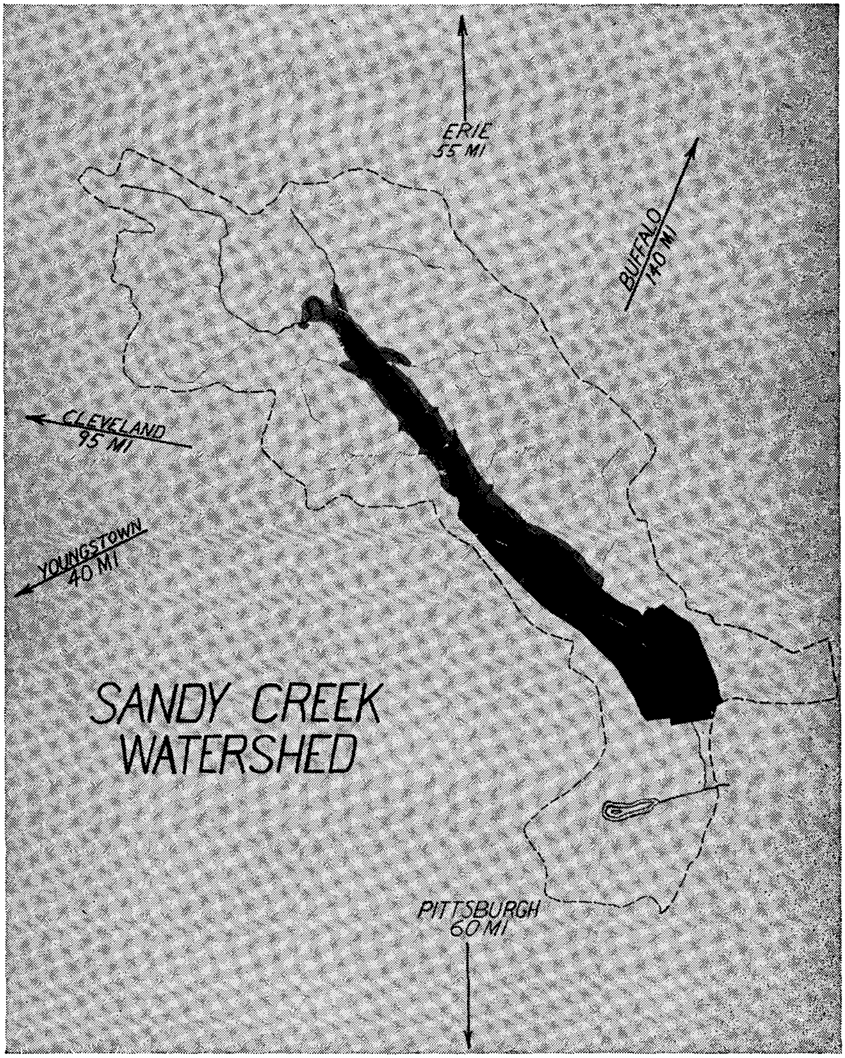

Fig. 3. Sandy Creek Watershed, Mercer and Crawford Counties, Penna. The photo shows the proposed multiple purpose reservoir which will provide both flood prevention and create a 1750 acre lake. A State Park is being planned near the lake and a wildlife area is being planned in the upper portion of the permanent lake. The lake will be managed for fishing by the Pennsylvania Fish Commission.

The major structure for this watershed will be built just above Sandy Lake. The maximum depth of water above the dam fill will be 22 feet. The multi-purpose structure will be designed and built to include fish and wildlife development and have a land border all the way around the lake to assure opportunities for recreational development and to prevent private encroachment. The permanent pool will cover approximately 1,700 acres. At flood crest level, 2,350 acres will be inundated.

Agencies participating in the development of this watershed include the Soil Conservation District, County Government, five townships, two boroughs, four divisions of State Government and three agencies of the U. S. Department of Agriculture. The State Department of Highways will be responsible for the relocation and elevation of the highways that will be kept and maintained. They will also be responsible for designing and building the North-South Throughway that will cross the lake so that it will be tied in to the completed program. The Pennsylvania Game Commission will be responsible for waterfowl management on the upper reaches of this major lake. In addition, this agency will take the leadership for other waterfowl developments on the headwaters of the watershed. The Pennsylvania Fish Commission will be responsible for the stocking and management of the 1,700 acre lake. The sponsors within the county will be responsible for the securing of all land easements and rights-of-way to 200 feet beyond the elevation of the top of the dam. The Department of Forests and Waters will share in the cost of construction with the Federal Government. In addition the Department of Forests and Waters will purchase all necessary land above the top of dam elevation for the development of a State Park. The Park, including the impoundment itself, will probably amount to more than 5,000 acres. The Department of Forests and Waters will assume title to all land involved and the responsibility for the future management of the area.

The Soil Conservation Service in carrying out its responsibilities under Public Law 566 is providing technical assistance in the development of the watershed work plan and is providing surveys and designs for the structural work. The Soil Conservation Service will also take care of the structural cost for flood prevention and share in the cost for fish and wildlife development as well as providing for technical assistance through the Soil Conservation District in carrying out the land treatment program. The U. S. Forest Service, in cooperation with the Pennsylvania Department of Forests and Waters, is assisting in the development of the watershed work plan and will assume the responsibility for the technical aspects of the forestry phase of the land treatment program. The Agricultural Stabilization and Conservation

Service will provide cost-sharing to farmers to speed up the carrying out of the land treatment programs called for in the work plan.

The land treatment program carried out under Soil Conservation Districts in the Sandy Creek and Mill Run watersheds, as well as in other watersheds and areas in Pennsylvania, will be giving maximum attention to water resource development. Throughout the last eighteen years the landowners in Pennsylvania have given serious attention to water resource development. This point is confirmed by the 12,000 ponds built throughout the State during the last eighteen years. These bodies of water, ranging in size from one-half acre to one hundred acres, are providing excellent habitat improvement affecting fish and wildlife. The recreation provided through this practice to farm families and many others has been substantial. In the watersheds under consideration, the aim will be to develop private water resources that fit into the fish and wildlife recreational opportunities being developed on public lands such as the Mill Run watershed and the Sandy Creek watershed. All landowners in the general area of the six watersheds for this section of Pennsylvania will be furnished background information and technical counsel in order that they may consider all alternative uses of their land. These alternative uses will include fish and wildlife development and recreation as well as what is generally considered agricultural uses. This will enable all landowners who so wish to take advantage of the general trend in this section of Pennsylvania toward using more land for fish, wildlife, and recreation.

The work we have outlined, which is now well underway, may be stepped up rapidly if a program, known as Project 70, now under consideration by State Government becomes a reality. In January of this year the Governor of Pennsylvania introduced into the legislature a bill providing for a $70,000,000 bond issue for the purchase and development of recreational areas. It is anticipated that this program by State Government would have further impact on the extent to which local people may go in fully developing all of the land and water resources under Public Law 566 watershed projects. There is enthusiasm throughout the State for this project, with little or no objection voiced to date. Regardless of the outcome of Project 70, it appears that the people of Pennsylvania have decided that Public Law 566, along with other approaches sponsored by Soil Conservation Districts, is one of the best ways to develop their land and water resources. It is accepted by all groups working in the State, whether Federal, State or local, that the most can be accomplished by working together—thus making it possible for each agency to accomplish more than by working individually.

We have attempted in this paper to review a few of the high points and give a few examples of how our land and water resources can be developed. We are naturally attempted to emphasize most the fish and wildlife aspects of the program. However, it must be remembered that every project must be justifiable for flood prevention and that many of the projects will include water for municipal, industrial, and agricultural uses.

DISCUSSION

DISCUSSION LEADER PAYNTER: Do private interests come into this at all or are these just Federal, state and local organizations? What opportunity is there for private developments?

MR. MCKEEVER: There is opportunity for private developments. In the group that I discussed in northeastern Pennsylvania, there has been interest and certain structures are being built there in cooperation with private interests for multipurpose use or recreation. In those cases, of course, the private interest must finance all of the costs involving recreation. We do have three or four instances now where projects are under construction and there will be more. Public Law 566 provides for combining where the structures are built on private lands, and their options are easements to the legal sponsors. Private ownership may cooperate in providing additional water for additional opportunities, provided they pay for it.

MOLLUSKS AS FOOD OF LESSER SCAUP ALONG THE LOUISIANA COAST

BOBBY G. HARMON
Louisiana Wild Life and Fisheries Commission, Grand Chenier

The Louisiana Coast is a major wintering area for Lesser Scaup (*Aythya affinis*), and during the 1960-61 season their numbers exceeded 1,500,000 (Smith 1960). Wintering scaup are normally found on large tidal lakes, bays, and in the Gulf of Mexico, and in late winter they are normally abundant in the adjacent marshes along the coast. The fact that thousands of lesser scaup remained three to four miles off-shore in the Gulf of Mexico without venturing into the adjoining marshes in the winter of 1960-61 stimulated considerable interest since during the previous winter numerous scaup were present inland on Rockefeller Refuge and over 600 were banded. In the winter of 1960-61 very few lesser scaup ventured inland and none were banded. Thus, with this in mind, the present study was initiated to determine (1) the extent to which lesser scaup were feeding off-shore in the Gulf of Mexico, and (2) what kinds of food were they eating, and (3) how much of this food was available for scaup in a heavily utilized area along the coast of southwestern Louisiana.

The author wishes to extend his sincerest appreciations to fellow wildlife employees who gave their time and assistance on this project.

Special thanks is extended to Robert H. Chabreck, chief biologist of Rockefeller Refuge, who made needed suggestions in the planning and collection of the field work and in preparing the manuscript. I also wish to thank Clark Hoffpauir, biologist at Rockefeller Refuge, who aided in collection and separation of the bottom samples, and for use of his airplane in securing aerial photographs. Special thanks is also extended to Donald Moore of the Marine Research Institute of the University of Miami, who identified all marine organisms in the study. I also wish to thank my wife for typing this manuscript.

STUDY AREA

This study was conducted south of Rockefeller Wildlife Refuge of the Louisiana Wild Life and Fisheries Commission near Grand Chenier, Louisiana, and extended from 100 feet to four miles south of the beach in the Gulf of Mexico. The water depth varied from three feet near shore to 25 feet at four miles from shore. Turbid waters were frequently present in the area and the bottom varied from a soft gray clay out to a distance of two miles, then to a firm gray clay in the outer portion of the study area.

Another part of the study area was located in Deep Lake which is a tidal lake on Rockefeller Refuge. The bottom of this lake was of soft clay and inundated to a depth of 14-24 inches at all times and the vegetation type surrounding the lake was wire grass (*Spartina patens*) and oyster grass (*Spartina alterniflora*).

PROCEDURE

Thirty-two lesser scaup were collected at random, then, aged, sexed, and the contents of their gullets and gizzards carefully examined and the weight of each recorded in grams. Also, to determine the availability of the foods consumed, bottom samples were taken along three transect lines that ran perpendicular to the shore of the Gulf of Mexico. Each line transect was one mile apart and ten samples, which varied in distance from 100 feet to four miles from shore, were taken on each transect line. These bottom samples were taken with a Peterson dredge which had an inside area of 128.8 square inches. The species of marine organisms from each sample were separated, counted, and the total weight was recorded in grams per sample (128.8 square inches). This weight was then converted to the total pounds of food per acre.

RESULTS

The sex-ratio of these lesser scaup was 5.4 males to each female with the average weight of each scaup being 33.4 ounces, and there were

1.91 immatures to each adult. In February, 1962, the projection and examination of several 135 millimeter color slides of large rafts of lesser scaup off-shore in the Gulf of Mexico revealed that the sex ratio of 1,018 birds was 828 males to 190 females (4.36 :1 ratio).

Upon gullet examination it was found that 99.8 per cent of the food eaten by the lesser scaup was surf clams (*Mulinia lateralis*), the remainder being several small spiral shells (*Nassarius acutus*). Seventy-five per cent of all gullets contained surf clams, and the average gullet-content weighed 12.5 grams. Many of the gullets were completely filled and several contained in excess of 400 surf clams. A similar study in Illinois of the gizzard-content from 220 lesser scaup revealed that 90.35 per cent was animal material and that 95.28 per cent of this material was of the Mollusca phylum (Anderson 1959).

Each surf clam was from one-quarter to three-eighths of an inch in length and yellowish white in color. The shell is triangular, smooth, and polished with beaks that are nearly central and inclined forward. This species is an important food item for many of our marine fishes as well as our sea-going ducks and is sometimes called the "duck clam." It occurs all along the Atlantic Coast from Canada to Mexico (Morris 1956).

A study in Connecticut waters indicated that the diet of lesser scaup was 61.7 per cent animal material with mollusk being the most important food item, and the feeding area after being sampled revealed the identical food items that were found in the scaup (Cronan 1957).

In the thirty bottom samples taken off-shore in the Gulf of Mexico a total of 16.55 grams of marine organisms were present and averaged 67.50 pounds of food per acre from the edge of the beach to four miles off-shore (Table 1). From the beach to one and one-half miles from shore there was an average of 13.23 pounds of marine organisms per acre of which 36.5 per cent of these organisms were *Mulinia lateralis*. From two miles to four miles off-shore there was an average of 147.85

TABLE 1. TOTAL POUNDS OF MARINE ORGANISMS PER ACRE FOUND OFF-SHORE OF ROCKEFELLER WILDLIFE REFUGE IN THE GULF OF MEXICO

Distance from shore	*Mulinia lateralis*[1]	*Nassarius acutus*	*Nunculana concentrica*	*Hemipholas elongata*	*Neanthes* spp.	Total
100 feet	0	0	0	0	0	0
500 feet	0	2.94	0	0	0	2.94
¼ mile	0	7.34	0	0	0	7.34
½ mile	12.24	0	1.59	0	0	13.83
1 mile	9.42	4.41	0	0	10.64	24.47
1½ miles	7.34	23.50	0	0	0	30.84
2 miles	22.40	1.47	1.59	0	0	25.46
2½ miles	119.95	8.81	3.31	8.93	0	141.00
3 miles	88.49	1.47	0	0	5.75	95.71
4 miles	272.94	14.69	1.59	40.02	0	329.24

[1]Traces of other marine organisms which showed up in the sampling were *Retusa canaliculata, Pinnixia* sp., *Epitonium rupicolum*.
Identification of marine organisms by Donald Moore 1961.

pounds of marine organisms per acre of which 85.2 per cent were *Mulinia lateralis.*

In order to compare the availability of the marine organisms present inland to the amount off-shore, ten bottom samples were taken in Deep Lake on Rockefeller Wildlife Refuge. The total contents of these ten bottom samples were made up on 5.60 grams of the small bivalve, (*Macoma mitchelli*), which averaged 68.51 pounds of organisms per acre inland as compared with an average of 67.50 pounds off-shore.

DISCUSSION AND CONCLUSIONS

During the winter of 1960-61, Louisiana wintered some 4½ million ducks with 33 per cent of the state's population being lesser scaup (Smith 1960). Even though the scaup was the most abundant duck in Louisiana, the composition of the state-duck-kill, based on 103,315 ducks checked in an eight year period (1950-1957), indicated that only 7.1 per cent of these ducks killed were lesser scaup (Smith 1961). This low kill of lesser scaup is evident because most birds inhabit the large open lakes, bays, and the Gulf of Mexico, while only a small segment of the population ventures inland where hunting is done. Also because of the off-shore habits of the scaup, the relative hunting pressure of this species is among the lowest of any other duck in the state, and in 1959, only 5 per cent of the wintering population was harvested in Louisiana (Smith 1961).

Lesser scaup have been hunted on the East Coast for several decades along the bays and coast line; however, this practice has not been done in Louisiana in the past to any extent because the abundance of puddle ducks in inland areas did not warrant this type of hunting. However, if species management is to be practiced with regulations formulated to control the harvest of certain species, as in the case of the canvasback and redhead, then why not formulate regulations to increase the harvest of lesser scaup, which I think would have considerable merit in Louisiana?

In November and December 1960 and January 1961 very few lesser scaup were seen inland in the marshes of Louisiana, but were observed off-shore in large numbers. However, this was not typical, since lesser scaup usually remain on large lakes and bays adjacent to the Gulf of Mexico until late November or early December (Smith 1960), then shift off-shore in the Gulf of Mexico.

Late spring migrants of lesser scaup may be seen off-shore as late as April and May, but by that time, most of the birds have begun their spring migration.

As for the physical condition of these lesser scaup when they leave Louisiana (based on the body condition of 32 birds collected in this study) their bodies are very heavily laden with fat from eating *Mulinia lateralis* or some other form of marine organisms in the Gulf of Mexico.

Past opinions on wintering scaup in the Gulf of Mexico were that the birds were forced inland during heavy seas; however, observations from aircraft and reports from crews on off-shore petroleum platforms show that this is not the case, since lesser scaup are found in heavy seas.

No one knows exactly how long these scaup have used the off-shore feeding areas, since past records are indefinite. However, *Mulinia* have been present along the beaches for many years with the present beaches composed primarily of *Mulinia* shells, and old stranded beaches located six to ten miles inland also contain a high percentage of *Mulinia*. Apparently, it seems that the future supply of food for wintering lesser scaup probably will not be affected by outside forces, including man, thus the future of this habitat seems secure.

The habits of lesser scaup flocks along the Louisiana coast are very similar to those found in southwestern Louisiana, and since the distribution of *Mulinia lateralis* is coastwide, it is assumed that the birds have similar food habits throughout the off-shore areas of Louisiana. Consequently the area of the off-shore wintering habitat for lesser scaup in Louisiana is in excess of one million acres. In addition the coastal lakes and bays heavily utilized by scaup during the early wintering season have an area even greater.

SUMMARY

1. Lesser scaup wintering in Louisiana are normally found in the large open lakes, bays, and off-shore in the Gulf of Mexico. They inhabit the lakes and bays during the fall migration and venture forth to the more open Gulf of Mexico before their spring migration occurs.
2. Collection of thirty-two (32) lesser scaup three to four miles off-shore in the Gulf of Mexico revealed that 99.8 per cent of the food eaten was surf clams (*Mulinia lateralis*).
3. In thirty (30) bottom samples taken in the same vicinity in which the scaup were feeding, a total of 16.55 grams of marine organisms were present which gave an average of 67.50 pounds of food available per acre.
4. From the beach to one and one-half miles from shore there was an average of 13.23 pounds of marine organisms per acre of which 36.5 per cent of these organisms were *Mulinia lateralis*. From two to four miles from shore there was an average of 147.85 pounds of marine organisms per acre of which 85.2 per cent of these organisms were *Mulinia lateralis*.
5. Bottom samples taken inland yielded about the same average poundage (68.51 pounds) of bivalves per acre as was off-shore in the

Gulf of Mexico (67.50 pounds).

6. In February, 1962 several color slides of large rafts of lesser scaup off-shore in the Gulf of Mexico revealed that the sex-ratio of 1,018 birds was 828 males to 190 females (4.36:1 ratio).

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DISCUSSION

DISCUSSION LEADER PAYNTER: I believe our speaker had something in his paper that he didn't bring out. Maybe some of you were wondering why they went to all this work, and what the scaup were doing out there and why they couldn't shoot them. If you are not going to ask him, I am. I can't see any reason for going to all that work if they didn't have something in mind. I believe in this case that these boys have got an idea that they are not harvesting the scaup as they should be. If we are going to be able to identify any duck, surely the hunters should learn to identify a scaup. What do you think about that?

MR. HARMON: Well, I certainly would like to see a special season on scaup. When these birds first arrive in November, they are on open lakes, but they do go into marshes and into deep wooded areas. About the time these birds would move into these areas, however, the season is closed, and that is a million and a half birds that are unharvested. We have two or three other wintering species of ducks that are not being harvested, but I think that perhaps I should not say anything about that.

MR. PALMER: Is there any indication in the sex ratio, which is so high in favor of the males, that there might be differences in the wintering areas of the male and the female, or is this the actual proportion in the sex ratio at large?

MR. HARMON: From the small group of birds we have taken photos of, I think that it is typical that there is a higher proportion of males over females. What I would like to do next fall, in particular, is to take some color shots of the birds when they first arrive on the coast of Louisiana and, in that way, see what the sex ratio is. I believe we can do it in that way.

MR. JOHN CRONIN: Did you get any chance at all to take bottom samples over a period of time to see what effects these birds might have on the feeding grounds? Also, just as a comment, I don't think your colored pictures would work, particularly in November, because frequently the immature males still look like females.

MR. HARMON: I don't know too much about that. John Lynch, U.S. Fish and Wildlife Service, has the theory that there is a sex ratio of fifty-five on the young birds. Then you would take aerial photos of the birds in the early winter and, by assuming that 50 per cent of the birds were males and 50 per cent were females, you could weed out the young birds. I can't say anything about it now, but I think we can get some early indication of the sex ratio involved. I might add that I mentioned that this shell beach was made up of quite a few million shells, which have been there for quite a few years. I believe that there are quite a few *Mulinia* offshore, and there should be plenty of food for these scaup in the future.

MR. JOHN ROGERS [University of Missouri]: Referring to the sex ratios of scaup, I had an opportunity two years ago on smaller areas to examine flocks during these periods at close range through a telescope. I think that these sex ratios of the order that Mr. Harmon mentioned are probably accurate, and the December sex ratios that I got are much higher than the spring sex ratios. I may not have heard what time of year you made your sex ratios.

MR. HARMON: This was in February, 1962.

MR. ROGERS: I would also like to comment on the populations of scaup. While that possibility exists, we know little or nothing about scaup production on most of the range, and I really don't think we can make the assumption that these last populations are really representative of the groups of scaup and that they could stand more loss.

MR. HARMON: The only thing I have to say is that we have studied the hunting pressure on species of birds in Louisiana and we have found that the scaup was the species with the lowest amount of hunting pressure, and only 5 percent of the total population of scaup was killed in 1959. That was brought out in my paper. Only a very small portion of these birds are being killed, and I can't see why we don't shoot more of them. Most of these birds are located in the southeast part of Louisiana where there is an absence of puddle ducks which the people go after in southwest Louisiana. In the southeast part, they have some puddle ducks but not too many. I think if we had a more liberal season on the lesser scaup, people would get out and try to hunt the scaup, also.

DISCUSSION LEADER PAYNTER: If there is no further discussion, I do want to thank you people who cooperated in our discussions on these papers. It has been a pleasure to endeavor to serve you this afternoon.

TECHNICAL SESSIONS

Monday Afternoon — March 12

Chairman: LEROY J. KORSCHGEN
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DISEASE, NUTRITION AND CONTROLS

MEANS OF IMPROVING THE STATUS OF VERTEBRATE PEST CONTROL

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If the status of vertebrate pest control needs improving, there must be something wrong with it. There is!

Vertebrate pest control is a disorganized and largely neglected field of science in need of being placed on a sounder scientific basis. It has no distinct niche of its own within existing organizations and institutions. There are no particular departments which are responsible for vertebrate pest control, such as those which exist for weed, insect and disease control. Vertebrate pest control does not fit in most zoology or wildlife management departments, as will be pointed out later on in this paper.

In February 1962 a California Association of Vertebrate Pest Control was established; otherwise this field is not represented by any professional or scientific society. There are no control-oriented publication outlets for research on this subject; hence lines of communication between workers in this area are practically nonexistent. Now vertebrate pest control research results usually get filed as an organizational report or are reworked, often at the expense of the original purpose of the study, so as to make them acceptable to a group of readers who are not control-oriented.

BASIC VS. APPLIED RESEARCH

A serious obstacle to improving the status of vertebrate pest control, and one of the main reasons why its current status is not higher, is the stigma many of our institutions of higher learning place on zoological research that carries either an economic or an applied label. The preposterous philosophical block so many teachers have toward doing any control-oriented or applied research in the fields of zoology and vertebrate ecology is socially wrong. Some of these purists fear they will lose not only their autonomy but their professional *esprit de corps* as well if they even associate with one or more practical undertakings.

What is the difference between basic and applied research? The impetus for carrying out basic research is curiosity; the immediate reward, intellectual satisfaction. Applied research, on the other hand, is initiated to solve pressing problems, and it is expected that the results will be put into practice as soon as possible. It is important to note that there is no implicit difference in content, techniques, or quality between the two types of work; only the motivations differ (Barr, 1958). In fact, a fundamental study inevitably becomes of applied nature, once a purpose for the discovery is found.

Many zoologists insist that basic research must proceed in the same spirit as "art for art's sake," and should not be appraised by its practical applicability. Yet, in defending this view, it is odd to find that they usually justify the potential usefulness of their study of the impractical by arguing that even the most abstruse research may eventually yield practical results (Selye, 1959).

To be really successful, both types of investigators need to allow their imagination to play with the most unlikely possibilities. They both must possess the power of abstract thinking and have a capacity to dream. This is why unifying concepts and fundamental principles of science are developed just as readily from applied as from basic research. That there is a need for applied, as well as for basic research, cannot be questioned. At the present time this is particularly evident in the areas of medicine and space dynamics. However, the important point is that we should not attempt to segregate or label them, for both types should freely intermingle.

Institutions of higher learning must overcome their reluctance to investigate vertebrate pest problems. These problems are challenging, and any investigator in this field quickly realizes that vertebrate pest control research uncovers all sorts of exciting research problems, most of them, interestingly enough, truly fundamental in nature. Furthermore, to investigate wild animals in disturbed and artificially manipulated environments is the only means of understanding the whole ecology of the organisms in question. I do not deny that positive correlations can be found by observing animals in undisturbed habitats, but the true cause-and-effect relationships will never be known unless hypotheses first are drawn up and then the environment manipulated in various ways to test the validity of the hypotheses.

BALANCE OF NATURE

Too often the ills of vertebrate pest control are attributed to man's culpability in upsetting the balance of nature. This is a fallacious generality, for man is merely a tamed or domesticated animal; his pests are those animals and plants which come into competition with him. What do we mean by the balance of nature? Does it involve sharing our apples with the codling moth and our lawns with the mole? Why is it always implied as bad to upset the balance of nature, that is, to alter the natural scheme of things? Has not man survived and improved his standard of living in direct proportion to the extent he has gained control of nature and manipulated its balance to his advantage (Howard, 1961)? We do not desire wild fires and floods just because they are natural events. Since man is part of nature, it is axiomatic that he will come into conflict with other phases of the environment around him, just as all other animals also have numerous species that are pests to them.

A matter often overlooked is that the presence of weeds, rodents, or insect pests does not mean that the farmer is being destructive to his land resource, as is so often claimed to be the explanation for the presence of these pests. Rather, it may mean that biologists have not learned how the farmer can increase his productivity in such instances without at the same time creating these pest problems. To attempt to control weeds, insects, and vertebrate pests is not just "treating the symptoms while ignoring the disease." Land-use is habitat alteration, and when the habitat is changed man must expect some undesirable things along with the good. The establishment of alfalfa or other irrigated pastures creates a favorable habitat for pocket gophers and meadow mice, as well as for certain insects, plant diseases and weeds; but this does not mean the land is being abused. At the same time, this altered habitat becomes inhospitable to a large number of other kinds of plant and animal life. The abuse occurs only when we do not follow up with the necessary pest control measures. However, the zealous desire of some to preserve too many feral burros, ground squirrels, or other animals on *grazed* rangelands in the interest of conservation may actually work against the very principle being striven for.

The persuasive pens of some who, well-meaning as they may be, in reality are either emotionally aroused or uninformed of the true cause-and-effect relationships, or lack a proper perspective of vertebrate pest control, often obscure the true facts. Sensationalism is easy to get into the press; facts are dull.

PREDATION

As far as most vertebrate pest problems are concerned, the degree of benefit provided by natural predators is usually only of academic importance; they seldom provide significant help, if any at all, in resolving most of the more common problems. It appears to me that predators, when taken as a population and not as specific individuals, usually increase the density of animal populations they prey upon, rather than control them.

The concept advanced herein is that natural predation by hawks, owls, snakes, and carnivores usually does more to stimulate an increase in the density of a prey population than it does to control or limit prey numbers. This predator-prey theory implies that for long periods (many generations) and over large areas (sufficiently large to support populations of both prey and predators) natural selection has enabled both predators and prey to coexist at the maximum ecological densities permissible in any specific habitat (environmental capacities). Implicit in the theory is the hypothesis that without the benefit of natural populations of predators, other self-limiting intraspecific stress factors (whether competition for food or water, weather, disease, territoriality, psychic, emotional, or other vicissitudes of life) will usually keep the density of each prey species at a lower level than would occur in the presence of a perpetual stimulation from predation. The maximum density of a prey species that is ecologically permissible in any area is primarily determined by the suitability of the habitat and species self-limitation (intraspecific stresses)—not interspecific competition between different species of predators, prey or both. The primary way in which the balance-of-nature concept operates with vertebrate animals is through habitat alteration and self-limitation, not through the minor role of interspecific competition.

The effects of natural predation in stimulating populations of game to increase more rapidly and to maintain higher over-all levels of density can be largely duplicated with the proper intensity of hunting or fishing. A logger destroys the trees he cuts, yet both the production of cellulose and the density of trees can be increased by logging; likewise, though wars kill people, they seem to stimulate a birth rate that more than compensates for the fatalities; and, similarly, though predators destroy each individual prey they eat, predation usually seems to increase the production and density of a prey population. "Game men are now convinced that the removal of cougar from the Kaibab (northern Arizona) had nothing to do with the boom and bust of the deer herd. The deer increase apparently was the aftermath of some habitat change" (Laukhart, 1961).

DEFINITION OF VERTEBRATE PEST

Vertebrate pests have been called animal weeds. Decker, *et al.,* (1962) encompass most kinds of pests in their definition: "By and large, those species of plants or animals that conflict with the immediate or long range needs and desires of man may be regarded as pests." This is not specific enough to serve our needs here. A vertebrate pest is more than merely an animal being where it is not wanted. I prefer to define a vertebrate pest as being "a native or introduced, wild or feral nonhuman species of vertebrate animal that is currently troublesome locally, or over a wide area, to one or more people, either by being a health hazard, a general nuisance, or by destroying food, fiber or natural resources."

It is important to recognize that any animal that may currently be a pest to one or more persons, may at the same time be either desirable or of neutral value to someone else. There are no such things as good animals and bad animals. Whether an animal is beneficial or undesirable depends entirely upon one's relationship with it. The same is true with plants, and that is why the better a person is as a gardener, the more likely it is that he will dislike the weeds he has to contend with.

Judgment as to the propriety of controlling vertebrate pests is a relative matter. A homeowner usually will not tolerate the presence of a single rodent, snake, or other animal that he may consider a pest, whereas a farmer usually does not object to most of these same species, unless they become so numerous as to cause him economic loss. Most state fish and game organizations have a policy of actively trying to protect nearly all kinds of wild animals, including predators; yet, at game farms, wildlife refuges, and fish hatcheries, and for removing rough fish in lakes and streams, we find that fish and game managers have well-organized programs for using poisons, traps, and other control measures to cope with their pests. For these reasons, both a clear understanding and a degree of tolerance of other people's relations to the situation are required in judging someone else's decision as to what he thinks is a pest (Howard, 1962).

Prior to the advent of the European, all of the United States was truly wildland—free from the pressures of today's expanding human population with its controversial land-use quandary. But as the number of people continues to increase, the conflicts between man and wild vertebrates also become more frequent, since man is forced to continue to alter the natural scheme of things and to compete with more animals. To obtain an increase in production from the land, farming methods must become further specialized, even though the resulting extreme modification of the environment often causes the local elimination of certain species of vertebrates, while others may become more numerous and adversely affect man's interests and welfare. For example, rats, mice, coyotes, and many kinds of birds are favored by man's manipulation of the environment.

Whenever man modifies a habitat he must expect some undesirable consequences along with the good. Artificial controls necessarily become a useful tool for conservation—to protect the soil that yields our food, and to control weeds, insects, and animal pests so that agriculture can practice better land use and be more efficient, hence requiring that less wildland be brought under intensive management.

VERTEBRATE PEST CONTROL

Control does not mean extermination. Professional pest control operators are not out to eradicate or exterminate all members of a species. Instead, their objective is to find acceptable means of reducing these animals to tolerable densities in areas where they are pests. The fact that many animals have been eliminated locally is usually not the result of intentionally applied artificial pest control measures, but rather the consequence of habitat alteration inimical to the needs of the species. Agriculture, out of necessity, not only destroys some wildlife habitats but also produces new habitats as well.

Domestic rats and mice, and field rodents are credited with the greatest economic damage, but losses from birds, rabbits, predators, and deer and other game animals may be even more serious. Vertebrate pests are by no means restricted to nongame wildlife. Yet, we must never forget that losses and nuisance factors are frequently compensated by esthetic, sporting, and other beneficial values of wildlife.

Human welfare will be well-served if more knowledge can be obtained on how to manage or control troublesome vertebrates. There is never, of course, a place for unwarranted destruction of animals or unwise use of control materials that harm the dynamics of beneficial species. The primary objective of all control methods should be to accomplish the desired effect with a maximum of safety to man and to forms of life useful or of neutral value to him.

THE WILDLIFE SOCIETY'S RESPONSIBILITY

The Wildlife Society's Committee on Economic Losses Caused by Vertebrates has prepared a report (Eadie, *et al.*, 1961) on what they think is the Society's responsibility with vertebrate pest problems. This report stresses the importance for the Society to decide whether "wildlife" includes all wild vertebrates or whether the Society's interpretation of wildlife is to be primarily restricted to game and gamelike animals. In 1961 the Society's Council replied to the above Committee that wildlife encompasses animals which may be harmful as well as other vertebrate forms of animals in the wild.

The Committee on Economic Losses Caused by Vertebrates also suggests that The Wildlife Society establish Divisions within its organization, one of which should be the Division of Wildlife Damage Control. Since there is little reliable data on economic losses caused by vertebrates, and since there has been a reluctance on the part of advisors to urge students to undertake studies in this field, the Committee hopes that The Wildlife Society will take the initiative in stimulating leadership in this area. A number of examples of the type of areas where The Wildlife Society should take leadership are presented in the above report.

An effort should be made to obtain more objective training on the subject of wildlife and resource management in public education and school programs, giving adequate attention to wildlife damage problems as well as stressing the esthetic and beneficial values. The need for foundations, industry and research agencies to work together in giving financial aid in this area should be publicized.

My personal views concerning The Wildlife Society's responsibilities regarding vertebrate pest control have recently changed. Previously, I felt strongly that the Society should take the leadership concerning the management of nongame vertebrates as well as leadership in the development of control of game animals. Ideally, this is still desirable, but at this point unrealistic. The Wildlife Society is predominantly fish-and-game-oriented, and the philosophy of most of this group is not too tolerant of control measures, which probably is as it should be. It would seem advisable that vertebrate pest control activities, especially those pertaining to nongame species, be centered in some new organization for the time being. Even though it is important that The Wildlife Society take a much greater interest in game-damage control than is now being done, I believe that to encourage the Society to encompass all vertebrate pest control problems at this time would probably create a rift within the Society.

The establishment of a vertebrate pest control organization would not attract personnel away from The Wildlife Society, for few interested in vertebrate pest control are now members and, similarly, few of The Wildlife Society members are interested in vertebrate pest control. That this is true was clearly demonstrated by a successful Vertebrate Pest Control Conference held in California on February 6 and 7, 1962, where 27 experts from North America and Korea reported on the best methods of controlling troublesome and pestiferous birds, mammals, and snakes, and discussed related problems concerning diseases and pesticides. No existing society was interested in sponsoring this conference. Of the more than 300 people who attended the conference, 19 per cent of those registering came from British Columbia, Saskatchewan, Korea, District of Columbia, and 14 states other than California. Yet, even though it had been advertised in The Wildlife Society News, by the National Wildlife Federation, and invitations had been mailed to all state game and fish organizations, only 16 members of The Wildlife Society (1955 membership list) who were not on the program, registered at the conference. The Vertebrate Pest Control Conference further illustrated that there is a lack of interest in this subject by most zoologists and wildlife people. All regional offices of the California Department of Fish and Game were notified, and the University of California and California newspapers publicized the conference; yet only one member of the University of California zoology and wildlife management faculty registered (remained for part of one morning), and only two California Department of Fish and Game members registered (both working on pesticide-wildlife relationships). I am afraid that vertebrate pest control and wildlife management are two separate entities and must be recognized accordingly.

Vertebrate pest control must be given an opportunity to develop on its own, independent of the existing zoology and wildlife departments now found in institutions of higher learning in the United States. And it needs to do this in a professional atmosphere, such as in colleges of agriculture or forestry, not in liberal arts colleges. It needs the chance to develop in its own unique way, both in research and in the training of future investigators and professionals in this area. It must be set free of the jealousies, stigmas and other emotional conflicts that are inherent when this field of endeavor is linked too closely with academic zoologists, and this is not the fault of the zoologists. It is not fair to zoologists to saddle them with this responsibility. The important peers of zoologists at any particular institution are not the people of that state or their campus colleagues, but, rather, other zoologists. The members of a zoology department cannot go out on their own and divorce themselves from the flock, without at the same time suffering the inevitable loss of prestige among other zoologists, with the consequental loss of standing in their own institution. Vertebrate pest control should be under a separate administrative leadership, such as Applied Vertebrate Ecology, where it can grow, mature, and be given a chance to contribute to knowledge and man's welfare.

AN INTERNATIONAL SOCIETY OF VERTEBRATE PEST CONTROL

The lines of communication among research workers, pest control operators, and industrial developers of materials used in the field of vertebrate pest control are inadequate. If conservation, sporting, recreational, and economic interests in vertebrate species are to work together in harmony, much more information on losses caused by these animals, and on methods of reducing these losses with maximum safety to man and forms of life beneficial to him, is required. And to bring about such harmony, educational institutions must recognize the value and ecological significance of vertebrate pest control and promote investigations of these problems.

Since animal control is one of the most important aspects of nature conservation, a well-rounded perspective and a healthy philosophy about scientific control methods, and a public informed about the true role of controls could quickly bring prestige to the words, "vertebrate pest control." One effective way of correcting some of these shortcomings is to improve communications between the individuals concerned with control problems by forming an International Society of Vertebrate Pest Control. There is no existing scientific society which is interested in this area. An international Society would help bring together the existing knowledge in this field and also help to coordinate this kind of research throughout the world.

Objectives of the proposed International Society of Vertebrate Pest Control would be: 1) to improve the effectiveness of scientists in securing such biological knowledge as may be required to provide the best and safest method of controlling vertebrates that become pests; 2) to provide needed technical advice and guidance in this segment of environmental health and human welfare; 3) to provide more rational thinking and an enlightened outlook on man's relationships with wildlife by improving the public's understanding and appreciation of the necessary roles of vertebrate pest control activities; and 4) to publish a quarterly Journal of Vertebrate Pest Control so that workers in this field will have a place to publish their research in language directed to a control-oriented audience.

It is hoped that the proposed International Society of Vertebrate Pest Control will be truly international in scope, with annual meetings being held in different countries. Publications could include articles in different languages, but perhaps with English, French, German and Russian summaries. It also seems desirable that the Journal should be printed in some country other than the United States, where printing costs are less. I have been assembling names and addresses of persons interested in such a society, and many have written giving strong support of it.

SUMMARY

Vertebrate pest control has been slow in being placed on a scientific basis, and it is time that this neglected field of science should come into its own. Vertebrate pest control is essential to our society, and doing it effectively is not simple. There is need for financial support to improve methods, for better answers are hard to find, and scientific research of the highest caliber is required.

One reason the current status of vertebrate pest control is not higher is because too many zoologists seem to avoid all investigations that might be labeled as applied research. Vertebrate pest control is applied vertebrate ecology, not zoology, and should be allowed to develop on its own.

The interrelationships of man and animals have become increasingly complex as human populations have increased. Man's demand for additional food, fiber, and timber have required more intensive use of the lands and waters. Most habitats for wild creatures have become so altered that many forms have suffered large population reductions. Other animals, finding these alterations to their liking, have substantially increased, often creating problems that adversely affect man's interests and welfare.

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DISCUSSION

DR. A. B. COWAN [School of Natural Resources, University of Michigan, Ann Arbor]: Perhaps we should have required that all sidearms be left at the door. I am going to say right off the bat that Dr. Howard has painted with a very, very broad brush, and as an educator in a professional school in which wildlife management is taught, I would take issue with him on some of the points that he has made, but as your Discussion Leader, it is not up to me to take issue with him. It is up to you. Dr. Howard's paper is now open for discussion.

DR. FRED BAUMGARTNER [Oklahoma]: First of all, I would like to congratulate and thoroughly agree with Dr. Howard that we do need a great deal of additional emphasis on the problem of pest control. I would be perfectly frank to admit that I am in the pest control business as a research member. My basic interest in this field is the conviction that we are going to have a great many pest control programs. I thought possibly I could help a little bit in the development of better approaches and better understanding of these problems. I do want to take exception to Dr. Howard's ideas relating to the place where pest control research and operations should be taken care of. I think he will agree with me that the majority of our pest control problems are based on vertebrate ecology, and I think that in the broad sense our colleges of literature and art, as he calls them, are the place where we are going to find the people who are better trained, and perhaps in the long run have the soundest basis for an understanding of pest problems, rather than to set up a new organization, a new department, or a new development in other professional schools. Thank you.

DR. HOWARD: Thank you, Dr. Baumgartner. Your point is well taken, but I would like to deviate slightly and ask you why we have in our institutions in the field of biology, departments other than zoology and botany? Why do we have departments of vegetable crops? Why do we have departments of animal husbandry? Why do we have departments of entomology? Yes, why do we have veterinary medicine? These all come about because the philosophy is different and the new ideas younger in stature haven't a prayer. I think it is up to the existing groups to show a willingness and an eagerness to adopt this neglected area, and I hope this will come about. As it now stands, my personal opinion is they have not shown this eagerness or willingness.

STANLEY P. YOUNG [Fish and Wildlife Service]: I am working on my ninth book, and I don't like control. The subject of this book will be "The Management of Injurious Mammals in the United States, Its History." We might just as well have a little fun out of this thing. You know it all depends upon which way your bread is buttered as to whether you want control or management. As the gentleman pointed out, one creature could be an asset to one man and be damaging to another man.

WELDON ROBINSON: I am Weldon Robinson of the Denver Wildlife Center. First, I would like to emphasize, as Dr. Howard has, that the committee has recommended that the vertebrate pest control group be a part of or division of The Wildlife Society. The idea of a separate organization is Dr. Howard's idea alone. He will readily say that. And then going on to the second question, what progress has been made in the development of that international society? What is its status now?

DR. HOWARD: Weldon, you are very correct. I alone have taken this on. I have some very enthusiastic letters from Canada, New Zealand, Australia, France, a number of other areas. We are not going to go fast with this. We have an informal offer of assistance through the UN, but we are not asking for anything at this particular moment. We are going into this with our eyes open, realizing that even if a society—an international society of vertebrate pest control—is not established during this process, we are gaining great improvement in terms of bridging this gap of communications in this area. We are getting acquainted with each other in foreign countries, and I find that a lot of people in other countries feel the same way in their areas as we do here, but I know they are much better off than we are. They don't have near the prejudices that we do. It is going slowly. It is not a threat against The Wildlife Society but it is there in case The Wildlife Society doesn't move along. It is definitely not a threat.

DR. JOHN BUCKLEY [Patuxent Wildlife Research Center, Maryland]: I wonder if the Doctor might devote more attention to the problems and dangers that the pest at any particular time creates? It appears to me that the big problem is not necessarily pest control but control of the damage which these pests do at any particular point. The second point that I would like to make is that we have had some rather unpleasant experiences with groups exercising control on invertebrates, where we were not professionally related to them, and for this reason I personally would be reluctant to see an organization devoted to this and separated from The Wildlife Society.

DR. HOWARD: I quite agree. I think your points are very good. Let's leave invertebrates out, however; it is an entirely different subject when you get to invertebrates. The reasons I am pushing vertebrate pest control are quite simple. I have been through a number of synonyms and antonyms and there is no better term. It is not so repugnant after you have heard it a few times. We have heard it a number of times now in California. Our State Department of Agriculture realized that it is not a bad title. They have renamed their men in this area; they are now called vertebrate pest control people. I am bucking it right square on when I use these terms, but I think we need a better philosophy in this country and I would rather start out by calling it vertebrate pest control. I want to see people able to stand up and point to a deer population and stress their values as game in the area, speak of their aesthetic values, either speak of them as a damn pest. I think animals can be damn pests. Damage as such doesn't imply that; damage is a real complicated word. I was only a member of the committee in The Wildlife Society; therefore, that committee now is called Wildlife Damage Control. If I had been alone, it would be called a committee on vertebrate pest control.

RUMEN CONTENTS ANALYSIS AS AN INDEX TO RANGE QUALITY[1]

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The technique of rumen contents analysis for range evaluation was tested during a study in Alaska of the physiological responses of deer (*Odocoileus hemionus sitkensis*) to ranges of varying quality.

In the field of wildlife management, the chemical determination of nutrient contents of winter browse species has been employed as a standard technique for the evaluation of the ranges of wild ungulates (Einarsen, 1946; Hundley, 1956; Lay, 1957 and others). There has been considerable speculation as to the validity of this approach in the absence of an understanding of the seasonal nutritive requirements of the animals studied. This attention to winter browse species has tended to divert interest from other seasonal range components which can be of greater importance in the annual nutritive regimen of ungulates.

Riney (1955) and Robinson (1956) have suggested that summer range and transitional spring and fall ranges are of extreme importance because these are the periods of active growth and buildup of fat

[1]Financed through Federal Aid in Wildlife Restoration funds, Projects W-3-R and W-6-R, U. S. Fish and Wildlife Service and Alaska Department of Fish and Game. A segment of research toward the Ph.D. degree at the University of British Columbia.

[2]The author appreciates the technical advice of Mr. Donald B. Siniff, biometrician with the Alaska Department of Fish and Game.

reserves in preparation for winter periods of reduced forage quality and quantity. While forage admittedly is seldom scarce during summer months, the quality of the available forage may be a factor limiting growth in animals.

Researchers in the agricultural sciences have developed techniques for the evaluation of forage quality through the use of the artificial rumen and *in vivo* studies in fistulated animals (Burroughs *et al.*, 1960; Pidgen and Bell, 1955; Kamstra *et al.*, 1958; Blackburn and Hobson, 1960 and others). These techniques have not been applicable to wild or range ruminants and alternative attempts have been made by Norris (1943) and Bissell (1959) to use rumen contents analysis to reflect range quality. Norris and Bissell, however, both indicate that variations in nutritive constituents of the rumen contents cannot be directly associated with forage quality and therefore they question the use of such analyses in range evaluation. Bissell, in finding higher protein values in the rumen contents of deer than in the forage collected from the range, assumed that it was likely the deer were selecting plant parts that had a higher protein content than those selected for analysis by the biologists. That range animals are capable of actively selecting high quality forage has been pointed out by Swift (1948) and Dietz *et al.* (1958). Nevertheless, Wood *et al.* (1960) pointed out that the phenomenon of higher ruminal protein levels is partly explained by the presence of large numbers of bacteria and protozoa in the rumen as well as the presence of mucin and urea nitrogen derived from the saliva. Even if operative, a selective factor should not affect relative comparisons of rumen contents with standards or between areas and times.

This study was conducted during the summer of 1959, 1960 and 1961 on two islands of different range quality located within the natural range of the Sitka black-tailed deer in Southeast Alaska. The two islands, Woronkofski and Coronation, are each approximately 25 square miles in area, forested with a western hemlock-Sitka spruce forest type and with varying amounts of muskeg and alpine areas. Woronkofski Island is located adjacent to the coastal mountains and experiences relatively warm summers and cold winters with heavy snow fall. Coronation Island, in contrast, lies on the western edge of the archepelago adjacent to the Pacific Ocean and has cool summers and mild winters of light snow fall. Over long periods of time these climatic disparities have had markedly different effects upon the deer populations of the two islands. On Woronkofski Island, deer have experienced wide fluctuations in numbers associated with series of relatively mild winters interrupted by severe ones. Heavy winter losses have been frequent and severe enough to prevent excessive overuse of the range.

Even during the relatively mild winters, availability of forage is greatly restricted and protected from overuse at elevations above a few hundred feet by the accumulation of deep snows. On Coronation Island, deer populations have not been restricted by winter snow accumulation and a continuing heavy population pressure on the range has resulted in the elimination of important winter and summer forage species.

METHODS

Qualitative measurements were made of both the deer and the range on the two islands. Twenty-six deer specimens were collected from Woronkofski and 37 from Coronation Island. Sex, age, weights and measurements were recorded, and rumen content samples were collected from all specimens. The range was evaluated through the use of line intercept transects located in the major cover types and correlated with chemical analyses of major forage species.

Results of these related studies (to be published elsewhere) indicate that deer on Woronkofski Island are larger (at the 0.05 level of significance) than deer of comparable sex and age groups on Coronation Island. Significant differences were found in body weight and femur length, and growth rates as reflected in weights and femur: hind foot ratios. In addition, age structures of deer collected and observed indicate a younger, more productive population on Woronkofski than on Coronation Island.

Vegetation analyses indicate higher forage plant densities and greater species variation in the major vegetation types on Woronkofski Island than on Coronation. A rating of the areas of the two islands on the basis of comparable forage plant densities in all cover types results in the reduction of the vegetated area value of Coronation Island from 121 per cent of the Woronkofski area to 68 per cent. Putting it another way, it takes 1.8 units of range on Coronation Island to equal one unit on Woronkofski Island. Chemical analyses of similar forage species from the two islands do not show significant differences for samples collected at comparable altitudes and dates. Quality of forage was highest in plants initiating growth regardless of altitude or site conditions but the greater altitude variation on Woronkofski Island results in a longer period of availability of high quality, new growth forage than on Coronation Island. Finally subalpine and alpine plant communities, which have far greater density and variety of forage species than other cover types, occupy 2.6 and 20.8 times respectively more area on Woronkofski than on Coronation Island. Forage species in subalpine and alpine communities are also of higher quality than species in comparable stages of growth in the forest type.

Conclusions of the comparative study of the two islands are: 1) the range on Woronkofski Island on a unit area basis has a greater quantity of forage and variety of species than the range on Coronation Island; 2) the forage is of higher quality on Woronkofski than on Coronation Island when compared on the basis of that available throughout the entire growing period; 3) deer are larger both in weight and skeletally and have more rapid growth rates on Woronkofski than on Coronation Island; 4) the limited data on age structures suggest that the deer population on Woronkofski Island is younger and more productive than the Coronation Island population.

Rumen Contents Analyses:

Rumen samples were collected from deer specimens during the standard autopsy procedure. Samples were removed from the opened rumen, placed in plastic bags and the air expelled from the bags before sealing. Fecal samples were collected from the lower portion of the rectum. Twelve to twenty-four hours later the samples were broken into subsamples and prepared in the following manner:

Subsample	Preparation
A	Gross fraction; no further treatment.
B	Gross sample was thoroughly washed with water on a 10 mesh/inch soil sieve (size of openings 1.981 millimeters) and the remaining vegetative material saved (called the washed vegetative fraction).
C_1	Gross sample was strained through two layers of cheesecloth; the liquid obtained was strained through a 60 mesh/inch soil sieve (size of openings 0.246 millimeters) and the collected liquid saved (called the whole liquid fraction).
C_2	The C_1, or whole liquid, fraction was centrifuged at 1500*g* for 20 minutes and the supernatant liquid saved (called the clear liquid fraction).
D	The deposit from the above centrifuging of the C_1 component was saved (called the microorganism fraction).
E	Fecal material.

All subsamples were preserved with 0.5 millimeters of 10 per cent formaldehyde per 100 millimeters of sample.

Final treatment of the rumen subsamples was as follows:

Subsample	Treatment
A Gross fraction	Chemical analyses of nitrogen, crude fat, crude fiber, total ash, calcium, phosphorus and moisture.
B Washed vegetative fraction	Chemical analyses of nitrogen, crude fat, crude fiber, total ash, calcium, phosphorus and moisture.
C_1 Whole liquid fraction	Microscope counts of all protozoa and separate counts of the large oligotrich, *Metadinium* sp., by the hemocytometer. Centrifuging of 15 milliliter portions at 1500*g* for 20 minutes to determine relative volumes of C_2 and D fractions.
C_2 Clear liquid fraction	Chemical analysis of nitrogen, crude fat, total ash, calcium, phosphorus and moisture. Per cent transmittancy of 1:20 dilution at a wavelength of 545^{μ} in the Beckman spectrophotometer.
D Microorganism fraction	Chemical analyses of nitrogen, crude fat, total ash, calcium, phosphorus and moisture.
E Fecal material	Chemical analysis of nitrogen, crude fat, crude fiber, total ash, calcium, phosphorus and moisture.

All chemical analyses were made by Curtis and Tompkins, Ltd., commercial analytical chemists at San Francisco, using Association of Official Agricultural Chemists methods (1955).

RESULTS AND DISCUSSION

Digestion and growth studies with domestic ruminants show a positive correlation between nitrogen content (protein) of forage plants and their nutritive quality, while fiber content is negatively correlated with forage quality. It was therefore assumed that similar correlations should exist between nitrogen and fiber in the forage eaten by wild ruminants and that in the contents of the rumen (which consist of the forage eaten plus symbiotic microorganisms and their products and saliva). The negative correlations found to exist between nitrogen and fiber content of both the gross rumen samples and the washed vegetative portion of the rumen contents are shown in Figures 1(a) and 1(b). The higher correlation in the gross rumen contents is surprising but may reflect the retention by rumen microorganisms of readily convertible nitrogen. In the washed samples the microorganisms have been removed. Moir and Williams (1950) estimated that about 50 per cent of the protein ingested by sheep is broken down and converted to microbial protein.

The large daily variations found to exist in nutritive components in the rumen contents of sheep by Blackburn and Hobson (1960) and Christian and Williams (1957) were associated with the length of time after feeding at which the samples were collected. For example Blackburn and Hobson found that sheep which were fed diets containing protein of varying digestibility all showed highest total nitrogen values in their rumens shortly after feeding with values rapidly decreasing to the prefeeding levels during the following eight hours. They also found that levels of protozoal and bacterial nitrogen remained fairly constant and interpreted this as a near balance between growth of microorganisms and loss of cells to the abomasum.

The saliva of ruminants is essentially a buffering agent for the rumen environment and contains large amounts of bicarbonate and phosphate ions as well as nitrogen in the form of urea and mucin nitrogen. Bailey (1959) found that the saliva flow added 98 to 190 liters to the rumens of experimental cows daily, and this flow was lowest immediately after eating and steadily increased to maximum values immediately before the next meal; he related this to its function of maintaining a constant state within the rumen.

These reported variations in nitrogen content, microorganism level and salivia flow were all associated with time of feeding, and were not considered important in this study because wild ruminants are known

TABLE 1. COMPARISON OF CHEMICAL ANALYSES OF SUMMER RUMEN SAMPLES FROM WORONKOFSKI AND CORONATION ISLAND DEER

Component[1]	Sample treatment	Island[2]	Sample Size	Total	Mean	Standard error	t	Level of significance
Nitrogen	Gross sample (A)	W C	22 24	141.16 107.33	6.42 4.47	0.096 0.097	14.35	0.001
	Washed sample (B)	W C	21 15	83.03 39.45	3.95 2.63	0.129 0.110	7.78	0.001
	Clear liquid fraction (C_2)	W C	15 14	84.29 71.01	5.62 5.07	0.375 0.300	1.15	n.s.[3]
	Microorganisms (D)	W C	4 4	34.62 32.73	8.66 8.18	0.088 0.177	2.43	0.1
	Fecal material (E)	W C	3 5	13.33 18.36	4.44 3.67	0.496 0.202	1.44	n.s.
Fiber	Gross sample (A)	W C	22 24	311.84 510.54	14.17 21.27	0.512 0.589	9.10	0.001
	Washed sample (B)	W C	21 15	609.65 518.26	29.03 34.55	1.085 1.040	3.68	0.001
	Fecal material (E)	W C	3 5	56.62 123.69	18.87 24.75	2.087 1.979	2.04	0.1
Fat	Gross sample (A)	W C	22 24	190.74 197.15	8.67 8.21	0.357 0.255	1.05	n.s.
	Washed sample (B)	W C	21 15	165.26 98.85	7.87 6.59	0.254 0.266	1.10	n.s.
	Clear liquid fraction (C_2)	W C	15 14	106.85 69.02	7.12 4.93	1.098 0.323	1.91	0.1
	Microorganisms (D)	W C	4 4	40.38 37.13	10.09 9.28	0.425 0.393	1.40	n.s.
	Fecal material (E)	W C	3 5	35.83 45.00	11.94 9.00	1.177 1.305	1.73	n.s.
Total ash	Gross sample (A)	W C	22 24	294.54 341.78	13.39 14.24	0.218 0.329	2.16	0.05
	Washed sample (B)	W C	21 15	126.95 93.46	6.05 6.23	0.268 0.319	0.43	n.s.
	Clear liquid fraction (C_2)	W C	15 14	503.35 542.03	33.56 38.72	1.728 1.744	2.10	0.05
	Microorganisms (D)	W C	4 4	66.44 65.04	16.61 16.21	1.124 1.764	0.17	n.s.
	Fecal material (E)	W C	3 5	29.99 61.42	10.00 12.28	1.834 0.629	1.18	n.s.
Calcium	Gross sample (A)	W C	6 10	5.122 15.336	0.854 1.534	0.092 0.114	4.65	0.001
	Washed sample (B)	W C	6 3	3.948 3.309	0.658 1.103	0.042 0.089	4.53	0.005
	Clear liquid fraction (C_2)	W C	4 3	3.329 1.999	0.832 0.666	0.184 0.111	0.77	n.s.
	Microorganisms (D)	W C	2 2	1.274 4.140	0.637 2.070	0.037 0.500	2.86	n.s.
	Fecal material (E)	W C	2 2	3.028 8.180	1.514 4.090	0.620 0.740	2.67	n.s.
Phosphorus	Gross sample (A)	W C	6 10	13.218 22.658	2.203 2.266	0.136 0.093	0.38	n.s.
	Washed sample (B)	W C	6 3	4.752 2.657	0.792 0.886	0.058 0.032	1.43	n.s.
	Clear liquid fraction (C_2)	W C	5 3	28.602 16.094	5.720 5.364	0.294 0.199	1.00	n.s.
	Microorganisms (D)	W C	2 2	6.683 6.810	3.342 3.410	0.141 0.255	0.80	n.s.
	Fecal material (E)	W C	2 2	1.788 1.240	0.894 0.620	0.471 0.348	0.47	n.s.
Moisture	Gross sample (A)	W C	22 22	1955.0 1957.8	88.86 88.99	0.191 0.203	0.47	n.s.

[1]All values on a dry weight basis except moisture.
[2]W = Woronkofski Island and C = Coronation Island.
[3]Not significant at the 0.1 level.

to feed at frequent intervals during the daylight hours on early summer range, thus maintaining a relatively constant state within the rumen. Increased feed intake and full rumens during spring and early summer are associated with peak physiological demands for growth, lactation and recovery of fat reserves lost during the winter. In support of this assumption of a relatively constant rumen environment as the normal condition in ruminants are the *in vivo* studies of Moir and Somers (1956) with domestic sheep. They showed that when the same ration was fed in four portions per day instead of one, the

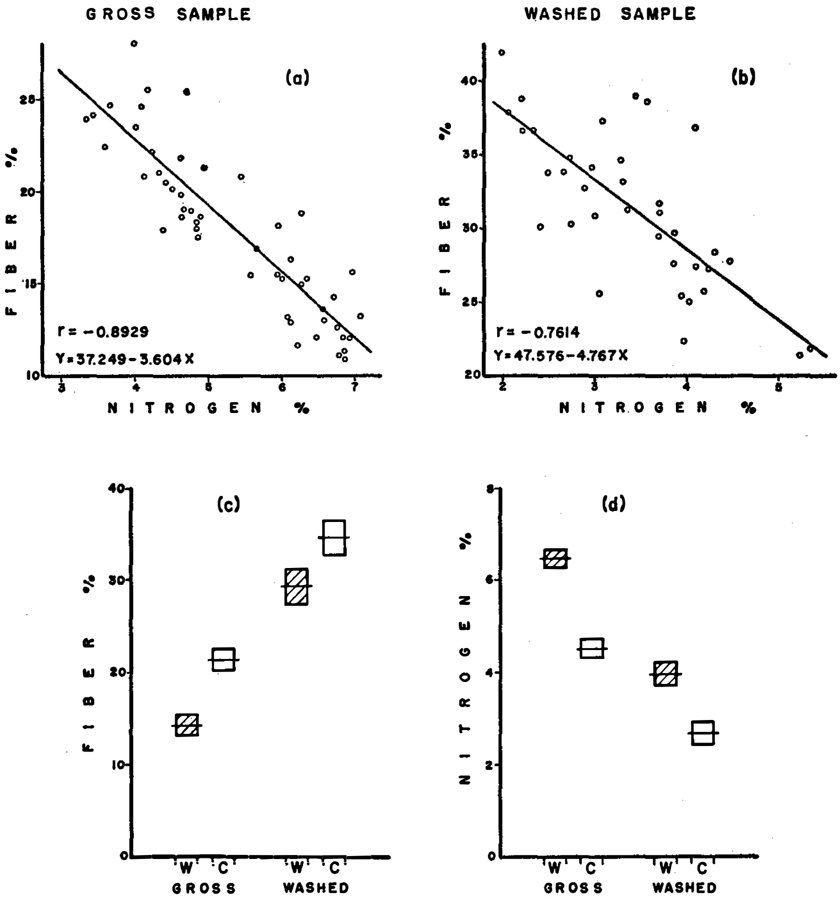

Fig. 1. Correlation diagrams, (a) and (b), show the relationship existing between fiber and nitrogen contents of both gross and washed rumen samples. Diagrams (c) and (d) show comparisons of mean fiber and nitrogen contents of gross and washed rumen samples from Woronkofski (W) and Coronation (C) Islands. The heights of the rectangles indicate the range of ± two standard errors.

protozoan population increased to approximately three times its previous level. Rakes *et al.* (1960) found that lambs made more rapid gains when the same amount of feed was consumed in eight meals per day rather than one. Also observations on *in vitro* cultures indicate that rumen protozoa appear devoid of reserve polysaccharide 24 hours after the addition of substrate and therefore cannot multiply or even maintain their numbers (Hungate, 1960). It was also felt that the phenomena of differential growth of rumen microorganisms on diets of different quality and varying length of retention in the rumen of plant nitrogens of unlike quality would tend to be compensatory and would have a minimal effect on the rumen samples.

Results of the chemical analyses of the variously treated rumen subsamples are shown in Table 1. It is apparent from the data that the gross and washed rumen samples both show highly significant differences between islands for nitrogen and fiber although the "t" values are slightly higher for the gross samples. Figures 1(c) and 1(d) show the clear separation obtained between islands in the nitrogen and fiber content of both the gross and washed rumen samples. Other components of the rumen analyses do not show distinct differences between islands with the exception of ash and calcium which are significantly higher in some of the Coronation Island samples. This is readily explained on the basis of the high calcium content of the limestone-derived soils of Coronation Island in contrast to the grantic soils of Woronkofski Island. Although high calcium: phosphorus ratios, in excess of 2 to 1, are frequently encountered in the forage of Coronation Island, it is not likely that such distorted ratios could result in inadequate absorption of phosphorus in wild ruminants where: 1) plant nutrients are not removed from the land and phosphorus levels in the forage appear adequate, 2) vitamin D is probably never in short supply and 3) large amounts of phosphorus are recycled to the rumen via the saliva. Calcium levels in the vegetation appear to be adequate in both areas and therefore the differences occurring in the rumen contents are not pertinent here.

Failure of the clear liquid fractions and the concentrated microorganisms to show significant differences ($p = 0.05$) between islands is understandable in light of the method of their derivation. The clear liquid fraction or rumen liquor includes primarily fermentation products and saliva in a water solution and is constantly subject to stabilization through absorption via the rumen wall and the addition of saliva. Large amounts of water, volatile fatty acids and ammonia are absorbed via the rumen epithelium (Annison and Lewis, 1959) and recent studies have demonstrated the absorption of amino acids as well (Smith, 1959). Salivary contributions to the rumen include as much as 10 per cent of the nitrogen requirements in sheep (Somers, 1957) while phosphate and sodium may exceed dietary sources (Bailey, 1959). A relatively constant state of the rumen liquor is essential for the maintainance of a suitable medium for proper rumen function and therefore one would expect only slight variations with diet.

The D samples represent microorganisms of the rumen concentrated through centrifugation and therefore chemical analyses of these samples are not representative of relative numbers of bacteria and protozoa. The high nitrogen content and phosphorus:calcium ratios obtained from the D samples are comparable to the chemical analyses of microorganisms (Porter, 1946).

The fecal sample analyses suggest a possible difference between islands in fiber content. Sample sizes were small and additional work is required to further explore the possibility of using fecal samples as valid indicators of forage quality.

Results of the evaluation of other methods of treatment of the rumen samples are presented in Figures 2(a), 2(b), 2(c) and 2(d). Results of all methods, with the exception of the microscope counts of *Metadinium* sp., showed linear correlations with the nitrogen content of the gross rumen samples. Positive correlations were found to exist between the nitrogen content of the gross rumen samples and both the volume of microorganisms present and the numbers of protozoa present. A negative correlation existed between the nitrogen content and the light transmittancy of the clear liquid fraction. Table 2 shows the evaluation of these treatments applied to the individual island data in which highly significant differences between islands were obtained with all but the *Metadinium* counts, indicating higher quality of range on Woronkofski Island. The degree of separation of mean values obtained, indicated in Figures 2(e), 2(f), 2(g) and 2(h), was greatest for the light transmittancy method, followed by the protozoa counts and the volumetric fractionation of microorganisms.

Greater light transmittancy of the clear liquid fraction from low quality rumen samples or, conversely, greater optical density of the clear liquid fraction from high quality rumen samples are apparently due to the relative amounts of dissolved plant pigments present in the rumen liquor. It seems logical that a linear correlation may exist between the relative proportion of plant pigments present and the nutritive quality of certain species of plants. This is quite likely associated with the stage of growth of plants, in which plants initiating growth have a relatively large proportion of highly pigmented and photosynthetically active tissue in contrast to maturing and less nutritious plants with a larger proportion of cellulose, lignin and other nonpigmented components. Reid *et al.* (1952) and Kennedy and Lancas-

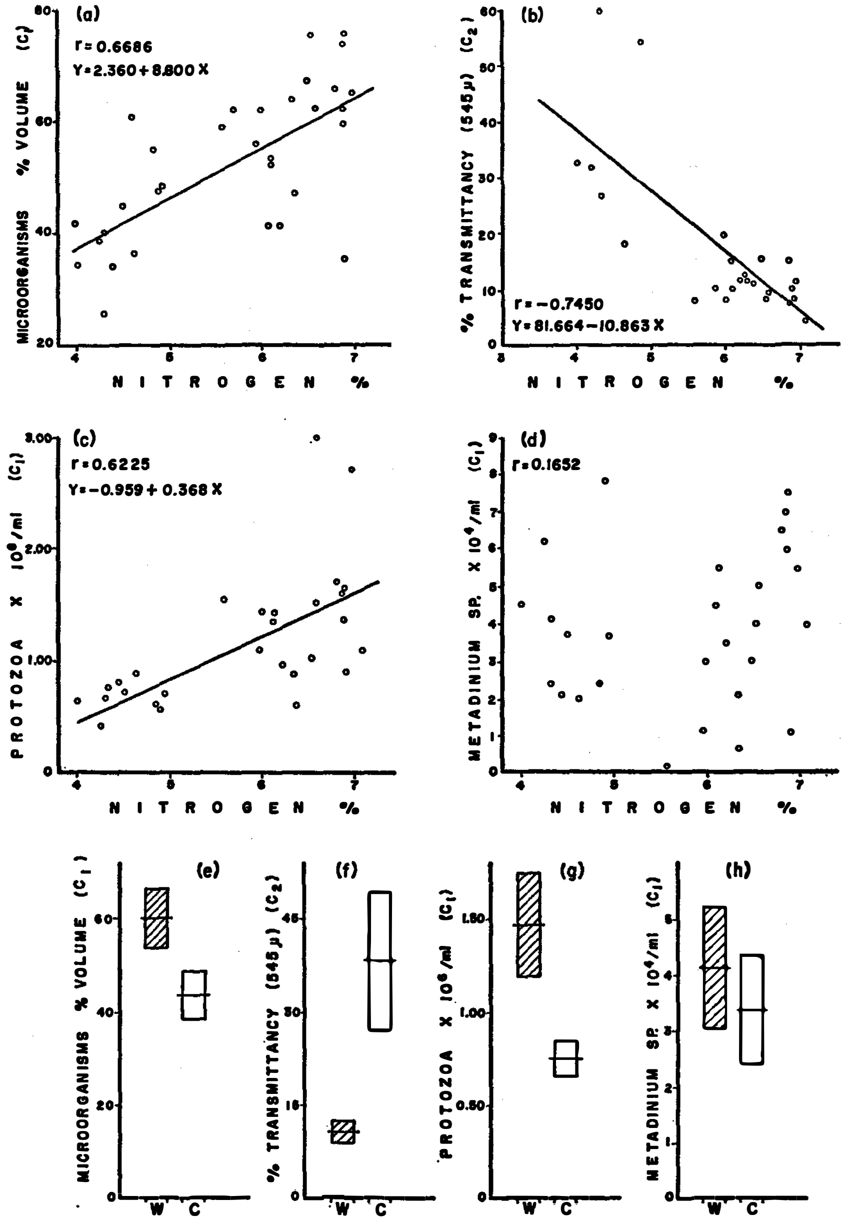

Fig. 2. The scatter diagrams show the correlations existing between nitrogen contents of the gross rumen samples and values obtained from the following treatments of rumen samples: (a) volumetric determination of microorganisms, (b) light transmission of rumen liquor and (c) and (d) microscope counts of protozoa. Comparisons of mean values from varying treatments of rumen samples from Woronkofski (W) and Coronation (C) Islands are made in (e), (f), (g) and (h). The heights of the rectangles show the range of ± two standard errors.

TABLE 2. COMPARISON OF SUMMER RUMEN SAMPLES FROM WORONKOFSKI AND CORONATION DEER SUBJECTED TO VARIOUS TREATMENTS

Treatment	Island	Sample size	Total	Mean	Standard error	t	Level of significance
Per cent volume of microorganisms in whole liquid fraction (C_1)	Woronkofski	20	1199.7	60.0	3.054	4.16	0.001
	Cornonation	19	826.5	43.5	2.535		
Light transmittancy (%) of clear liquid fraction (C_2)	Woronkofski	19	206.5	10.85	0.855	4.90	0.001
	Coronation	10	380.2	38.02	5.464		
Numbers of protozoa $\times 10^6$ per milliliter in whole liquid fraction (C_1)	Woronkofski	18	26.48	1.47	0.138	4.94	0.001
	Coronation	16	12.05	0.75	0.047		
Numbers of the oligotrich *Metadinium* sp. $\times 10^4$ per milliliter in the whole liquid fraction (C_1)	Woronkofski	18	74.4	4.13	0.540	1.04	not significant
	Coronation	16	53.7	3.36	0.493		

ter (1957) have shown that as forage digestibility increases the concentration of pigments in the feces of dairy cows also increases.

The correlations found to exist between nutritive quality of the rumen contents and determinations of amounts of microorganisms both volumetrically and by actual counts are understandable in the light of other studies. Mowry and Becker (1930) have shown that protozoa numbers may vary in sheep rumen contents from 200,000 per milliliter on hay alone to 700,000 when starch is added and 2,000,000 when protein is added, while Van der Wath (1942) found seasonal fluctuations of rumen protozoa in grazing sheep from 98,000 per milliliter in mid-winter to 455,000 in summer. Bryant and Burkey (1953) found similar fluctuations in numbers and species of bacteria with different quality diets but found that the level of feeding of a given ration had little effect on the numbers or diversity of the bacterial flora present. Protozoa, while fewer in numbers than the bacteria and usually numbering less than 1,000,000 per milliliter of rumen contents, may be equivalent in bulk to the bacteria. Christian and Williams (1957) found higher rumen microbial counts for sheep which were fed fresh grass than for those receiving dried grass while Hamlin and Hungate (1956) found rumen bacterial concentrations in sheep greater on a high protein grain diet than on a hay diet. While certain types of rumen microorganisms show considerable variation with the type of diet, there does appear to be a general correlation between total numbers of bacteria and protozoa and the nutritive quality of the ration.

CONCLUSIONS

The chemical determination of nitrogen content of gross rumen samples offers a very reliable technique for the evaluation of summer forage quality. Analyses of nitrogen content of the washed vegetative rumen components and fiber content of both the gross and washed samples also were reliable indicators of forage quality and can be used separately or in support of other analyses. Utilization of these standards enabled a clear separation between Woronkofski and Coronation Islands on the basis of range quality.

Simpler techniques of rumen analyses involving (1) centrifuge fractionation of microorganisms, (2) light transmittancy determinations of rumen liquor and (3) microscope counts of protozoa were all effective as techniques for evaluation of forage quality.

Additional work is required to further investigate the possibility of the use of fiber content of fecal pellets as an indicator of forage quality. The simplicity of collection of fecal material over rumen samples would make this a very practical field technique should it prove effective.

It is concluded that rumen contents analyses can serve as a useful technique for evaluation of forage and range quality of wild ruminants; however, some basis for comparison of values must exist. This requirement can be met through the adoption of standard values derived from ranges of known quality or comparison between ranges, seasons or years.

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DISCUSSION

DR. COWAN: We come now to the discussion of Mr. Klein's paper. Mr. Klein has introduced what may be the possibility of new techniques in evaluating range. Now, there undoubtedly are quite a few people in this audience who have been working along the same line. At least many of us have been concerned with the problem of evaluating range condition and range carrying capacity, so that we might ultimately be able to predict what populations we can tolerate on any given range. I would like to now open Mr. Klein's paper for discussion.

DR. C. M. HERMAN [Patuxent Wildlife Research Center, Maryland]: I think Mr. Klein is to be congratulated for an excellent presentation and for doing some very interesting work. I would, however, like to point out—and he has indicated this to some extent in his presentation—that the deer or any ruminant is not able to utilize the food that it has eaten until after the microorganisms in the rumen have converted this into material that the deer's physiological system can utilize, and perhaps the thing that will advance our knowledge even more than what Mr. Klein has presented—the biology of these rumen microorganisms—is a field, at least in wildlife, that we have not yet touched.

MR. KLEIN: I certainly agree and I think that one thing that should be pointed out is that the knowledge of human physiology has progressed considerably in recent years and there are many advances that are being made now. The literature available in the agricultural sciences is certainly worth-while utilizing. I think we have been overlooking this in the past, but again I agree that we need more work done on rumen physiology and the relationship of the microorganism to the quality of the diet.

DR. COWAN: Mr. Klein has made reference to the analysis of feces collected in the field. Would you care to comment on that, Mr. Klein?

MR. KLEIN: Yes, we took feces from the rectums of our specimen deer, and we compared and analyzed them chemically; and although the samples for analysis were very small, there appeared to be a negative correlation between the fiber content in the feces and the quality of the range. I would like to see a little more work on this before I come out with a blanket statement, but there is a good possibility that there would be a correlation. If the technique was useful, it obviously would be exceedingly more simple than techniques I have employed.

DR. COWAN: Mr. Klein, would deer, on ranges of equal quality, but consisting of different forage species, be expected to yield similar rumen analysis values?

MR. KLEIN: First of all, in the comparisons of the range between the two islands, Woronkofski and Coronation, there was a difference in the species represented, although some of the same species were utilized. Coronation Island was so poor that many of the highly palatable species had been eliminated. Now, if the species were exceedingly different in fiber content and nitrogen content, I don't think that there would be any serious problems in utilizing the chemical analysis technique. As far as the other more simple techniques of light transmittancy determination, you might run into a little trouble; certainly the amount of plant pigments in various species would vary with the quality of the forage, and this should be taken into consideration. However, I would like to see this technique used in drier areas.

DR. BUCKLEY: Mr. Klein, is there any intent to continue this over a period of time as the forage on the islands changes?

MR. KLEIN: I think that is a good idea. However, the assumption that the Woronkofski range is going to change significantly is perhaps not a valid one, because the Woronkofski range has been protected by two factors. One, a heavy wolf population, and another one, a heavy snowfall which causes the deer to die off, but protecting the range during the winter months. We undoubtedly hope to follow it up. We hope to try it on other species such as moose and caribou.

DR. AL GREICHUS [University of Wyoming, Laramie]: One aspect that you haven't covered that I thought might be important. You stuck quite a bit to rumen analysis and also to fecal analysis, but as far as the protein aspect of nutrition in the ruminant, the microorganisms are broken down in the small intestine and utilized in that respect. Have you ever given any thought to analyzng the intermediate area between the two ends that you have been talking about?

MR. KLEIN: We try for a complete utilization of specimen material; however, we have avoided the intermediate region because the microorganisms are broken down there and absorption is taking place. The rumen has the microorganisms present and we included them obviously in our analysis of the gross sample but not of the washed sample. I think that it could be followed up in other studies.

DR. E. L. CHEATUM [New York State Conservation Department]: First of all, I would like to commend the point of view that was expressed in the first part of this paper, implying the very important and often neglected area of the summer range—the total nutritional status of the deer. In the first place, as we all know, following a wintering hardship, the summer range and the quality of the food on that summer range have profound influence on the reproductive performance the following fall, and also in the development of antlers and as a consequence, the summer range clearly is something of vital importance. It is interesting to see the increasing attention paid to this huge fermentation vat, the rumen of deer, and the growing recognition of the importance of this vital organ to the animal. I was in attendance in Athens, Georgia, the other day at the Deer Disease Symposium where it was stated hat the deer pays very close attention to what he puts in his rumen, and the rumen apparently also tells the deer that he needs a little bit of this and a little bit of that in order to keep to a healthy state. So attention to this vital organ, I am sure, is going to yield some very distinguished results. As. Dr. Herman pointed out, the secondary but perhaps primely important function of microorganisms in that rumen and the way they manage the constituents of that food to that deer, is something that needs a great deal of attention and is another aspect of this study.

RELAPSE OF *HAEMOPROTEUS SACHAROVI* INFECTIONS IN MOURNING DOVES[1]

JOHN N. FARMER
University of Missouri, Columbia

Becker and co-workers (1956, 1957) described naturally occurring *Plasmodium* and *Haemoproteus* infections in the common pigeon. Birds harboring these infections were obtained from a pigeon colony at Gilbert, Iowa. Some of the blood films obtained from the birds were positive for *Haemoproteus sacharovi* Novy and MacNeal. There is little bert, Iowa. Some of the blood films obtained from the birds were positive for *Haemoproteus sacharovi* Novy and MacNeal. There is little information available concerning the biology of this organism. Although its morphology has been described by Huff (1932) and by Coatney and West (1940), no further stages of its life history have been clearly defined.

Farmer (1960a) established that patent *H. sacharovi* infections in the Gilbert pigeons were evident only during the summer months. Consequently, to ensure the yearly appearance of *H. sacharovi,* either a natural reservoir host was available, or, a relapse phenomenon, similar to that exhibited by some *Leucocytozoon* infections was responsible.

During 1957, 1958 and 1959 the blood of pigeons, ranging in age from one to ten weeks, was examined. A number of older birds were also included in this survey. Infections of *H. sacharovi* were demonstrable only in birds two through five weeks old. No infections were noted in pigeons older than five weeks. Apparently, *H. sacharovi* does not relapse in the pigeon. Accordingly a reservoir host was suspected to be responsible for the annual appearance of *H. sacharovi* in the pigeons.

Since the mourning dove is considered to be the natural host for *H. sacharovi,* doves were trapped and their blood examined for the

[1]From a dissertation submitted to Iowa State University, Ames, Iowa, in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The study was supported in part by research grant No. E 992-C from the Division of Research Grants, National Institutes of Health, Public Health Service.

presence of these haemosporidians. Farmer (1960b) reported 22 of 41 doves examined to harbor patent *H. sacharovi* infections. The fact that the gametocytes of this organism disappeared from the blood of infected doves for days at a time, a characteristic also reported by Wetmore (1941), led to the following investigation.

MATERIALS AND METHODS

Doves were trapped in the vicinity of Ames, Iowa. Drop door traps operated by trip wires and baited with cracked corn, and funnel traps similarly baited were utilized to capture the birds.

Blood samples were obtained from the birds by puncturing a toe with the blade of a scalpel. After fixation in absolute methyl alcohol, blood films were stained in diluted Giemsa.

Preliminary examination of an entire smear was made under the low power of a Bausch and Lomb binocular microscope equipped with 10× oculars. Blood films, even when apparently negative, were examined under oil immersion for a period of five minutes. Care was taken not to re-examine the same fields, thus permitting the examination of approximately 250 to 300 different fields. All identifications of parasites were confirmed by using oil immersion. The measurements of parasites and blood cells recorded during this investigation were obtained with the aid of a calibrated ocular micrometer.

RESULTS AND DISCUSSION

In *Haemoproteus* infections, relapse can be recognized only by the appearance of gametocytes in the peripheral circulation, since exoerythrocytic development occurs elsewhere. For example, the asexual developmental processes of *H. columbae* in the pigeon is known to take place within capillaries of the lung.

The parasitological phases of avian malarial infections include prepatent, patent and subpatent periods. The prepatent period encompasses the length of time between the entrance of the parasite into the vertebrate host until it is demonstrable in the peripheral circulation. The patent period includes that interval during which parasites may be readily observed in the blood. The subpatent period is one in which parasites may be present in the blood but are so few in number that they are usually overlooked using routine techniques.

Any reappearance of young gametocytes following a subpatent condition, excluding reinfection by the intermediate host, constitutes a relapse.

At the onset of a relapse of *H. sacharovi* infections in mourning doves, small, ring stages are observed in erythrocytes. On the following day, the developing parasites are usually elongate, lying adjacent to the nucleus of the host cell. In Giemsa stained smears, the parasite nucleus stains pink and sometimes contains a maroon stained karyosome. By the third day, hyperthrophy of parasitized red blood cells is very obvious.

Some macrogametocytes at this stage completely fill the red blood cell. In a majority of invaded erythrocytes, the host cell nucleus is displaced laterally by the developing gametocyte. Where the host cell nuclear displacement is polar, however, the parasite tends to envelop the nucleus rather than to displace it. Sex of gametocytes is easily differentiated at this stage of their development. The cytoplasm of macrogametocytes stains blue with Giemsa, and generally possesses a mottled or vacuolated appearance. Numerous fine granules and several slightly larger, more conspicuous granules are scattered throughout the cytoplasm. The nucleus of the macrogametocyte is ovoid to elongate and stains reddish pink. It is generally located toward one end of the parasite and possesses a circular maroon staining karyosome. This karyosome is invariably situated at the periphery of the nucleus. Indeed, in many macrogametocytes the location of the karyosome is almost completely outside of, but never quite losing contact with, the boundaries of the nucleus.

The cytoplasm of microgametocytes stains a rather diffuse pink with Giesma. Vacuolation is less apparent in microgametocytes than in macrogametocytes. Eosinophilic granules are present and are more conspicuous, but less numerous, than the granules observed in the female stages. The nucleus of the microgametocytes is considerably larger than the corresponding structure in macrogametocytes, and stains a slightly darker pink than the surrounding cytoplasm. It is located near the center of the parasite and possesses a round, maroon staining karyosome generally located near the center of the nucleus. The peripheral orientation of the karyosome never appears to approach the extremes exhibited by corresponding structures noted in macrogametocytes.

By the fourth day, gametocytes may completely fill the infected erythrocytes. Other than an increase in size, there is no morphological change in microgametocytes. In macrogametocytes, however, the cytoplasm tends to stain a darker blue, with pigment-like granules appearing more distinct. Such granules become increasingly conspicuous day by day as long as macrogametocytes are demonstrable in the blood.

An extensive experiment concerning relapse was begun in November, 1958. Eight doves were used, seven of which were known to harbor, or to have harbored, *H. sacharovi* infections at the time the experiment was started. Of these eight birds, two (Doves #1 and #13) were designated as controls. *H. sacharovi* had been diagnosed from Dove #1 at the time of its capture in June, 1957. The infection was apparently a terminal one, since gametocytes had not been demonstrable in the blood for at least six months preceding the start of this experiment. Dove #13 had been under observation since August, 1957 and was considered free from haemosporidian parasites of any kind. All the birds were kept in the same cage for the duration of the experiment. As a precautionary measure, to exclude the possibility of reinfection, the birds were examined periodically for the presence of ectoparasites, as were other birds maintained in the same animal room but not involved in the test.

Details of the relapse phenomena as shown by six of these infected doves are indicated below, as well as by Figure 1.

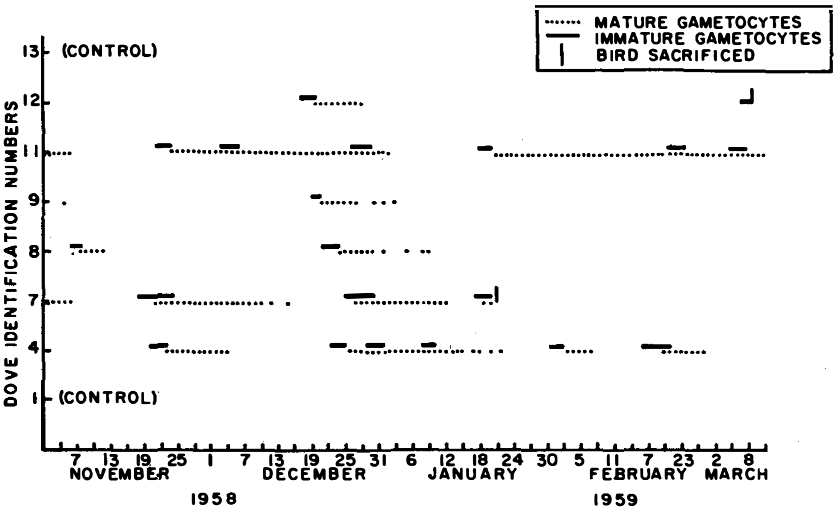

Figure 1. Relapse phenomena exhibited by mourning doves examined daily for 130 days.

Dove #1: During the 130 days that it was under daily observation, its blood remained parasite-free. Although having been infected with *H. sacharovi* at one time, this bird had apparently been successful in throwing off the infection.

Dove #4: During the period of 130 days that this bird was under observation, the infection relapsed six times with five latent periods being recognizable. From November 1 to 19, 1958, parasites were not detected in its blood. The first relapse occurred November 20th-24th, with fully developed gametocytes being observed November 23rd. Mature gametocytes were present in the blood for a period of twelve days. The sexual stages then disappeared for a period of 18 days, followed by the onset of a second relapse December 23rd-25th. Fully developed gametocytes were noted December 26th and were demonstrable in the blood for 20 days thereafter. During this period, the appearance of young gametocytes was observed December 31st-January 1st, 1959, and again January 8th-10th. Although they do not follow periods of latency, the reappearance of young gametocytes in this way constitute the third and fourth relapses of infection. After January 15th, the infection appeared to have reached such a low level that only occasional gametocytes could be detected in the blood with the infection becoming latent January 23rd. A fifth relapse occurred January 31st-February 2nd, with fully-developed gametocytes being demonstrable until February 7th. A latent period of nine days was interrupted by a sixth relapse February 17th-21st, with mature gametocytes being observed daily until February 28th, at which time the infection became subpatent.

Dove #7: During the 81 days that this bird remained under observation, parasites completely disappeared from the blood five times. Fully-developed gametocytes were noted in the blood from the time that the experiment was begun and remained present until November 6th, 1958. A latent period, lasting 11 days, ended on November 18th, with the appearance of ring-like stages in the blood. Developing stages were conspicuous in the blood until November 24th, with fully-developed gametocytes being detected November 21st and remaining demonstrable for the following 20 days. A single, degenerate macrogametocyte was noted December 12th and another on December 15th. There followed a period of nine days during which the blood remained parasite-free. The reappearance of young gametocytes was observed December 25th-30th, with fully-developed gametocytes first being noted December 27th and remaining demonstrable in the peripheral circulation for the following 16 days. A latent period of only four days was followed by a third relapse January 17th-20th, 1959, at which time the bird was sacrificed.

Dove #9: During the 130-day examination period, only one relapse occurred. A single fully-developed gametocyte was observed November 4th, 1958, after which the peripheral circulation remained free from parasites for 44 days. The relapse occurred December 19th-21st, with fully developed organisms being detected daily December 21st through December 27th. Single gametocytes were again observed December 30th, January 1st, 1959, and January 3rd. The blood remained parasite-free throughout the remainder of the experiment.

Dove #11: During the course of infection, six relapses were observed, with parasites completely disappearing from the blood two times, both for intervals of 15 days.

Mature gametocytes were noted in the blood at the start of the experiment and remained present until November 6th, 1958. A latent period of 15 days duration was interrupted by the first relapse November 22nd-24th. Fully developed gametocytes could be detected in the blood for the next 39 days. During this span, two relapses were observed; one December 3rd-6th, the other December 26th-30th. A latent period, 15 days in length, ended with the appearance of young gametocytes January 18th-20th, 1959, constituting the fourth relapse of this particular course of infection. Mature sexual forms remained demonstrable in the peripheral circulation for the remainder of the experiment, a period of 48 days. Two more relapses occurred, February 18th-21st and March 4th-7th.

Dove #12: The course of infection included two relapses separated by a latent period of 66 days. Gametocytes did not appear in the blood until December 18th, 1958. Ring stages were observed on this date only, with development of gametocytes continuing until December 21st. Fully developed gametocytes were first detected December 20th and remained until December 28th. A latent period of 66 days ended with the re-appearance of young gametocytes March 7th-8th, at which time the bird was sacrificed.

Dove #13: The blood of this bird, used as a control, remained parasite-free throughout the course of the experiment.

From the data presented above, it is apparent that relapse of infection of *H. sacharovi* in mourning doves are of common occurrence. Furthermore, it emphasizes the fact that birds which appear to be parasite-free when first examined may, nontheless, be subject to relapse even though maintained under conditions whereby reinfection by possible intermediate hosts is unlikely. Since the birds used in these experiments were all maintained under the same environmental conditions, it would appear that relapse is not necessarily influenced by extrinsic factors but by the variability in physiological processes of individual hosts. Ben-Harel (1923) in her studies concerning the mechanism of relapse in bird malaria stated that some birds relapsed at varying intervals, although environmental conditions had not been altered in any way. Moreover, she was able to provoke relapse in some cases, using ultraviolet radiation and injections of adrenalin. Coatney (1933) also noted a wide variation in the frequency of relapse in *H. columbae* infections. He stated, however, that there appeared to be some correlation between intensity of initial infections and the frequency of relapse. In the present study, since no experimental infections were made which involved birds known to be parasite-free, no information can be given relative to this aspect of the problem.

Further aspects of relapse phenomena are considered below.

Periodicity of relapse. The data in Figure 1 suggest a lack of periodicity of any type in successive relapses of *H. sacharovi.* For example, Dove #4 relapsed six times at intervals varying from nine to 33 days. Dove #7 underwent three relapses at intervals of 23 to 37 days, while in Dove #8, a second relapse followed the first after an interval of 45 days. Dove #11 underwent six relapses at intervals ranging from 11 to 33 days. Two relapses were recorded in Dove #12, 78 days apart. These data agree with the findings of Coatney (1933), who, although investigating a different species, (*H. columbae*), recorded similar results concerning the lack of periodicity of relapse.

Frequency of relapse. From the data presented in Figure 1, it is apparent that the frequency of relapse varies from bird to bird. Thus, in the space of 130 days, Doves #4 and#11 each relapsed six times while Dove #7 relapsed three times in 111 days. Doves #8 and #12 each relapsed twice during 130 days, while in Dove #9, young gametocytes reappeared only once.

Hypertrophy of parasitized erythrocytes. The most striking characteristic of gametocytes of *H. sacharovi* is their size. Although several investigators have commented on the size of these organisms, none have specified their actual dimensions. According to Huff (1931), gametocytes of *H. sacharovi* completely fill infected red blood cells and enlarge them to a size 1.3 times as wide and 1.4 times as long as a normal red blood cell. Illustrations comparing normal and parasitized erythrocytes were published by Huff (1932) but measurements were not included. Coatney and Roudabush (1937) also did not publish any dimensions in their descriptions of *H. sacharovi* in the mourning dove.

In the studies here presented, it was noted that parasitized cells are greatly distorted and enlarged by the presence of gametocytes. Fully developed gametocytes often fill the host cell completely, although some mature gametocytes are contained within erythrocytes whose dimensions are greater than those of the invading organism. Hypertrophy of erythrocytes is noticeable even in early development stages of the parasite. Accordingly, measurements were made to determine the size of uninfected red blood cells, infected erythrocytes and gametocytes. Films made from blood obtained from Doves #4, #7, #8 and #11 were examined. The dimensions of randomly selected red blood cells were recorded from each of the doves, 25 from each bird. These data indicate that uninfected erythrocytes average 12.94 μ in length and 5.95 μ in width. A total of 19 micro-gametocytes was measured, 14 from Dove #4 and five from Dove #8. Their mean length was 10.06 μ and their mean width, 6.42 μ. The host cells for these microgametocytes averaged 16.92 μ in length and 7.55 μ in width. The dimensions of 181 macrogametocytes were also recorded, 72 from Dove #4, 54 from Dove #7, 18 from Dove #8 and 37 from Dove #11. These data indicate 14.18 μ and 6.74 μ as their mean length and width, respectively. The dimensions of the host cells for these female forms were a mean length of 15.77 μ and a mean width of 8.35 μ.

CONCLUSIONS

H. sacharovi infections in mourning doves are characterized by their tendency to relapse. Whitmore (1922) was able to produce relapse in birds having latent infections of *Plasmodium relictum.* These were induced by exposing the birds to the light of a quartz mercury vapor lamp. Ben-Harel (1923) noted that malarial infections in some birds relapsed more than others, although the surrounding conditions had not been changed. She also produced experimental relapse in some cases by exposing birds to ultraviolet radiation or by injecting them with adrenalin. Taliaferro (1925) observed, while studying malarial infections, that during latency, although parasitemia is low, the same asexual cycle persists as did during the patent period. He concluded that relapses occur only when the host-defense mechanism is unbalanced to the extent that the parasites are able to resume reproduction on a larger scale. However, no one has yet demonstrated the basic mechanism which brings about this decrease in resistance and subsequent relapse. Coatney (1933), while describing variations that he noted in the frequency of relapse during *H. columbae* infections in pigeons, attributed them to the intensity of the initial infection. The *H. sacharovi*-infected mourning doves utilized in my experiments concerning relapse were maintained under similar laboratory conditions. No attempts were made to decrease their resistance and thereby induce relapse. However, the infections in these birds relapsed at varying intervals and at different times. Since only naturally-infected doves were examined, however, the intensity of the initial infections is not known. The discovery of the transmitting agent for *H. sacharovi* would permit controlled experiments to be performed, at which time any correlation between intensity of the initial infection and frequency of relapse may be elucidated.

Of considerable importance is the fact that *H. sacharovi* tends to relapse in mourning doves and not in pigeons. Since penned pigeons may harbor *H. sacharovi,* a source of infection must be available. Infections in pigeons are initially observed after mourning doves return in the spring, with no new infections being noted after the middle of September. This coincides with the southward migratory flight of mourning doves. Blood examination of a number of avian species, other than mourning doves, revealed none harboring *H. sacharovi.* Consequently, it is assumed that the mourning dove is the reservoir host for this organism.

SUMMARY

1. The reappearance of young gametocytes of *H. sacharovi* in the blood of infected doves after gametocytes apparently disappeared from the peripheral circulation is attributed to a relapse phenomenon.

2. Experimental evidence indicates that relapses of infection of *H. sacharovi* in mourning doves are of common occurrence. Furthermore, mourning doves which are apparently parasite-free may nonetheless be subject to relapse even though reinfection by possible intermediate hosts is unlikely.

3. Experimental evidence indicates a lack of periodicity in the reappearance of gametocytes.

4. Variation in the frequency of relapse from bird to bird was also recorded. Since the mourning doves were maintained under uniform conditions of light, food, water and temperature, some other factors, apparently, is responsible for one bird to experience more relapses than another.

5. Complete measurements of micro- and macrogametocytes from infected doves indicate a distinct hypertrophy of infected erythrocytes.

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DISCUSSION

DR. COWAN: To the best of my knowledge this is the first study to be concerned with the relapse phenomenon in *Haemoproteus sacharovi*, and I am mighty glad that I saw Mr. Farmer's slides of gametocytes before I was called on to diagnose the disease. I would like to start the discussion myself, if I may take that prerogative. In the studies of relapse in *Leucocytozoon*, Korschgen found that the advent of the breeding season most normally brought on relapse with leucocytes. Jim Barrow, working at the Biological Station at the University of Michigan, has found that he can bring on relapse in ducks by submitting them to social stresses. Now, this is by breaking up some way or other their relations to the flock, and I would like to ask Mr. Farmer if he has done any work along this line in studying the relapse phenomenon in *Haemoproteus sacharovi*.

DR. FARMER: We are on the periphery of this, I think, at the University of Missouri. We have an endocrine man there, a physiologist, who is extremely interested in this and we are hoping to use the parasite as sort of a tool in this area. We have already injected some birds with testosterone propionate in an attempt to knock down the lymphatics of these birds, thus permitting relapse to occur, but at present the results are completely and absolutely negative. I have a horrible feeling they will continue to be so.

DR. CARLTON HERMAN [Patuxent Wildlife Research Center, Maryland]: I would like to add some remarks to this. First of all, Arch, there have been a number of other studies in the relapse in *Haemoproteus*, one that I did myself a number of years ago on the *Haemoproteus* of the quail, if you recall, and there have been some on ravens in Germany. We have been very much interested in *Haemoproteus* in mourning doves and pigeons in some of the work that we have been doing in Patuxent. As part of our studies on trichimoniasis in doves we have been holding pigeons and mourning doves in order to have these birds available. In the process, we have been studying the bird protozoa, too. One of the boys on our staff has been making studies of blood smears that we have obtained from pigeons—some of them, however, have been coming from the yards where they have been kept penned—and we have found a tremendous fluctuation and we have found that the protozoa apparently remain in the blood demonstrably for long periods of time. The thing that fascinates us most about this is the transmission of the infection. We know from work that others have done, both reported in the literature and talking with people that are raising pigeons for the squab market, that *Haemoproteus* of the pigeon is transmitted by *Hippoboscid* flies. This is a blood-sucking fly that lives its entire adult life on the host, and it is so severe that the man raising large numbers of squabs for market unless he controls these flies will get epidemics which will put him out of business unless he does. In the mourning dove we have various *Haemoproteus* types, but we have no evidence of the *Hippoboscid* fly on the mourning dove throughout most of their range. The only reports ar eof *Microlynchia* that has been reported in the most southern areas of the United States. Yet, we have this in the dove throughout the range. It has been demonstrated in the last few years that ducks that have *Haemoproteus* but where no *Hippoboscid* flies are present, have a life cycle which goes through the *Culicoides* fly area and we are assuming therefore that the *Haemoproteus* of the mourning dove is transmitted by the *Culicoides* primarily in its natural habitat. The evidence, however, on the *Haemoproteus* in the pigeon is that the primary vector is the *Hippoboscid* fly. We are carrying on studies at the present time which are a ramification of this fly but are not far enough advanced to show whether they are the cause of *Haemoproteus*. I might conclude this by saying that this has been done by Huff and Coatney and others in transmitting from the pigeon to the dove and from the dove to the pigeon.

DR. FARMER: In the course of my work with *Haemoproteus sacharovi* I was, of course, interested in the invertebrate host which was the transmitter of organisms. Realizing that Huff and Coatney had done work in the transmission of this particular organism, using the *Hippoboscid* fly, I attempted to follow in their footsteps, thinking that I would be able to then utilize these forms for a quantitative study, poboscid fly. About this time, the *Cylicoides* emphasis came into being, principally in the works of Fallis, up in Canada, and Wood; so I managed to get a colony of *Cylicoides variipennis* in an attempt to use *Culicoides* flies in the transmission with miserable results. I was unable to get them to bite and transmit *Haemoproteus sacharovi.* They didn't even suck blood from these forms. Of course we run into these and similar problems with black flies. Then I got pretty desperate. I started using stable flies. They sucked blood from the pigeons and mourning doves, but did not transmit the organism. I tried mosquitoes of various types, since *Plasmodium relictum* was also present in this colony. I decided that maybe by some outside chance mosquitoes were the invertebrate host. I used several forms of mosquitoes, all with negative results.

DR. HERMAN: If I may, I would like to add one other interesting sidelight to this relapse phenomenon. Much more work has been done on *Leucocytozoan* experimentally than on *Haemoproteus.* You recall the work of Korschgen, and in this possibility I thought it would be interesting to bring up his work again. He was working with leucocytes in doves and was aware of the relapse phenomenon, took some of these birds back to his laboratory and tried to determine when the relapses occurred. All of us who have worked with ducks know that sometime in the spring we have a reoccurrence of the gametocytes in the blood. Chernin found that by changing the amount of light available each day to these birds in captivity, he could move the time that the relapse occurred up as much as a month and a half, and peculiarly they started laying eggs earlier, also. He tried this with hormones but had no success. I think this is an interesting sidelight that may revert back to our studies in *Haemoproteus* as well.

RELATION OF ECTOPARASITE LOAD TO HOST SIZE AND HOME AREA IN SMALL MAMMALS AND BIRDS[1]

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Ectoparasites are the vectors of a multitude of diseases from host to host: tularemia between rabbits and birds; typhus between rat and rat, or rat and mouse; spotted fever between meadow mice and rabbits, and sometimes one or another of these diseases, and others, to man. However, though house mice, *Mus musculus,* share plague- and typhus-bearing fleas with domestic rats, *Rattus norvegicus* and *R. rattus,* they are rarely regarded as important in epidemics of typhus and plague. And although house wrens, *Troglodytes aedon,* share tularemia-bearing ticks with rabbits, neither wrens nor other small birds are particularly important sources of tularemia in man. Apparently the number of vector parasites on the small species is too low for efficiency. The larger hosts tend to bear the larger parasite load and this, in turn, affects the prevalence of certain arthropod-borne diseases. There may also be an upper limit beyond which increasing numbers of ectoparasites do not increase transmission. There are, of course, other

[1]This investigation was supported in part by a research grant (E-3653) from the National Institutes of Health, Division of Research Grants, Public Health Service.

factors: age, degree of physiologic susceptibility, morphology, microhabitat, grooming ability, state of health, and time of activity of host and parasite. The relative effects of these can be evaluated in part by checking experiment and observation of one factor against those of others.

Here we shall discuss the observed relation between the size of the host; its home area (which is the result of the area over which it moves) and the number of various kinds of field-inhabiting parasites to be found. The field data to be presented below are based on 424 observations on parasitism by chiggers (Trombiculidae) on 76 California meadowmice, *Microtus californicus,* during a 1-year period in San Mateo County, California.

Comparisons are made between these data and those presented by other writers concerning infestations by ticks, other species of chiggers and certain fleas.

The home ranges (or territories) of the mice were determined by live-trapping, marking, releasing and retrapping them every other week. The traps were set at 10-foot intervals in a study area of 1 acre and baited with rolled oats. Data on mice whose ranges lay partially outside of the study area were excluded. Mice observed at least 4 times were used. Over 1,200 observations were made on home ranges of the mice.

Ticks and chiggers were chosen as the parasites for field study because they lie in wait in the general habitat of their hosts, and hence are notably influenced by the size, population, and activity of their hosts, whether bird or mammal.

OBSERVATIONS

The average home range of all the meadowmice which were caught 4 times or more was linear: 1 unit wide by at least 2.5 units long. (Fig. 1 c) It varied with season and other factors but was essentially as described by Stumpf and Mohr (1962) based on a smaller number of observations.

Ninety-four per cent of the meadowmice which were examined for parasites maintained relatively narrow home ranges, while under observation. Their home ranges varied from 1 unit wide by 3.0 units long to 1 by 12. Six percent maintained relatively broad home ranges varying from 1 unit wide by 1 long to 1 by 2.9.

Essentially equal percentages of the male and female meadowmice were parasitized by chiggers. The size of the host individual, or some factor related to it, governed the percentage infested. Seventy-nine percent of the observations (131) on hosts over 100 mm long showed chiggers present. Only 34 percent of the observations (84) on small

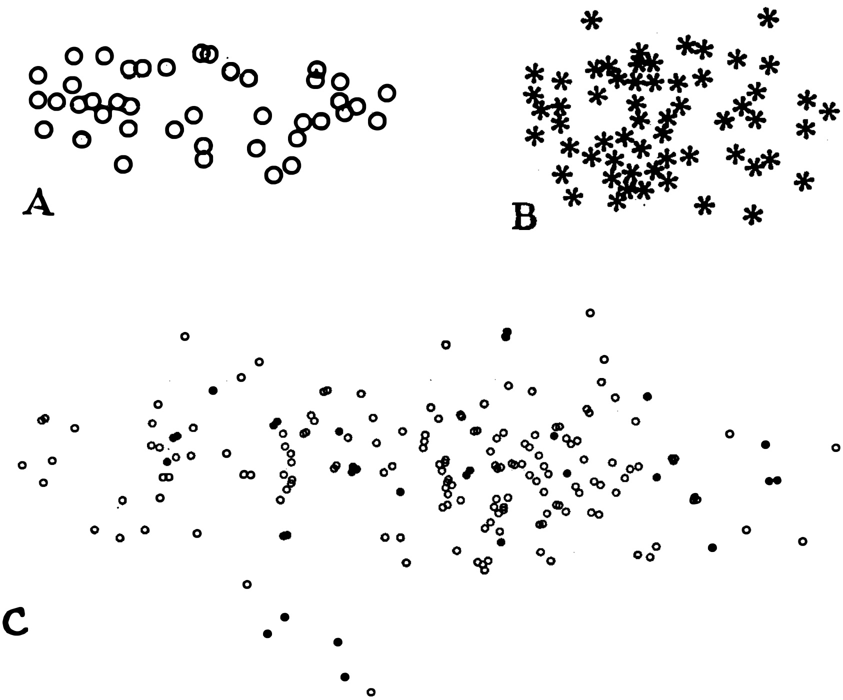

Fig. 1. Territories of ring-neck pheasant (A) and red-tailed hawk (B) adapted from figures by Taber, 1949, and Fitch, Swenson and Tilton (1946). (C) Composite range of California meadowmouse. Circles represent records of capture during a 52-day period; spots represent those over a 1-year period.

mice showed chiggers present. These differences are significant statistically according to graphs provided by Davis and Zippin (1954).

The size of the home range (area or territory) of the host was related positively to the size of the host. Large meadowmice (over 100 mm long) maintained large observed ranges; 36 percent had observed ranges varying from 1000 square feet up to 5,240 square feet in area, and 29 percent had ranges varying from 235 to 349 square feet. Small hosts maintained relatively small observed ranges; 24 percent had ranges varying from 1000 square feet to 2,329 square feet, and 38 percent from 86 square feet to 349 square feet. Thirty-five percent of the large hosts and 38 percent of the small hosts maintained home ranges in the middle category: from 350 square feet to 999 square feet.

The shape of the home range of the meadowmice, that is whether relatively broad or relatively linear, appeared to have no effect on the percentage of hosts infested; 42 percent of those with observed broad (nearly circular) ranges were infested, whereas 40 per cent of those with ranges from one unit wide by four or more units long were infested.

DISCUSSION

The positive relation of the percentage of meadowmice infested to the size of the home range is in keeping with findings and suggestions of other workers: Milne (1949) for *Ixodes ricinus* on various animals; Worth (1951) for various ectoparasites on sylvan rats; Mohr (1961) for chiggers on two species of rats in New Guinea; Audy (1961) for chiggers on Asiatic rats.

The positive relation of the percentage of meadowmice infested and the size of host is in keeping with the findings of Hirst (1953) Milne (1949), and Mohr (1961). A notably sharper increment in increase of parasitic load than in size of hosts in a number of species has been suggested (Mohr, 1961) to be partly attributable to the proportionally larger home areas of the larger hosts in various species. By calculating the probable effect on the parasite load of the home-range factor, much of the difference in parasitism, not accounted for by the size of the host, was accounted for by the relative size of home range. So far, as accuracy of observation permitted, the remainder of the difference in parasitism is assignable to more purely biologic factors such as place, nature, time and intensity of activity of the host.

Relatively narrow home ranges have been observed in a considerable number of ground-inhabiting hosts by various observers: Brown (1956) and Stumpf and Mohr (1962) as well for the California meadowmouse (Fig. 1c). Offhand it would seem that animals with narrow home ranges might sample more kinds of microhabitats than animals with nearly circular home ranges; hence might acquire more ectoparasites. Similarity of the percentage of meadowmice infested in this study, whether they occupy nearly circular home ranges or ranges which are markedly linear suggests that shape of range, per se, had little effect on parasitism by such parasites as chiggers which are largely nurtured by the host individual and by its immediate associates.

Examination of the literature pertaining to the percentage of various species infested by ticks and chiggers also shows a relation of parasite load to host size or factors associated with host size. The percentage infested in such small animals as mice, wrens, sparrows and warblers is small, whereas that of large species is large. The highest number of parasites on small species is notably small, it increases rapidly with increase in size of the host in question, then tends to level

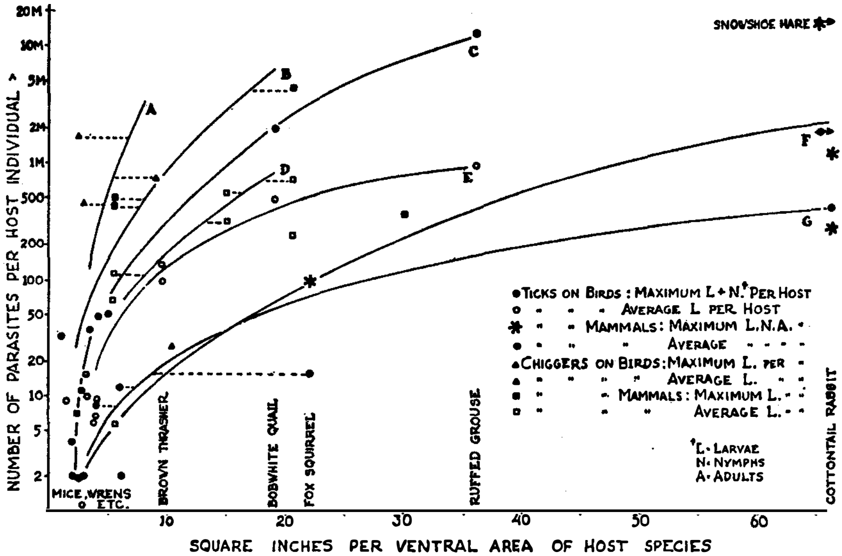

Fig. 2. A comparison of the number of chiggers (lines A, B, and D) and ticks (lines C, E, F, G) reported on birds and mammals. The approximate size of certain hosts is indicated by name in the lower section of the graph.

off (Fig. 2). The average number follows the same trend as that of the highest number, provided the habits and habitats of the species under comparison are similar.

Although it is difficult to compare the size of such different animals as long-necked pheasants with plump chickadees and both of these with mice and rabbits, some useful comparisons can be made. The parasitic load is therefore charted on the graph (Fig. 2) against the length of the body proper times its width. Infestations on birds tend to be higher than infestations on mammals for given kinds of parasites. (Fig. 2, A, C, and E versus lines B, D, F, and G.) Obviously comparisons among animals of similar shapes are relatively easy; the length and breadth of the bodies are related on one hand to the amount of contact that may be made by the host's body with infested ground, and on the other, to the relative sizes of infestible areas or patches on the bird's body. There will be a tendency for data on birds with long necks, or mammals with long ears or other divergent parts to fit somewhat different lines. Semi-log graph paper is used in order to save vertical space.

Comparisons can best be made between species that have been studied in the same habitats or at the same time or in similarly infested habitats. One such set of data comes from Green, Evans & Larson

(1943). When the average number of *Haemaphysalis leporispalustris* on snowshoe hares, *Lepus americanus,* was 1537, that on ruffed grouse, *Bonasa umbellus,* was about 905, and that on cottontail rabbits, *Sylvilagus floridanus,* was 425. The maximum number on the most heavily infested member of each species from Sept. 30 through Oct. 15 was 4,739, 1,546 and 1,166. Further data are available from Joyce and Eddy (1942). The house wren, *Troglodytes aedon,* in a heavily infested area averaged 9 *H. leporispalustris* larvae.

The grouse bore more than 94 times as many of these ticks than did the wren, but it was only about 15 times as large. In each case, the size of the host is important to the acquisition of parasites but does not account for the total difference in parasite load; the larger hosts tend to suffer a disproportionate infestation. Much of this difference seems to be the result of a larger home range, or area of activity, of the larger host. Stannard and Pietsch (unpublished data based on their 1958 study) found 320 *leporispalustris* on one cottontail rabbit.

Infestations by ticks *Amblyomma americanum* (Brennan, 1945) and *Dermacentor variabilis,* (Smith et al., 1946) on mammals and birds vary in the same way. The number of *A. americanum* on the small hosts is small indeed, the maximum number being 2 per such hosts as housemouse, *Mus musculus,* Carolina wren, *Thryothurus ludovicianus,* and American redstart, *Setophaga ruticillia.* But the maximum number increases rapidly with the size of the host. Whereas individual cardinals, *Richmondia cardinalis,* have approximately 2.8 times as much area, the largest infestation on them is about 29 times as large. The maximum number of ticks on the wren was about one per square inch whereas the maximum number on the cardinal was about 10 per square inch. But a decided break in this type of correlation occurs at about the size of the cardinal. Its area is about one fourth the size of the quail, *Colinus virginianus,* its maximum infestation was only 38 times as large. From this point on, the increment in parasitism is low.

It will be noted that the birds for which data have been presented spend a considerable portion of their time on the ground; the smaller ones to feed and the larger ones to feed and sleep there.

Some birds which were not included in Figure 2 are of interest, since they are of about the same size as those shown but live in different habitats. One roadrunner, *Geococcyx californicus,* bore 25 larvae; a scissor-tailed fly catcher, *Muscivora forficata,* bore one; a red-tailed hawk bore 12 nymphs and 4 larvae; and a yellow-billed cuckoo, *Coccyzus americanus,* bore 13 (Brennan, 1945). Eleven American robins, *Turdus migratorius,* averaged 1.0 nymphal and 8.4 larval *H. leporispalustris;* 2 ring-necked pheasants averaged 4 larvae; one American crow *Corvus brachyrhyncos,* bore one larva and another was uninfested (Joyce & Eddy. 1942). Although data for none of these are extensive enough to establish any sort of norm, they are sufficient to indicate en masse the habits which induce low degrees of infestation. Some of these birds do not occupy the same habitat occupied by ticks, and others which do so spend relatively little time on the ground or near it. The red-tailed hawk, which might be expected to bear a thousand or so ticks purely on the basis of size, bore only 16; the roadrunner, crow, and pheasant, which might be expected to carry hundreds, carried fewer than 26. Among these the low infestation on the pheasant is surprising but seems to be consistent. On 11 pheasants observed in England (Milne, 1949) the largest infestation was 80 ticks, *Ixodes ricinus*. The pheasants spend much time on bare ground or in cropland that is relatively unsuitable to these ticks.

Similar relations occur between parasites, size of host, home range, and habitats in the mammals. A more influential factor than mere chance was involved in the occurrence of only one flea on 12 *Cryptotis parva* in Kansas (Poorbaugh and Gier, 1961) and only one on 16 *Sorex cinereus* in Illinois (Verts, 1961). All told, only two out of 28 of these tiny shrews were infested. At the same time 54 mouse-sized shrews, *Blarina brevicauda,* in Kansas, and 107 in Illinois bore 84 fleas. Although it is probable that the small shrews are more proficient at cleansing themselves, size, *per se,* seems to exert an important effect. Their smaller nests may harbor fewer fleas.

Other records from small mammals are illuminating: the largest number of *Leptopsylla segnis* reported by Morlan (1952) on a single housemouse out of 250 housemice examined was 16. Only 3.3 per cent of these housemice were infested. There was an average of only two of these fleas per housemouse, the individual with 16 being excepted from the calculation. The largest number of fleas on a single Norway rat was 126. Twenty-one percent of the rats were infested.

Only 2 ticks, *D. variabilis* (larvae) were found on a housemouse (Morlan, 1952). Shrews and mice, of course, comb off and destroy their ectoparasites more efficiently than do larger hosts; but a study of the relation of parasitism to size helps to separate the factors. Chiggers normally attain larger populations on their hosts than do most ticks or fleas, provided the host is physiologically and morphologically suitable. Daniel (1961) never found more than eight *Trombicula autumnalis* on a housemouse in Europe.

Mohr (1947) reported an estimate of about 4000 *T. deliensis* on a coarse-haired rat, *Rattus ruber,* in New Guinea and about 430 on a small rat, *R. exulans.* The coarse haired rat is about the size of the

Norway rat, and *R. exulans* is about the size of a large meadowmouse (*Microtus*) in North America.

Tuxen (1950) reported more than 700 chiggers, *T. autumnalis,* on a single European blackbird, *Turdus merula*—a bird of about the size of the American robin (*T. migratorius*) but Audy (1956) reported as many as 16,000 *Trombicula akamushi* and *delienses* from a button quail, *Coturnix chinensis,* in Malaya, which has a ventral square area of about 7 inches long versus the blackbird's 8.5 inches. In general, the mammals bear a smaller level of infestation by ticks and chiggers, which infest both groups, than do birds, and in general infestations on both groups rise rapidly in relation to size, and at intermediate sizes level off rather sharply.

The sizes of the home ranges and the nature and intensity of use by different species seem to be responsible for the trend indicated: small species use their ranges more intensively than large species and birds more than mammals of equivalent size.

Most species that live on or very near the ground maintain narrow home areas, and many that live well above the ground maintain home areas that are nearly circular. Ring-necked pheasants, *Phasianus colchicus,* (Fig. 1A), and quail, *Colinus virginianus,* maintain elliptical areas (Stumpf and Mohr, 1962) whereas song sparrows, *Melospiza melodia,* Nice, 1937; Stumpf and Mohr, 1962), and redtailed, hawks, *Buteo jamaicencis,* tend to maintain more nearly circular territories (Fitch et al. 1946). The pheasants maintained areas averaging 1 by 3; the sparrows 1 by 1.8, and the hawks 1 by 1.5. Tree squirrels may maintain moderately broad ranges. Sixteen adult *Tamiasciurus hudsonicus,* for example, maintained areas of one unit wide by 2.1 units long according to figures published by Layne, 1954. During a portion of one year, seven individuals maintained home areas of 1 unit wide by 3.0 units long. This generalization about the shape of home ranges holds for many other groups. Lizards and amphibia also tend to maintain areas that are notably linear.

Therefore, when comparing the relation of ectoparasite load on animals of different species, or even individuals of the same species, it is necessary to determine the breadth of home areas as well as the length in order to determine the area over which the animal ranges. For rough comparisons, this may be done by recognizing the general shape of the range—that is, whether it is very narrow, moderately narrow, or broad. Obviously the greater the precision, the sounder the generalization. Usually the more marked the territoriality of the species or individual the narrower is the standard deviation and the more precisely measurable are the limits of the areas in which the animals are active.

SUMMARY

1. The percentages of California meadowmice infested by chiggers were compared to the observed areas of their home ranges (areas or territories) and to the sizes of the individual hosts. A higher percentage of larger than smaller individuals is infested.
2. Home ranges of the mice are decidedly linear rather than circular and calculation of the area occupied must take this into consideration.
3. The larger mice maintain the longer ranges.
4. Parasitism by ticks and chiggers common to several species of birds and mammals is compared. The small species bear more than expected on the pure basis of host size and large ones bear fewer.
5. This appears to be largely the result of intensity as well as nature and kind of activity. Small hosts also appear to be the more effective self-cleansers.
6. Mammals bear fewer than expected purely on the basis of size of host and size of home area.

ACKNOWLEDGMENTS

We are indebted to Frank Prince of the Communicable Disease Center, Public Health Service, U.S. Department of Health, Education and Welfare, for certain laboratory space, data, advice and assistance; and to Deane P. Furman, Department of Entomology and Parasitology, University of California at Berkeley, for advice and support.

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DISCUSSION

DR. COWAN: Thank you, Dr. Mohr. An understanding of this matter of parasite-host relationships becomes increasingly more important to us as we begin to delve deeper and deeper into the whole matter of population dynamics. It could be that Dr. Mohr is showing us the way to use actual parasite loads on our animals to evaluate the range conditions as to normal if we ever learn what normal is. Dr. Mohr's paper is open for questions. Dr. Mohr, would you be able to give us any idea of the biomass which is represented by different species of hosts which would represent ability to support these parasite populations?

DR. MOHR: I believe the answer is yes. I have a case in mind. One reason there is a more rapid rise in the number of parasites on smaller birds, that is the increment in relation to body size, is because small birds within their home range cover a larger area than the large birds, that small mammals cover a greater range for their mass than the large mammals, and that the mammals cover a smaller home area for their mass than birds do.

THE FEDERAL PEST CONTROL REVIEW BOARD

ROBERT M. PAUL
Department of the Interior, Washington 25, D. C.

My purpose in appearing today is to give you a short progress report on the organization and operations of the Federal Pest Control Review Board.

The Federal Pest Control Review Board was established through the joint action of the Secretaries of Agriculture, Interior, Defense, and Health, Education and Welfare on June 22, 1961. In the order establishing the Board, it was directed to:

1. Review pest control programs in which there is active participation on the part of the Federal Government in planning and developing procedures and where there is some degree of responsibility for supervision.

2. Advise the various Departments and agencies of government concerning problems in the use of pesticides and other chemicals, especially in cases involving interdepartmental interests and responsibilities, to insure that effective, economical and safe procedures are followed.

Perhaps it would be well to review the history of why the Federal Pest Control Review Board was established at a time when there is a well-known, concerted effort on the part of the Administration to streamline operations and reduce the time spent in committee meetings—an action that will probably be applauded by members of the audience who are in government service.

To my knowledge, the earliest recognition of the need for establishing an administrative procedure like this was expressed by Dr. Neely Turner, entomologist for the State of Connecticut, during the controversy resulting from gypsy moth control operations in the Northeastern United States a number of years ago. At that time, Dr. Turner expressed doubt that administrators of control programs should have sole authority for decisions as to when, where, and how public-supported pest control activities should be undertaken. He aptly described such arrangements as comparable to court cases wherein the responsibilities of prosecutor, judge, and jury might be vested in the same individual. Not too much later, the views expressed by Dr. Turner were shared, at least in part, by Supreme Court Justice William Douglas, who suggested that the problem of mass spraying of toxic chemicals should be reviewed by the Supreme Court.

Public opinion was probably focused most sharply on the need for top-level administrative review of federal pest control programs in 1957 after the initiation of the Fire Ant Control Program in the South. The initial aerial application of two pounds per acre of heptachlor caused serious wildlife losses, and, perhaps inevitably, these complaints resulted in the introduction of several bills during the 86th Congress requiring that the Fish and Wildlife Service and State conservation interests be consulted before federally financed pest control programs were undertaken.

This proposed "Chemical Pesticides Coordination Act" was reintroduced by Representative John Dingell of Michigan during the first session of the 87th Congress.

Shortly after taking office, President Kennedy sent to Congress a special message on natural resources that spelled out several courses of action that would be undertaken by his administration to insure the preservation and wise utilization of our living natural resources. One of the examples cited by the President was the need to resolve the conflict that had arisen between several agencies of Government over the use of chemical pesticides that might harm public health and our fish and wildlife resources. The Federal Pest Control Review Board was established as a result of this message and subsequent discussions between Secretary of the Interior Stewart Udall and Secretary of Agriculture Orville Freeman.

The present membership of the Board consists of two representatives designated by the Secretaries of the four Federal Departments that are directly concerned. The chairman of the Board is Dr. Robert J. Anderson of the Public Health Service. Other members are: Mr. J. K. Kirk, Food and Drug Administration; Brig. General D. B. Kendrick, U. S. Army; Captain Richard T. Holway, U. S. Navy; Dr. W. L. Popham, Agricultural Research Service; Mr. W. S. Swingler of the Forest Service; and Mr. Lansing A. Parker and I now serve on the Board as representatives of the Department of the Interior. Several other officials of these Departments also serve in a liaison or alternate capacity.

The Board held its initial organizational meeting on April 23, 1961, and in several subsequent sessions developed a proposed charter on policy and procedure which was later unanimously approved by the Secretaries of the four Departments. The 11 meetings held to date have been devoted to an intensive review of current pest control problems and the programs now being carried out by the four Departments. The Board has reviewed the programs to be undertaken in 1962 by the Public Health Service, the Department of Defense, and the Forest Service, and in each case has "cleared" the plans. A number of suggestions have been made for closer liaison and additional research.

At the present time the Federal Pest Control Review Board is making an intensive review of the other pest control programs of the Department of Agriculture. We have requested that the entomologists and wildlife biologists continue to critically review all technical aspects of the Fire Ant Control Program in the South in order that the Board will have the background knowledge that is necessary to critically evaluate this program in terms of overall public benefits and administration policy. Later this spring, pest control activities by agencies of the Department of the Interior will be considered. I can assure you that the task of assembling and reviewing data on each of these activities is no simple undertaking. I, for one, have been surprised to learn of the number and variety of pest control activities engaged in by Federal Agencies.

As an example of the operations of the Board, I might cite the recently completed review of the United States Forest Service pest control plans for 1962. The complete plans were assembled, the costs and benefits were weighed, and the extent and kind of coordination—both planning and operational—were discussed at length to insure that the plans included adequate precautions for safeguarding human health and fish and wildlife. The Board then advised the Secretary of Agriculture that the Forest Service's 1962 program was cleared because it was satisfied the plans minimized the hazard to fish, wildlife, water, recreation, food and pasture lands in areas scheduled for treatment.

Someone might ask, why do we have to have any pest control program on forest lands? For one thing, insects and other forest pests destroy more timber annually than fire, and this year many places on America's 450 million acres of commercial and recreational forest land—Federal, State and private—are facing insect outbreaks of epidemic proportions. There is no doubt that the destruction of forest cover by such pests would cause irreparable losses. The application of insecticides by low-flying aircraft is the most effective present weapon for combating epidemics of tree defoliators. To provide maximum protection to other values, however, careful controls are needed including the avoidance of any spraying of open water or pasture areas to prevent fish mortality and pesticide residues in human foods.

In addition to insuring stringent controls over aerial spraying operations, the Review Board has urged the Forest Service to intensify its search for control methods that won't cause undesirable side effects. Progress is gratifying. One newly developed tool is an antibiotic fungicide which heals western white pines infected with white pine blister rust. Very small amounts of the fungicide make an effective solution that may be sprayed either by helicopter or by ground equipment.

The Board plans to review in similar fashion all Federal pest control programs as quickly as possible. As each program is reviewed, the Secretary of the Department is advised regarding the Board's findings and its recommendations for modifications in pest control materials and techniques for their application. One recent example has been the suggestion that Public Health Service water pollution personnel be assigned to work with the Department of Agriculture to determine if ground application of pesticides for nematode control is causing ground water pollution problems on Long Island. Should circumstances warrant, the Board will make recommendations directly to the Secretary of the Department that is concerned. If more liaison with other agencies is indicated, arrangements for joint study and consultation are made directly with the administrative office concerned. Speaking for the Department of the Interior, I can say that we have been very gratified by the cooperation and interest of the other Departments.

While we are enthusiastic, we do not have illusions that the establishment of this Board will resolve all aspects of the pesticide-wildlife controversy. For one thing, only a very small percentage of the pest control chemicals now being used are under direct control of a government agency. However, we intend to set our own house in order by setting the best possible example for others to follow. I am optimistic that the Federal Pest Control Review Board will serve as a very worthwhile catalyst in bringing about many desirable improvements in pest control practices.

Perhaps the most important part of the Board's work is encouraging needed research. Results already are apparent and most important the groundwork has been laid in a number of cases for the early substitution of materials that pose less hazard than some now in use. We know that methoxychlor, pyrethrums, and malathion are less hazardous to most forms of wildlife than are compounds such as aldrin, dieldrin, and endrin. By encouraging use of the former materials in sensitive wildlife areas, we can often achieve satisfactory pest control with much less hazard than would be the case if the other chemicals were employed. For example, the Bureau of Commercial Fisheries has found that some pesticides are far less toxic than others to fish and shellfish, and we are urging that the less toxic materials be used in the Gulf States where drainage of chemicals into important estuarine areas is becoming an increasingly serious problem.

Another development of particular interest concerns current research on a compound identified under the code designation GC-1283. This product is being tested for use with bait as a specific control for fire ants, and preliminary findings are very encouraging. It appears to have a good margin of safety for most forms of fish and wildlife—the acute toxicity to quail being perhaps only 1/50th that of heptachlor. Since only four grams of actual chemical per acre are required, little hazard is indicated. The bait has now been registered and is ready for large-scale use this summer.

We must all recognize that many forms of pest control are essential and, as I see the future, pesticidal compounds will continue to be used on an ever-increasing scale. By steering a course away from the trend toward large-scale use of highly toxic, broad-spectrum, residual-type chlorinated hydrocarbons, and by stimulating adequate research prior to the initiation of large-scale pest control programs, the Board can render a great service in the public interest. Likewise, by helping agencies to pursue recent breakthroughs in the realm of systemics, chemo-sterilants, antimetabolites, and synthetic sex attractants, it can aid in bringing about new means for combating the many forms of plant and animal life that compete with man's interests.

One of the major problems in discovering and developing pesticidal materials has been our inadequate knowledge of the effects of such materials on forms of life other than man and the target species. Often we have, to our regret, acquire this added knowledge only through large-scale use of the products and at the expense of heavy losses among fishes, birds, and mammals in treated areas.

A start toward the establishment of a chemical screening program is already under way at the Wildlife Research Center here in Denver. In this pilot operation, new chemicals known to possess some biological activity but not yet marketed, are tested on several species of native western rodents. In a few cases, additional tests are conducted to determine phytotoxicity to tree seeds, systemic action in growing plants, and toxicity to some forms of fishes and birds. These findings are reported to the chemical manufacturer so that early knowledge is available regarding these biological properties of his new compound.

In addition, the screening tests are revealing a number of new compounds which may have utility in the solution of problems directly concerned with fish and wildlife management. For example, it is encouraging to note that compounds are being discovered that may make it possible to kill meadow mice that destroy new forest seedlings and not harm the deer mice that help to protect these same seedlings from insects. Other chemicals are being disclosed that can be absorbed by vegetation from soil applications and circulated in the sap stream to all parts of a growing plant.

This is a beginning. If we can learn more about the biological properties of pesticidal chemicals and apply this knowledge intelligently, public agencies, farmers, and homeowners can all accomplish necessary pest control with minimal harm to other values.

In conclusion, I can sum up the policy of the Federal Pest Control Review Board as one of recognizing that proper usage of pesticide chemicals to destroy unwanted pests and disease organisms as they affect plants and other animals, including man, has an enormous potential for the public good. There must, at the same time, be a recognition that chemicals which will kill or control pests are, in many cases, capable of causing harm. It is, therefore, essential that any contemplated use of a pesticide chemical be first evaluated as to the good that its use is expected to achieve, the harm which may result, and the precautions which should be taken to minimize harmful effects and a decision must be made as to whether any risk that may be involved is warranted in the light of the benefits contemplated.

On February 28, 1962, President Kennedy said, "We must reaffirm our dedication to the sound practices of conservation which can be defined as the wise use of our natural environment; it is, in the final analysis, the highest form of national thrift—the prevention of waste and despoilment while preserving, improving and reviewing the quality and usefulness of all our resources." I am confident that the Federal Pest Control Review Board will meet its responsibilities to the public interest in carrying out this policy.

DISCUSSION

DR. COWAN: Mr. Paul has pointed out that pesticides are now one of the facts of life and we are going to have to learn to live with them and certainly we hope that groups such as he is affiliated with are going to show us how.

MR. CHARLES CALLISON [National Audubon Society]: Have any of the Federal pest control programs or operations that have been reviewed by the Pest Control Review Board been modified before clearance?

MR. PAUL: Yes, there have been modifications along these lines. The Defense Department has rewritten their manual on pest control operations, principally because some current research had not been called to their attention. I think this is true of several agencies in the Defense Department. We have suggested certain modifications and programs which have been accepted. Perhaps most important, has been the mechanism that has been set up to get other people into the act at a much earlier time. The assignment of personnel from one agency to another in the research phase at the time field operations are under way and the general realization on the part of very high levels that these programs are very touchy and very critical has made our job easier. The Forest Service made some changes as the direct result of this activity.

MR. CALLISON: Only a small percentage of pesticide used was under the jurisdiction or carried out by the Federal Government. This, of course, is true. I think we all realize this. Are there any steps being taken as a Federal Pest Control Review Board develops new principles of safety and caution, to publicize those decisions, those new principles through any of the agencies that are involved? In other words, is any of this information going to get out to the public to help sell the general public, farmers, householders, lodge keepers and others, on the greater safety precautions?

MR. PAUL: I think the example of the Fish and Wildlife Service screening program offers the best hope for getting the manufacturers, long before they invest sums of money to develop new insecticides, informed about the hazards. I feel there should be, perhaps a massive educational effort on the part of the various levels of government and the agencies, farm groups and others that are actually using these materials in addition to the manufacturers.

MR. CALLISON: Who is going to initiate this massive educational effort?

MR. PAUL: I was under the impression that the National Audubon Society was doing a pretty good job but I feel all conservation groups shopld be more concerned.

MR. D. D. REHDER: I am D. D. Rehder, Corps of Engineers, Omaha District. In relation to this particular program I would like to relate to you some of the steps that we have taken in it. This includes the Jaffee Point, Randolph, Fort Peck reservoirs. We have what we call an inter-agency council, established at each of our major projects. At the onset of this review board committee a subcommittee was established by our inter-agency council, whose function was to establish a guide concerning the use of chemicals on our government-owned lands and waters. We are very much limited in our attempt; however, we do feel that it is a step forward. This is a cooperative agreement or undertaking between the respective state fish and game agencies, Public Health Service, State Public Health Service, the Extension Service, the Fish and Wildlife Service, all of whom are cooperating with it, and, of course, the Corps of Engineers. We hope that we are aiding in getting this program under way as far as the general public's recognition is concerned.

MR. DON FORRESTER: Don Forrester, Montana State University. I am wondering to what degree the manufacturers are required to test these pesticides themselves, rather than putting this burden onto the Fish and Wildlife Service and other such governmental organizations?

MR. PAUL: There are probably other people more familiar with this than I. In the past the controls imposed by various labeling restrictions of the Federal Government have limited the manufacturer's responsibility pretty much to the hazards to human health and the methods of application that are recommended to prevent damage to fish and wildlife. There is no requirement that specific research be done by the manufacturer now. I think it is logical for the Fish and Wildlife Service to perform the needed research. It is an activity that we want to encourage and develop—this is a function that we can provide, I think, very nicely for the states fish and wildlife departments also. As for additional control, this is a subject that is up to Congress. I don't anticipate any particular changes in this in the next few years.

MR BUCHHEISTER [National Audubon Society]: With respect to the labeling of pesticides and particular attention to insecticides, we have been told upon inquiry to the Department of Agriculture that manufacturers and distributors of insecticides are required to put adequate information labels on their packages if any hazards pertain to wildlife. I am a hobbyist gardener—and every time I go to a garden shop or hardware store, I study and read these labels. I have yet to see wildlife appear on any of these labels. The warning refers to animals, and to most people this means dogs or cats or domestic animals. I don't think this carries through that there is a danger to wildlife to most people. I have seen this kind of caution, "Care should be taken about spraying near fish ponds etc.," and that is just about all the warning or caution with respect to the hazards to wildlife that you will ever find on any of this labeling and it is totally inadequate on the very potent chlorinated hydrocarbons.

DR. GEORGE HALOZON [Kansas State University]: In this labeling act the manufacturers are required to show that the chemicals have a specific approved use. Now, there is no one who enforces this particular use. The chemicals are in the store and someone can use it for unapproved use. However, if the residue remains, there is legal grounds for legal action. You probably remember the cranberry case a few years ago. The manufacturers are not normally the ones that cause us the biggest trouble. They are interested in making money, but, they also realize that they have to maintain the support of the public. Our biggest trouble comes with governmental agencies and quasi-governmental agencies contradicting the reports that are put out, particularly with chemicals that have not been evaluated for every species of animal. We can, and I am speaking of the Extension Service, train the farm groups and private organizations to handle chemicals with care and use them only when there is a bona fide need for it.

However, there are other agencies that come out with contradictions that a chemical hasn't hurt so and so, and it is perfectly safe to use without following the manufacturer's recommendations. Too many times we have reports which, in actually carrying this out, are contradicted in the store by personal comments made to the individuals. These comments are then amplified and spread out to these various groups. I think this goes back to Dr. Howard's comment earlier in the afternoon. The Wildlife Society has failed to take a rightful stand until abuses have occurred. At that time it is too late to prevent the accidents, and we engage in some of these emotional conflicts. If we make full use of this legal requirement, we would be a lot better off.

MR. PAUL: Thank you. I think that pointed up the need for increased coordination, and I hope that we are making good progress.

DR. SCOTT: I think that wildlife managers can be greatly encouraged by the establishment of this board of which Bob is a member. I think that the Administration should be congratulated for its recognition of this serious problem. I am interested in the power of the board. Does it have power or is it purely advisory? Can it bring a halt to a program in the event it does not approve of that program or in the event there are dissenters among the representatives?

MR. PAUL: I would say the Board has to be primarily advisory, but I don't think that quite covers the whole story. As far as the Administration and the broad context is concerned, I think we have demonstrated our concern over these programs and, speaking from a current experience, I would say that the board will have very strong actual control of programs by working with the Budget Bureau. We are unlikely to reach the point where any Secretary would not accept the recommendations of the board.

THE JACKSON HOLE ELK HERD IN YELLOWSTONE AND GRAND TETON NATIONAL PARKS

ROBERT H. BENDT

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For many years the elk herds of the Yellowstone region have been subjected to considerable thought, many studies, reports, committees, and controversies. This kind of attention, however, has been given to many elk herds in the United States because they passed through periods of early abundance, then depletion, and then restoration through protection, transplanting and management. Now populations are near optimum and above in much of their present habitat.

Of the greatest importance in the early 1900's when most elk herds were endangered were the native herds of the Yellowstone region. In this area of the Rocky Mountains there existed at that time not only the largest remaining elk numbers, but the largest unsettled area of public land in the form of a national park and several national forests, that were best suited to the perpetuation of elk in large numbers in their natural habitat. Of an estimated 70,000 elk for the entire United States at that time, 40,000 to 45,000 were found in the Yellowstone region. Fortunately, recognition of this animal's value by many states and conservation organizations was then responsible for improved protection programs of original remaining elk herds, and the beginning of restocking programs using trapped animals from Yellowstone National Park's northern herd. Since 1892, a total of 10,478 elk have been trapped and transplanted from Yellowstone's northern herd alone, with most requests to the National Park Service being received from the state game and fish departments between 1910 to 1930.

Many of these early restocking programs were disappointing in that sometimes the introduced elk did not increase to expectation, or increased beyond expectation with accompanying problems of control, damage complaints and competition with other species. Problems with elk that state game departments experience are usually quite different from those of the National Park Service, but I think that many will agree that elk generally create some conflicts with other land uses no matter where they occur.

While the Jackson Hole elk herd has presented various problems ever since it became nationally known in 1910, the National Park Service's active responsibilities with this herd did not begin until Grand Teton National Park was created in 1929. It was shortly after this that studies of both the spring and fall migrations of elk in Grand Teton were initiated. By 1943 these studies had been expanded and a track counting transect established across the northern end of Jackson Hole valley. The objective of this transect was to obtain as much information as possible on where and when the migrations took place, the factors that might affect elk migrations, and the numbers of elk using a particular migration route. Interest in this migration data increased greatly around 1945 when enlargement of Grand Teton National Park and the National Elk Refuge was being considered. Many people familiar with the problems of the Jackson Hole elk herd thought that any enlargement of the refuge and park would pose an additional problem in the control of this elk herd.

During the period from 1945 to 1951 several important actions were taken by the federal and state agencies in Jackson Hole concerning the future of this elk herd. In 1947 the Teton Game Preserve which had prohibited hunting since 1905 in the vast areas south of Yellowstone, west of the Continental Divide to the Idaho boundary and north of the valley was abolished by Wyoming and the U. S. Forest Service.

By 1950 the National Elk Refuge and Grand Teton National Park had been enlarged, using donated land and lands which were part of the Jackson Hole Monument. With changes in land status for the park, monument, and refuge, Congress passed Public Law 787 which included a provision for an elk control program in certain portions of Grand Teton National Park. This control program is designed to go into effect when the necessary reduction of elk cannot be accomplished in other areas, and when control measures are necessary for the proper management of this elk herd.

Specifically, the law provides for "a program to insure the permanent conservation of the elk within Grand Teton National Park with the use of qualified and experienced hunters licensed by the State of Wyoming and deputized as park rangers by the Secretary of the Interior, when it is found necessary for the purpose of proper management and protection of the elk." The need for the program is determined each year by joint field studies, and becomes effective when approved by the Governor of Wyoming and the Secretary of the Interior. Each such qualified and experienced hunter referred to the National Park Service by the State of Wyoming to participate in this program is specifically permitted to remove from the park the carcass of the elk he has killed as part of the plan. The lands concerned amount to approximately 20 per cent of Grand Teton National Park, or about 100 square miles.

In addition, the National Park Service assists both the Bureau of Sport Fisheries and Wildlife and the Wyoming Game and Fish Department in making available to these agencies approximately 1500 acres of land for the raising of hay for the elk winter feeding programs in the Jackson Hole area. Under this arrangement the Park Service provides the land, the National Elk Refuge irrigates and brings the hay crop to maturity, after which the Wyoming Game and Fish Department then contracts for the cutting and hauling of the baled hay to the various feeding grounds. By this cooperative arrangement over 23,000 tons of hay have been harvested from this land in Grand Teton National Park since 1952.

Almost all of the range used by the Jackson Hole elk herd is federal land administered by the U. S. Forest Service, National Park Service, and National Elk Refuge (Fig. 1). The Wyoming Game and Fish Commission is primarily responsible for management of the elk. These four agencies then all have a concern and responsibility for the Jackson Hole elk herd and its habitat. In 1958 these four agencies by formal agreement formed the Jackson Hole Cooperative Elk Studies Group. It includes an Advisory Council consisting of the administrators for these agencies, and a Technical Committee which is made up of the technicians actively engaged in the many field studies being conducted by the group. All agencies feel that significant progress is being made as a result of this cooperative approach to studying the Jackson Hole elk herd.

All of the early writings and reports concerning the Jackson Hole

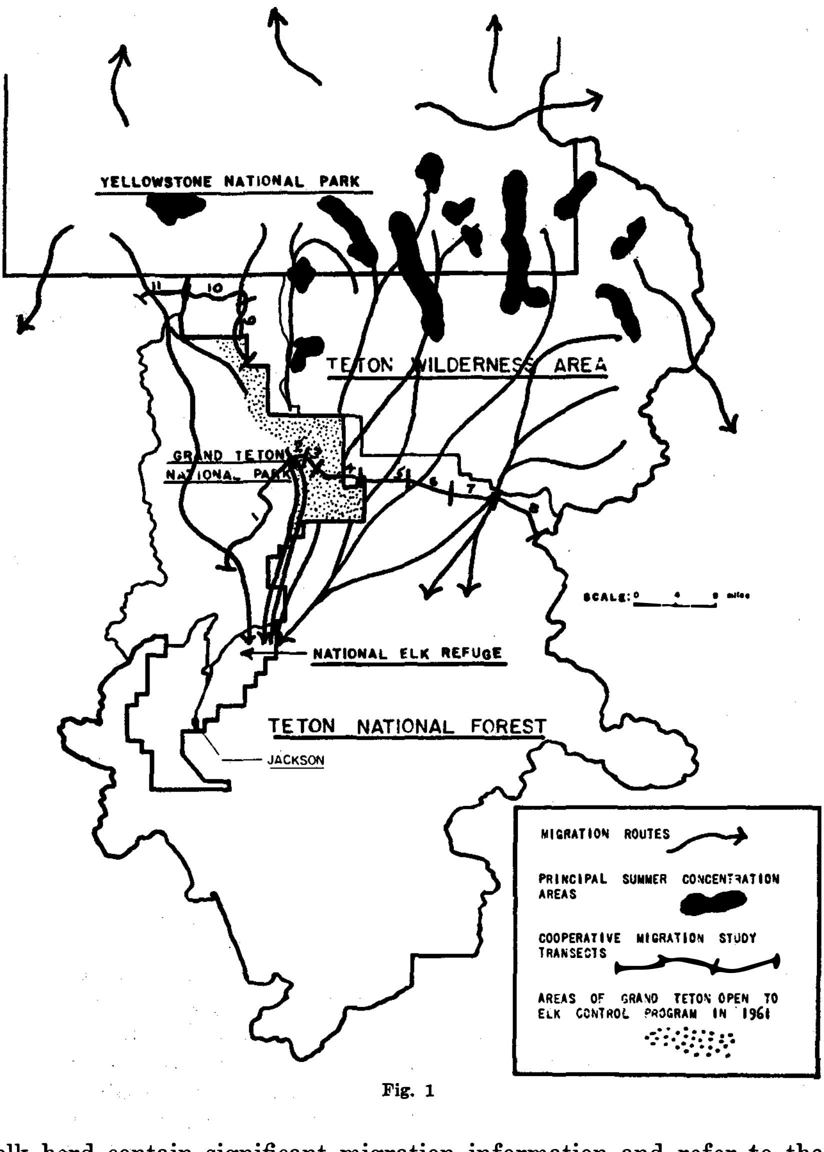

Fig. 1

elk herd contain significant migration information and refer to the factors that contributed eventually to the complete elimination of the 100- to 200-mile migration which was characteristic for this herd. The hard winters of the 1880's, increased settlement of valleys, and intensive meat and elk tooth hunting were among the factors that eventually eliminated the original fall migrations of the Jackson Hole elk herd to the Green River and Red Desert areas. The last extensive migration of the Jackson Hole elk herd south out of the Jackson Hole-southern Yellowstone areas occurred in 1913. Therefore, those elk that did not migrate great distances and always remained during the winters in Jackson Hole have provided the initial stock for the herd that we are concerned with today. Efforts to perpetuate these particular elk then led to the first supplemental winter feeding programs and the original appropriations from Congress in 1912 to purchase land in Jackson Hole as a refuge for raising hay to feed a portion of the elk herd. Today the National Elk Refuge has approximately 24,000 acres of land administered by the U. S. Bureau of Sport Fisheries and Wildlife and feeds about half the elk of the Jackson Hole herd for half the year. However, contrary to most impressions, these elk obtain most of their feed by grazing and only when weather becomes severe are they fed baled hay. Annual numbers on the refuge during the fall, winter, and spring period have been averaging between 7,000 to 8,000 elk with the largest recorded population of 11,500 on the refuge during the deep snow season of 1955-56.

In migrating north from the National Elk Refuge in the spring many elk move through portions of Grand Teton to their summer range area in Grand Teton National Park, the Teton National Forest and Wilderness Area, and southern Yellowstone National Park, usually by the end of April and the first part of May, or as soon as the melting snow permits. Calving takes place the latter part of May and June and brings a very distinct pause in this migration. And it is in these sagebrush calving grounds that the calving cows separate from the bulls, "dry" cows and yearlings. As a result of this separation, the bulls, either alone or in small groups, and the "dry" cows and the yearlings continue their northward movement and are the first arrivals on the high summer range. The wet cows and their calves arrive some two or three weeks later. Immediately after the calving in the valley, the migration again moves northward, but now it is on a much broader front because of the additional snow-free areas that have opened by the time the calves move.

Much of the Jackson Hole elk herd escapes summer range problems by dispersing widely over an abundant summer elk range of good quality. But, unfortunately, we are finding that not all of the elk are evenly distributed. Elk populations in several areas of the Teton Wilderness Area and southern Yellowstone National Park are many times larger than those of other sections of their summer range. These areas of heavier summer elk concentrations coincide, with few exceptions at the present time, with areas showing range damage.

In 1958 a reconnaissance trip by biologists of the agencies that were to participate in the Jackson Hole Cooperative Elk Studies Group spent several weeks observing range conditions and elk concentration areas. Accompanying this group were range specialists from the University of Wyoming who are also members of the Technical Committee. As a result of their recommendations to the Advisory Council, two five-acre exclosures were constructed in southern Yellowstone in 1959 and a third five-acre fenced plot is scheduled for construction in 1962 in Grand Teton National Park. In addition to these range studies, the Forest Service has constructed several exclosures, and several more are planned.

All these exclosure sites have been selected jointly by personnel of the cooeprative study in order to eliminate possible site duplications. This coordinated approach has also allowed the selection of many more fenced range condition types than would be possible for any one of the agencies to construct and study. These protected sites, as well as many other key areas, are presently being studied to determine their trend so that eventually we possibly may be able to predict what we can expect in the future for these fragile summer ranges.

Of real concern is the possibility that because of artificially wintering elk by feeding that the summer ranges are now becoming increasingly important as the limiting factor in supporting this herd. The research and management of the Jackson Hole elk herd is very important to the National Park Service because we provide sufficient land in Grand Teton to produce from 2500 to 3300 tons of hay annually for the winter feeding program. We are responsible for much of the spring, summer, and fall habitat used by the elk, and under the provisions of Public Law 787 we are able to conduct an elk control program within portions of Grand Teton when factual data support its necessity.

While the spring migrations to the summer ranges follow a rather consistent pattern except for very minor differences in the time of the year, such is not true for the fall migrations. The fall migration has wide variations in the time the elk move from particular summer range areas of southern Yellowstone, Grand Teton, and the Teton Wilderness Area. Of particular interest to us are those elk leaving southern Yellowstone areas where severe range conditions and elk concentrations occur, and the time and routes used when they pass through those areas of Grand Teton National Park where the elk management program can be allowed under Public Law 787. Techniques used for our cooperative migration studies with Wyoming in recent years have included aerial flights, ground observations of movements, track counting transects, and census counts on the National Elk Refuge throughout the fall migration period. Since 1959 the Wyoming Game and Fish Commission has been carrying on an elk neck-banding program using various colored identification bands for each winter range area to assist in determining migration routes, summer distribution, and the intermingling of the various herds on the summer range areas. The National Park Service is also conducting a neck-banding program with the northern Yellowstone elk herd since there we are vitally interested in its movements as well as its possibly intermingling with the Jackson Hole herd in southern Yellowstone.

From our migration studies, which began shortly after the original Grand Teton National Park was established, we have found that over a 26-year period the heaviest waves of fall migration of the Jackson Hole elk herd have occurred in November for 20 years, in December for two years, and in October for four years. This information becomes important when attempting to effect as large a harvest as possible when the elk management program is conducted in areas of Grand Teton National Park.

The influence hunting pressure exerts on a migration route has been studied but has been difficult to evaluate. However, much information indicates that sufficient hunting pressure seldom can prevent intensive fall migrations of this elk herd from eventally passing through established routes. However, there are exceptions, and we have found that sometimes elk can be quite sensitive to disturbance by hunter activity. Nevertheless, in all instances, they have returned to their habitual migration routes several miles from their point of disturbance.

Too often the fluctuating number of elk using a particular route has been interpreted as a change in the migration route and that because of hunter activity these elk have been forced to use another area. In reality our studies show that such fluctuations reflect the cumulative harvest of elk along the particular route. An over harvest in some instances has completely eliminated those elk that have traveled that particular migration route. This development cannot only apply to individual migration routes but to an entire herd as in the case of the historic Red Desert migration of the Jackson Hole elk herd.

Based on our cooperative studies with the Wyoming Game and Fish Department an elk management program has been conducted under the provisions required by Public Law 787 each year from 1951 to 1958 in various portions of Grand Teton National Park. In 1959 and 1960 no control programs were recommended but several areas in the park were again opened to hunting in 1961. From 1951 to 1958, 1200 special permits were made available to public hunters for participation in the elk control program in Grand Teton National Park. The number was increased to 2,000 permits in 1961. However, our increased number of permits last year in an attempt to obtain a larger harvest from the southern Yellowstone elk resulted in only 1,002 hunters reporting of the 2,000 permits requested and authorized.

During the nine years in which public hunters have participated in the elk control programs, 11,600 special permits were made available and were requested, but only 5,866 hunters, or 50 per cent, have reported. The success of their efforts has varied from 50 per cent in 1955 to a low of 6 per cent in 1952, when 455 hunters killed only 27 elk.

The total number of elk killed since 1951 is 1,610, or an average of 178 animals for the nine-year period.

TABLE 1. SPECIAL PERMIT HUNTING—GRAND TETON NATIONAL PARK

Year	Season	Permits Requested	Permits Utilized	Elk Killed	Harvest Success
1951	Sept. 10-Oct. 31	1200	510	184	36%
1952	Sept. 10-Nov. 16	1200	455	27	6%
1953	Sept. 10-Nov. 5	1200	568	112	20%
1954	Sept. 10-Dec. 12	1200	600	104	17%
1955	Oct. 20-Nov. 20	1200	624	310	50%
1956	Oct. 20-Nov. 20	1200	776	325	42%
1957	Oct. 20-Dec. 10	1200	748	160	21%
1958	Oct. 20-Nov. 30*	1200	583	110	19%
1961	Oct. 15-Nov. 30	2000	1,002	278	28%
	Total	11,600	5,866	1,610	
Nine-Year Average		....	50%	178	27%

*Season originally to December 15—State request for emergency closure.

The public interest in participating in the park's elk management program has not been as great as anticipated. A large number possibly only request a permit to utilize as a reserve in the event they are not successful in killing an elk during the regular season in some other favorite area.

It is necessary to restrict hunters to designated roads and established special camping areas. We allow them to use horses but these must be corraled and not allowed to graze. Campsites must be cleaned up and tent frames and corrals removed before the hunters check out of the area. We do not allow any other wildlife, including predators, to be killed in the special permit area of the Park. Closed areas one-half mile wide along the main highways, and one mile wide around the large Jackson Lake Lodge developments are necessary. We also require all hunters participating in the program to check into the area for their permit and instructions and again at the checking station when they leave, if they were successful in killing an elk.

Generally, we have found the majority of the deputized hunters very cooperative in accepting the necessary regulations governing this type of special hunt. Disturbing us to an increasing degree, however, are those hunters whose actions reflect on the entire hunting fraternity. Some of their actions would be legal or overlooked in areas outside the park, but cannot be accepted because of policy in areas of the National Park Service. Many of their actions, however, are flagrant violations.

Some of the deputized hunters cannot understand why they are not allowed to drive their jeeps or motor scooters off the roads we must designate for use, or up the sides of the mountains to retrieve their elk. Far too many disregard these regulations. Their clean-up of campsites and removal of tent frames and corrals before their check out from the management area, although requirements of their appointment, are far too often disregarded.

With hunters having an excuse to carry guns and be traveling other park roads the poaching of all wildlife is becoming an increasingly serious problem in other areas of the park not open to the program.

Although these violations have not reached serious proportions as yet, the increasing disregard of the National Park Service's administrative and other responsibilities by many hunters does cause considerable concern. The fact that this sort of thing occurs almost everywhere cannot be used as an excuse for in a national park, where hunting is under special scrutiny, such behavior is even less acceptable than it would be anywhere else.

Our summer range and migration studies, our provisions for the use of deputized Wyoming hunters to participate in an elk management program in Grand Teton and making hay available from park lands for the winter feeding of many of the elk in Jackson Hole stand as evidence of the National Park Service's interest in the Jackson Hole elk herd. We share the concern of all agencies participating in the Jackson Hole Cooperative Elk Herd Studies. We hope that these cooperative efforts will eventually develop the best possible program for the Jackson Hole elk, and give just recognition to all of the objectives of the agencies involved.

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DISCUSSION

MR. PIERSALL [Wyoming]: Do you have any record or a reasonable estimate of the illegal kills of the various species that are taking place in the hunting in the Grand Teton National Park?

MR. BENDT: Yes, Mr. Piersall, we do. Last year's program resulted in illegal kills of 23 elk, 11 moose, 2 bear and several coyotes. A very large amount of illegal killing existed, however, in areas other than the special permit area that is open under the law. This, of course, can be attributed to the large number of elk along the roadside that are relatively tame. Does that answer your question?

DR. COWAN: Bob, is it possible for you to say whether or not these illegal killings were perpetrated by your licensed hunters or by someone else?

MR. BENDT: This is difficult to answer because these violators were not apprehended. They were carcasses which were found. One of the most unfortunate illegal killings that we experienced this year, however, was in the special permit unit, and involved four moose in one particular area, and there was no indication that there was any utilization of the meat at all. They were just found laying in one place.

DR. HOWARD: Dr. Howard, University of California. Mr. Bendt, if these hunters are Wyoming hunters, I wonder if this is not partially a rebellion of some sort? Is there a particular issue that has antagonized them? I have a little more confidence than that in the population of Wyoming hunters. Would you care to comment or reply to that?

MR. BENDT: It is extremely possible. Of course the largest percentage of the special deputized hunters are Wyoming hunters. To give you an idea of response, however, we ran out some data on the hunt ths year, and compared the response of the various classes of hunters—in other words, local Jackson Hole residents, Wyoming hunters, and non-resident hunters. Of 2,000, we only had 98 non-resident hunters apply for this program. In fact, all the way through just about 50% of the non-resident hunters reported to participate in the program. Of the local residents, where probably most resentment would come, in this particular place, the Grand Tetons, we only had 164 hunters from the immediate Jackson Hole area. Their response to the program was also about 50%, and, amazing enough, their hunter success was less than the non-residents and the other residents from other areas of Wyoming. There is also a rather high response to this program from what Wyoming calls a "pioneer license hunter." These are people who have been in the state a certain number of years. They are 65 and over, 60, possibly, and many of them feel that hunting in the Grand Teton National Park special permit area is a plum, so we have quite a response from them. However, their success is about the same, or roughly what we have found, over the nine years of the program, 27% hunter success.

MR. JOHN HOLZWORTH [Grand Lake, Colorado]: Have there ever been cowboy style attempts to move those elk to different areas?

MR. BENDT: I think you may be confusing the Jackson Hole elk herd with the northern Yellowstone elk herd. The Jackson Hole elk herd, of course, summers on the Teton National Forest, Grand Teton National Park, the Teton Wilderness Area and areas of southern Yellowstone. These elk migrate to winter areas in Jackson Hole, and they are on the winter ranges and a number of feeding grounds operated by the State of Wyoming and the large one maintained on the National Elk Refuge. Now, are you confusing these herds?

MR. HOLZWORTH: Well, I am, but I do know years ago that we had a game warden who used to move these elk, just by horse and was very successful in doing it. Of course, we have been very successful with our elk herds in our community and I am interested because tomorrow night I am to hear a ranger talk on this reduction, how they were able to make a reduction of kill and how they were able to hold them with the helicopters. I would like to know if they could have a test made with these helicopters rather than the range program?

MR. BENDT: Well, the only control in the Jackson Hole program in these special areas that I have outlined in the Grand Tetons. Of ourse, the moving of

Jackson Hole elk to their original wintering areas in the Red Desert and Green River country has been attempted. This has not been by driving, however, because of its extent, but through an elk lift in the 40's by Wyoming, in which they trapped a number of elk, tagged them, and released them in areas all the way down through the desert to their winter range. However, the reestablishment of this original historical migration never worked out.

MR. KLEIN: You emphasize the importance of the winter feeding program. Do you feel that winter feeding would be necessary if the herd was reduced substantially to allow recovery of some of the winter range that you are referring to? And along the same line, do you feel that the hunt has accomplished your management objective?

MR. BENDT: No. 1, the Grand Teton National Park, provides no significant winter range for this elk herd. Of course, there is much history, controversy, and many studies that have been carried on by other agencies, which relate to the winter range conditions of Jackson Hole. It is a matter principally, of course, of civilization, development, fences, roads, that have all restricted, not only the horizontal historical migrations of the elk herd, but also has affected their elevational movements.

Your second question, do we feel that the elk control program, after nine years, has significantly accomplished the desired objective? This, of course, was the reason for the formation of the Jackson Hole cooperative elk herd study, which was to find as much research data for application of management eventually as we possibly could with all of the agencies concerned. We are finding out, as I mentioned in my paper, that we are beginning to experience summer range problems in southern Yellowstone, as well as on the north end of the Teton National Wilderness area. Essentially, it is not a matter of obtaining as large a harvest as we possibly can but of obtaining a harvest from those elk that spend the summer on particular problem areas. Therefore, the migration studies of this elk herd have been particularly important to know where the most effective harvesting can be done. Our objective, of course, in increasing the number of permits available last year to 2,000, was the result of some of the information we are now obtaining from problem areas in southern Yellowstone. So it is not particularly a matter of obtaining as large a harvest as you possibly can but of a harvest of a particular segment of the elk herd. As far as the desired objectives go, this is one of the things that we hope the study is going to come up with.

DR. COWAN: Does the Park Service make any effort to assist the hunters in this harvest?

MR. BENDT: No, there is no control. The assistance that we render as such is the operation of the registrations, the establishment and preparation of these special camp areas. That is all the active participation and assistance that we give. We do not accompany any of the deputized hunters, if that is what you mean.

DR. COWAN: Any further questions?

ROBERT A. JANTZEN [Arizona]: Bob, you mentioned the assignment of specific camp areas. Does that in any way imply that a hunter assigned to a particular camp has to hunt within a certain portion of the area or can he hunt in this entire open area?

MR. BENDT: The entire area is open, Bob. If we know where the man is, we could locate him and for any purpose that we might have. He can go to any one of these camp grounds, but we request him to inform us of what camp ground he is in. We do not assign him to any particular area. They can hunt in any area that is open.

DR. COWAN: I now am going to return the program to your chairman. I wish to thank you on my behalf for the excellent discussion.

DR. KORSCHGEN: And as Sectional Chairman, I wish to thank the speakers who made this program possible. I want to thank Dr. Cowan who actually guided the discussion and thank each of you for your kind attention and participation in our program. Since this concludes the papers, this session will stand adjourned.

TECHNICAL SESSIONS

Tuesday Morning—March 13

Chairman: C. EUGENE KNODER
In Charge, Game Production and Investigations, Ohio Department of Natural Resources, Columbus, Ohio

Discussion Leader: VINCENT SCHULTZ[1]
Ecologist, Division of Biology and Medicine, Atomic Energy Commission, Washington, D. C.

FIELD AND FARM RESOURCES

WILDLIFE IN KENTUCKY AGRICULTURAL PROGRAMS[1]

ROBERT HORNSBY, JOE BRUNA, ROBERT EVERSOLE, ROBERT KESSLER
Kentucky Department of Fish and Wildlife Resources, Frankfort

Agricultural programs currently in operation throughout the United States provide for the inclusion of wildlife benefits and the enhancement of wildlife habitat. The standards and specifications dealing with wildlife in these programs are usually determined by Federal and State Agencies in cooperation with local boards and county committees. In a sense, these considerations are directed toward the management of wild game.

"*Modern conservation* is concerned with our basic natural resources, soil and water, with associated plants and animals, considered *as a whole or community unit*. . . . It is realized that cooperation is necessary, *since resources are interrelated,* in managing our resources to the full. Soil, water, plants and animals are a *community unit* and must be managed as such." (O'Donnell, 1957).

Kentucky Department of Fish and Wildlife Resources Administrators and Biologists have acknowledged the large amounts of wildlife

[1]In the absence of the Chairman, Dr. Schultz assumed the chair.
[1]A contribution of Kentucky Federal Aid Projects W-37-D and W-38-R.

habitat subjected to land use manipulations in conjunction with the activities of agricultural programs.

Kentucky personnel have focused much attention and exerted considerable effort toward evaluating the effects of agricultural programs on wildlife habitat within the State.

Investigations and analyses were conducted on the following programs: (1) Conservation Reserve Program (Soil Bank), (2) Agricultural Conservation Program, (3) Special Study of Landowners Acceptance of Wildlife Habitat Improvement Practices, (4) Watershed Protection and Flood Prevention Act (P.L. 566, Small Watersheds).

It is the opinion of the study group that *agricultural objectives* such as (1) increased pasture establishment, (2) increased development of drainage systems, (3) improved productivity of land, and (4) soil protection from wind and water erosion are being accomplished. Agricultural subsidies are achieving their goals.

Kentucky studies evaluating agriculture programs in relation to wildlife benefits provide very little evidence that wildlife habitat enhancement goals are being attained. In general, the quality of wildlife habitat is altered to less desirable conditions for some game species and destroyed for others, particularly the wetland species.

It appears that the popularity status of wildlife is being employed as a promotional aspect for some agricultural programs. With this in mind, it is recommended that the proponents of agricultural programs use sincere and practical approaches to substantial wildlife benefits or remove misleading claims from these programs.

SOIL BANK EVALUATION

Field observations on contracted farms participating in Soil Bank Conservation Reserve Program revealed questionable aspects associated with wildlife benefits. In view of this, further investigations appeared justifiable to determine the over-all value of Soil Bank lands to wildlife habitat enhancement.

U. S. Department of Agriculture figures revealed that 373,593 acres of land were contracted over a five-year period in Kentucky. This included only 441 acres in G practices specifically designed for wildlife benefits. At the same time Kentucky farmers had contracted for 224,423 acres of land under practice A-2 (permanent grass-legume seeding). (USDA, 1960a).

"It was felt that the lack of wildlife practices applied on Soil Bank lands in Kentucky was due, in part, to a negative attitude on the part of County Agricultural Stabilization Conservation personnel." (Eversole, 1960).

Study Methods and Procedures

Seventy Soil Bank farms were evaluated by wildlife biologists. The majority of the study data obtained was in relation to practice A-2. This was the most common practice involved in Kentucky Soil Bank lands. Longevity of the practices included in this study ranged from one to four years.

Evaluations were made during the fall of 1959, before frost, and in the spring of 1960, after most plants had begun to grow.

Study Results

Most Soil Bank lands were previously devoted to the production of corn, soy beans and tame hay. In some instances, large tracts of Soil Bank land were in solid blocks of grasses and legumes. This land use change eliminates edge effects that are of high value to farm game species.

A large portion of lands in practice A-2 consisted of fescue grass. Fifty-three farms had fescue grass in the seeding mixture. Observations revealed that in many cases fescue became the dominant species in a planting mixture. This grass often becomes so dense and matted that it is of very limited value to rabbits and quail. Crop analyses and controlled feeding studies conducted in Kentucky revealed that fescue grass ranked very low in food preference for both wild and pen-reared quail. (Wunz, 1959—Eversole, 1960).

Eighty-six per cent of the farms checked for mowing were found to have been mowed at least once a year. Major reasons for mowing were (1) to keep a neat appearance, and (2) noxious weed control. Sixty-eight per cent of the known mowing dates were included in the period June through August. Mowing operations conducted during this period are particularly detrimental to nesting quail. Mowing operations altered natural plant successional stages eliminating potential food and cover, in some cases.

The evaluations of study results, as a whole, seem to indicate that the qualities of wildlife habitat utilized by important farm game species in Kentucky are greatly reduced.

AGRICULTURAL CONSERVATION PROGRAM PRACTICES AS THEY RELATE TO WILDLIFE

"The Agriculture Conservation Program (herein referred to as the ACP) shares with individual farmers and ranchers the cost of carrying out soil and water conservation measures intended to (1) protect farm land and ranch land from wind and water erosion, (2) improve the productivity of the Nation's agricultural resources, and (3) protect and improve the source, flow and use of water for agricultural purposes." (USDA, 1960b). According to the U. S. Department of Agriculture figures, during the years 1950 to 1959, the ACP in Kentucky has had gross annual expenditures ranging from $5,000,000 to $7,794,500. (USDA, 1960c).

Cost sharing is largely confined to those practices which would not ordinarily be carried out without assistance. Standards are dictated by federal agencies and state committees, but the county committees determine local program needs and direct the expenditures of available funds. "Wildlife benefits accrue only if they happen to coincide with specific ACP practices and objectives. For example, in practices to prevent erosion (A-8) ACP recommends consideration be given to wildlife habitat enhancement, but there are practically no benefits in this practice specifically for wildlife. (USDA, 1961). Erosion control is the primary objective and wildlife receives little or no consideration." (Bruna, 1961).

There are four practices in the Kentucky ACP Handbook which state that due consideration shall be given to wildlife habitat maintenance and enhancement. However, there are eight other practices that result directly or indirectly in wildlife habitat destruction. These subsidized practices are explained under the headings that follow.

Alteration of Habitat

The A-2 practice, which is the initial establishment of permanent grass-legume seedlings for soil protection or land use adjustment, resulted in the establishment of 204,000 acres of hay and pasture fields during 1959. (USDA, March, 1960). The destroyed acreage of wildlife habitat composed of broomsedge and weed fields can only be estimated. Figures on this are not tabulated by any of the agencies, but from biologists' observations, the acreage is sizable. In Kentucky, most of the land clearing under this practice is confined, by regulations, to rolling type topography. Many of the cleared hillsides are planted to grasses.

The practice of improving established vegetative cover (B-1), though commendable from the standpoint of rejuvenating old pastures, is destructive of some fine rabbit habitat. This practice is usually confined to neglected pastures that are being invaded by broomsedge, briers and weeds. This is especially true in Kentucky's bluegrass region. By encouraging discing and reseeding, the overstory of briers, broomsedge and weeds is destroyed. During 1959, there were 43,700 acres treated under this program. (USDA, March, 1960).

In many instances when gullies or depressions are reshaped or filled for waterways or terraces (practices C-1, 4) natural habitat is destroyed. These areas are then seeded to grasses (usually fescue).

When it is necessary to relocate fencerows to make way for waterways they usually end up in sod also. Sod, especially fescue, does not constitute good wildlife food and cover as found in Kentucky.

Drainage

There were 20,600 acres drained in one year (1959) under ACP practices C-9, 10. (USDA, March, 1960). These two practices pay up to 50% of the costs of installing tile drainage systems and constructing or enlarging permanent open drainage systems.

Wildlife habitat values are destroyed in four ways under practices C-9, 10: (a) Clearing of rights of way for open ditches destroys considerable wildlife habitat; (b) Spoil banks are required to be kept free from trees and brush and must be mowed, thus excluding wildlife habitat from these strips. Most of the spoil banks are seeded to grasses such as fescue which are not attractive from a wildlife standpoint; (c) Ditching which cuts through lowland woods jeopardizes timber and wildlife values. By drying out these sites, hydrosere type plants die or are excluded; (d) Drainage also promotes land clearing practices that bring land previously unavailable into agricultural production.

Although ACP does not participate directly in the resultant increase of corn land, cost sharing payments for ditching, tile drains, diversions and terraces encourage stabilized production and greater crop yields.

A recent attempt made by the Kentucky Department of Fish and Wildlife Resources to help agricultural agencies formulate recommendations for wildlife benefits was in conjunction with ACP. The new 1962 program includes the "G" practices. The National ACP Memo No. 431 (USDA July, 1861), page 11; paragraph 4 says that the state wildlife agencies should be consulted and that a statement on whether agreements were reached should be recorded. Although the state ACP 1962 written material implies that this situation was met, the biologists' recommendations were in effect ignored.

The practice of arranging words in using wildlife to promote agricultural subsidy programs is being overdone. It is apparent that policies formulated on the National level, regardless of good intent, have but little influence on what actually goes into effect on the state and local levels.

Thus it seems that wildlife is due for another publicity push through the injection of recreation into agricultural programs. It is possible that this could be a valuable asset to wildlife agencies, but this will be true only with proper management. However, it might pay dividends for the wildlife agencies to keep one foot on the ground, when this band wagon rolls by.

SPECIAL COUNTY DEVELOPMENT AND RESTORATION

Boyle County, located in the Bluegrass Region of Kentucky, was designated as a separate work unit with maximum effort devoted to restoring depleted game habitat and developing potential game habitat. Attention was given to as great an acreage as feasible and total restoration, commensurate with the county economy, was the goal.

During the past ten years of Statewide farm game habitat restoration work, little, if any, measurable results have been obtained relative to increased game populations. To determine effects of intensive efforts to possibly formulate more effective practices, which might be applied over a large area, maximum effort was directed to habitat restoration in a single county.

Procedures and Results

A special study of landowners' acceptance of wildlife habitat improvement practices in Boyle County, a cooperative program involving landowners, sportsman clubs, and the Department of Fish and Wildlife Resources, was initiated in July, 1959.

There are 1,237 farms located in Boyle County. An estimated total of 71,265 contacts with landowners were made by the biologist through all mediums of communication.

A total of 68 applications for habitat improvement planning were received by the biologist. Sixty-four farms were mapped and planned for habitat improvement. Twenty-nine plans for habitat improvement were implemented. Of the 29 plans implemented, seven were considered successful and 22 were considered failures. Evaluations of habitat plans were primarily based upon survival of the planting materials supplied to the landowner and the amount of implementation of the complete habitat management plan.

It is estimated that it took 1,114 contacts to secure one cooperator and nine cooperators to produce one successful wildlife plot.

"Results tend to show that even where plans, plants and technical assistance are provided, a landowner will not necessarily avail himself of the opportunity to improve wildlife habitat on his land." (Kessler, 1961).

It seems obvious that further incentives must be provided before landowners can be induced to practice wildlife management. There are good reasons for believing that such an incentive must be monetary. It is just possible that the new A.C.P. "G" practices might provide some incentive if these practices were not in direct competition with production subsidies for the available funds.

WATERSHED PROGRAM AS IT RELATES TO KENTUCKY WILDLIFE

The Watershed Protection and Flood Prevention Act (Public Law 566) was enacted by the Congress in 1954. This Act was amended in 1956 and again in 1958. This law allows the federal government to furnish technical assistance and financial assistance to local organizations for the purpose of flood prevention and the conservation, development, utilization and disposal of water in watershed and subwatershed areas not to exceed 250,000 acres.

The Kentucky Legislature authorized the formation of Watershed Conservancy Districts, as subdistricts of the Soil Conservation Districts, in 1956. According to the Kentucky Watershed Progress Report (USDA, Sept. 1961), 46 districts have been organized. This report lists criteria for providing planning assistance and states the following: "The watershed project is a complete unit and the works of improvement are an integral part thereof. The proposed project would be in harmony with programs of other Federal, State, and Local agencies."

Twenty-five applicant watershed projects, representing 2,108,000 acres of land, have been authorized for planning within the State. Sixteen watershed projects are in various stages of operation. Four projects have been designated as unacceptable and five project plans are in the development stage. (USDA, Sept. 1961).

History and Procedures of Department Participation

The Kentucky Department of Fish and Wildlife Resources gives technical assistance in developing the biology phase of the watershed work plan.

Active participation in the watershed program with the U. S. Soil Conservation Service and other cooperating agencies began during 1956. In the interests of wildlife habitat restoration, the Department has expended considerable effort to further better working relationships with the agencies associated in the watershed program. In conjunction with the State-wide Game Management program that was in operation during the period 1956 to 1959, Department personnel formulated working relationships with S.C.S. on watershed areas. Department Biologists, through routine field work, hunter success data, and contacts with the local people prepared general recommendations for the enhancement of wildlife habitat. Special allotments of free planting materials were made available to watershed landowners. These planting materials included trees, japonica lespedeza, bicolor lespedeza, multiflora rose, annual seed mixtures, and various other annual seeds. Biologists offered their services to prepare wildlife habitat plans, but the landowners received the free materials by merely submitting a plant or seed request.

Results

Habitat improvement evaluations conducted on some watershed areas disclosed little difference in the results that were attained on non-watershed areas. Few measurable results have been obtained relative to increased game populations.

A review of sixteen completed work plans prepared by S.C.S. for proposed watershed projects discloses the following land use changes: (1) A proposed reduction of 83,013 acres of idle land from a total of 119,635, with the idle land being converted mainly to grassland which showed an increase of 81,572 acres; (2) A proposed increase of 3,954 acres of land devoted to woodlands.

The grassland will be planted mainly to fescue, other grasses and legumes and will no doubt be used for pasture in the future. The natural food and cover plants existing on much of this idle land will be eliminated from this type game habitat.

The proposed increase in woodland acreage is most often planted to pine trees which are inferior to native vegetation as game habitat.

A study of the Caney Creek Watershed includes typical conservation measures that are cost-shared by A.C.P. (Bruna, 1961). These include diversion ditches, land smoothing and tiling, open and tile drains and grassed waterways.

These practices fit into the stream channel improvement phase of the watershed project. The SCS does not provide drainage in the watershed project, is is claimed, but drainage is provided for and the landowner has simply to connect his tile or open ditch to the channel after the watershed project has been completed. On only four of these projects there is a total of 171 miles of stream channel improvement work, an average of over 40 miles for each project.

In addition to this manipulation of streams there is clearing and snagging, terrace construction, tile drainage and open ditches.

These four watersheds in the western part of the state contain thousands of acres of swampy forest and other wetland habitat. Subsequent drainage and clearing as facilitated by the watershed projects will seriously deplete or eliminate this wetland habitat.

One landowner on a project reported (Dibble, personal conversation, 1961) that as soon as he could drain his wetlands his intentions were to clear the vegetation (mainly a pin oak flat) and plant pine trees.

Portions of two watershed projects account for about 60 per cent of the entire area of Calloway County. The area of these four watersheds includes 41 per cent of the Jackson Purchase Region consisting of eight western Kentucky counties. The state's prime waterfowl and wetland areas are located in this region. The state-owned Ballard County Waterfowl Management Area is included also.

A leaflet was prepared for the benefit of landowners on the Humphrey-Clanton Creek Watershed project area. This printed material compares the value of the wetlands for waterfowl and other wildlife with corn values on a per acre basis. It was shown that without the costs of clearing, draining, and ditch maintenance and land preparation for cultivation expense, that timber and wildlife would provide a margin of $5.55 per acre above corn. This was based on current hunting fees of up to $15.00 per man day on adjacent hunting clubs. Timber values were reported by a State forester.

A bulletin published by the U. S. Department of Interior (1960) contains an illustration to show that it is possible to channelize a stream without destroying the bank cover. This is ideal, but there is no evidence to show that this has been done in Kentucky.

Natural stream banks are ideal habitat for fur, fish and game. Observations of some drainage ditches and improved channels 15 to 20 years old in Daviess County reveal that the bank is inaccessible due to a dense stand of pole-size saplings.

Observations conducted on recently completed channels in Ohio County show a bare bank. Heavy erosion has occurred where the cover has been stripped for a distance of 40 feet on either side of the channel.

A biological recommendation was made to provide deep pools for fish in a channel to be improved on the Big Muddy Creek Watershed. The watershed district supervisors rejected the plan because it was believed that erosion and washing would fill in the pools and necessitate a costly maintenance program.

It appears that Soil Conservation as Dr. Hugh Bennett thought of it is a thing of the past. In modern times there can be no conservation of the soil unless it is coupled with a drainage project. This is bringing in more land for production despite the current estimate by the Department of Agriculture that 50 million acres of tillable land should be retired from cultivation for at least 20 years hence.

CONCLUSIONS

It has become obvious that providing technical plans, giving away plant materials and the agricultural wildlife programs as now applied do not provide sufficient incentive to landowners to cause them to practice habitat improvement.

Neither the Fish and Wildlife Coordination Act nor the P.L. 566 Watershed Act have much influence on whether such practices are incorporated into a project.

We have been through the various programs and find that they actually accomplish very little in the way of wildlife benefits. The Kentucky Department has dropped its give-away plant program. It still makes planning assistance available to any landowner upon request. We realize that this service alone will never meet the needs and that farm wildlife habitat management is basically an agricultural problem. It is time for the officials responsible for the wildlife practices in the agricultural programs to make a reappraisal of objectives and implementation. Officials of Federal and State wildlife agencies should insist that this be done.

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DISCUSSION

MR. LARRY GALE [Missouri]: I would like to say that our experience in Missouri has not been quite so pessimistic or so discouraging as Bob has recounted in his report. I do believe, however, that it brings out one principle which is all important, and that is that these agricultural programs, although they do offer opportunities for wildlife, do not provide automatic benefits. It requires a great deal of effort on the part of the wildlife agencies, both at the state and the local or county levels, to realize these benefits.

I would like to ask about the farms in Boyle County of which, although they had a wildlife plan implemented, twenty-two were failures out of a total of twenty-nine. I see that this was due primarily to the lack of survival of planting materials or the fact that the farmers did not carry out the entire plan. I would like to ask whether the failure of planting materials to survive was due to local weather conditions or the method of handling the plants, or do you have any ideas about why this did not succeed once the plan had been implemented?

MR. HORNSBY: Mr. Gale, it is unfortunate that Robert Kessler of the Kentucky Department of Fish and Wildlife Resources, who conducted the study, is not here to give you more detailed information on your questions. However, I will give a general answer to that. It is my understanding that the failure of the plants was due to weather conditions—to a drought condition that then existed—and also to the conditions of the plants. Apparently when they were received by the landowner, the plants could have been in better condition than they were in some cases.

CHAIRMAN SCHUTZ: Being the discussion chairman, I suppose I have to ask a question. I was curious as to whether or not the study concentrated on any physiographic region of the state. I realize that Kentucky is highly diversified. Did the study emphasize the bluegrass region or did you work in the mountains, or another portion of the state?

MR. HORNSBY: Are you referring to the whole study?

CHAIRMAN SCHULTZ: I was thinking particularly of the Soil Bank program.

MR. HORNSBY: The farms that were included in the Soil Bank study were more or less a cross section of the farming district in Kentucky. Seventy farms were selected in all of the various physiographic regions. It was not a study conducted in just one area such as the bluegrass region.

CHAIRMAN SCHULTZ: Thank you. If there are no other questions, we will proceed to the paper by Dr. Frank Golley, who is slightly incapacitated. His paper will be presented by William Rickard of the Hanford Laboratories, General Electric Company at Richland, Washington. The study is unique in that this eight-year trend study was located on the AEC Savannah River plant area which is an area of approximately 315 square miles taken out of agricultural production approximately eight years ago.

THE EIGHT-YEAR TREND IN QUAIL AND DOVE CALL COUNTS IN THE AEC SAVANNAH RIVER PLANT AREA[1]

FRANK B. GOLLEY[2]
Institute of Radiation Ecology, University of Georgia, Athens

As a part of the University of Georgia ecological studies on the 250,000 acre reserve of the AEC Savannah River Plant, Aiken, South Carolina, game animals have been censured regularly. The objective has been to determine trends in wildlife populations following the abandonment of land for agriculture and evacuation of human residents which took place in 1951-52 when the atomic energy installations were established. Conventional, relatively uncomplicated methods were chosen so that censuses could be repeated in a consistent manner year after year and also so that comparisons could be made with similar censuses outside the reservation. The present paper is concerned with the relative abundance of the bobwhite quail (*Colinus virginianus*) and breeding mourning doves (*Zenaidura macroura*) between 1952 and 1959 determined by the call count census technique.

[1]A contribution from the University of Georgia Institute of Radiation Ecology, supported by contract number AT(07-2)10, between the U. S. Atomic Energy Commission and the University of Georgia.

[2]In the absence of the author this paper was read by William H. Rickard, Hanford Laboratories, General Electric Company, Richland, Washington

The study was conceived and directed by Dr. Eugene P. Odum as part of a continuing long range program. Since a consistent pattern in the call counts was evident during the first eight years of censuses, the author, at Dr. Odum's suggestion, has undertaken a detailed analysis of the annual counts with the help of Dr. James Carmon and the staff of the Institute of Experimental Statistics of the University of Georgia. Mr. Leonard Foote, Wildlife Management Institute and Dr. Vincent Schultz, U. S. Atomic Energy Commission, have kindly examined the manuscript.

Game biologists have regularly used the whistles of bobwhite quail and the coos of mourning doves to locate and count individual birds. When these call counts are made in a standard way, they can be used as indices to the population density of the species. Actually the majority of calling activity is carried out by unmated male quail and doves (Stoddard, 1931; Frankel and Baskett, 1961), or possibly paired male doves between nestings (Jackson, 1961), and it is assumed that the proportion of unmated males to the total population of birds remains constant from year to year for a given season. Certainly this proportion may vary with population density. At low densities of birds a smaller proportion of unmated males would result in an underestimate of the population, and at higher densities a high proportion of unmated males would cause an overestimate.

In addition, when comparing the call counts between years and areas it is necessary to consider variables such as the time of year, time of day, temperatnure, and wind which influence the number of birds calling and the ability of the observers to hear the calls (Bennitt, 1951; Lowe, 1956). The variation due to these factors can be determined with suitable statistical procedures (Elder, 1956). If the problems of density, time of count, and the weather conditions are considered in the interpretation of the data, call counts can be used as indices to changes in bird populations.

METHODS

The method of making the call counts was standardized so that the data would be comparable between years and census routes. The counts were made on 20 mile routes, each having 20 observation points located one mile apart. In general the counts were begun 30 minutes before official sunrise and lasted 2 hours. Approximately 3 minutes were spent at each station and 3 minutes driving between stations. At each census several observers drove together in a car, but each man made separate counts. During the eight years 13 different observers participated in the study as follows: Drs. E. P. Odum, E. J. Kuenzler, L. B. Davenport, W. H. Cross, L. D. Caldwell, C. Connell and Mr. W.

K. Willard, W. Tarpley, J. B. Gentry, L. Riley, J. Lowe, M. M. Provo, and R. W. Pearson. The mechanics of the sampling procedure are summarized in Table 1.

TABLE 1. SUMMARY OF INFORMATION ON THE CONDITIONS AND PROCEDURES OF THE CALL COUNT CENSUSES

	1952	1953	1955	1956	1957	1958	1959
Number of observers	4	4	5	3	4	2	2
Number of censuses							
Route 1	4	3	3	4	3	2	2
Route 2	4	3	3	1	0	0	0
Route 3	0	0	0	3	3	2	2
Range of census dates	5/17-7/25	5/25-7/17	5/28-6/12	6/6-7/16	6/7-7/5	6/6-6/25	5/25-5/29
Average temperature °F	73.1	74.2	70.3	72.4	69.7	71.0	71.8
Range of temperature during the censuses °F	15	4	13	11	7	12	2
Average wind during censuses, beaufort scale reading[1]	1.06	1.00	0.50	0.50	0.50	1.20	0.37

[1]Beaufort scale: 1 = 1-3 mph, 2 = 4-7 mph, and 3 = 8-12 mph.

Wind velocity and air temperature were measured before and after each census (Table 1). Wind velocity was determined with the Beaufort scale (Bennitt, 1951) and the censuses were not made if the velocity exceeded 13 mph. Counts were also not made during rainy weather. The census was resumed on the next favorable day following unsuitable weather.

When the study of quail and doves began in 1952 two routes were used. Both of these were on the Aiken Plateau, a region located above the 270 foot contour with hilly topography, highly dissected by small streams. One route ran inside of the Savannah River Project where the land had been abandoned for farming in 1952 and the other route ran outside of the Project where farming, human occupancy, and hunting continued. In 1956 a new route within the Project on the Pleistocene Coastal Terrace below the 270 foot contour was added. Finally, in 1957 the route outside of the Project was discontinued. Thus we are concerned with three different routes, one of which was operated for seven years and two others each operated for four years.

Since the intensity of calling activity may vary during the spring and summer, it was necessary to determine the period of peak calling in order to properly schedule the censuses. Bennitt (1951) reported that Missouri quail have a relatively narrow peak calling period extending from June 21 to July 20, and Lowe (1956) reported an extended peak cooing period for Georgia doves which lasted from mid May to July. Therefore, in 1952 and 1953, call counts were made from May 17 to July 25 to span these peak periods. Since the 1952 and 1953 counts indicated that the peak period of calling for both quail and doves was from late May through June, later censuses were made during this period (in 1956 and 1957 early July counts were also included). Thus the call counts covered a three month period in 1952 and 1953, and a two month period for the other years. No counts were made in 1954.

The original objective of this study was to determine if there was a difference in the number of quail or doves calling on the different routes in the various years. After the data were collected and subjected to a preliminary analysis it was decided that the effect of observer, station, month, temperature and wind on the number of birds calling should also be considered. However, since the study was not originally designed for statistical analysis the number and character of observations were controlled only within wide limits, with the result that there was a disproportionate number of observations during any one year. In the analysis a further difficulty was encountered; the entire set of data could not be fitted to the IBM 650 computer matrix. Therefore, each year was analysed separately considering the variables stations, routes, observers, months, temperature, and wind, and then all years were analysed together considering the variables years, stations, routes, temperature, and wind.

The model used to describe the yearly data was as follows:

$$Y_{ijkl} = \mu + r_i + s_j + o_k + m_l + b_1(x_1\text{-}\bar{x}_1) + b_2(x_2\text{-}\bar{x}_2) + e_{ijkl}$$

where

Y_{ijkl} is the observation made on the i^{th} route at the j^{th} station by the k^{th} observer in the l^{th} month,

μ = the adjusted mean,

b_1 = the partial regression of census number on temperature,

b_2 = the partial regression of census number on wind velocity, and,

e_{ijkl} = random error and error due to equation since interaction could not be included in the model.

The procedure in using the linear model was to fit the entire regression and to consider the independent variables as fixed, rather than random. The residual was used as the error term. In each instance the individual observations for each station were employed in the comparisons, and a conventional least square analysis was used to estimate all constants. A 95% level of statistical significance was used throughout. The efficiency of this analysis was indicated by calculating the square of the multiple correlation coefficient, R^2, which measured the percentage of the variation accounted for by the regression analysis.

Because of the limitations of the experimental design and computer capacity the statistical analysis was not especially rigorous. In particular, it was regretted that interaction between variates could not be tested. Further, errors of intepretations could result from linear correlations between the fixed independent variables (See Schultz and

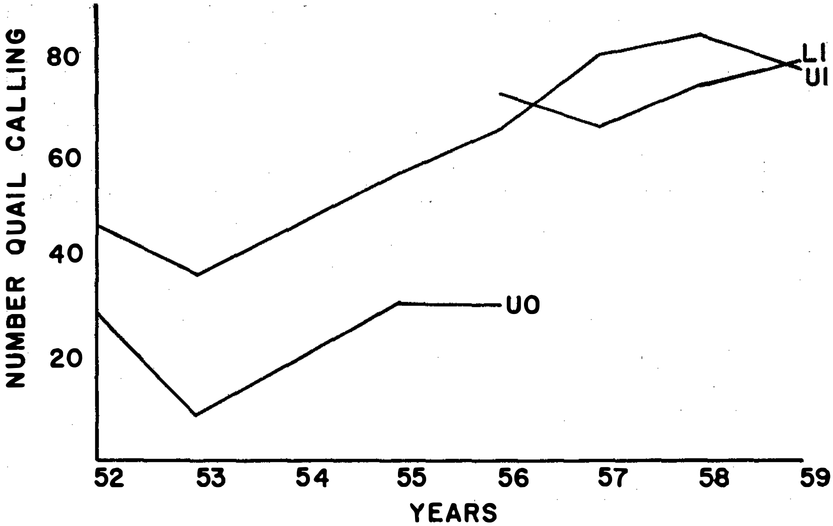

Figure 1. The average number of quail calling during each year on the three census routes. UI indicates the upland route inside the SRP; LI, the lowland, inside route, and UO the upland route outside of the SRP.

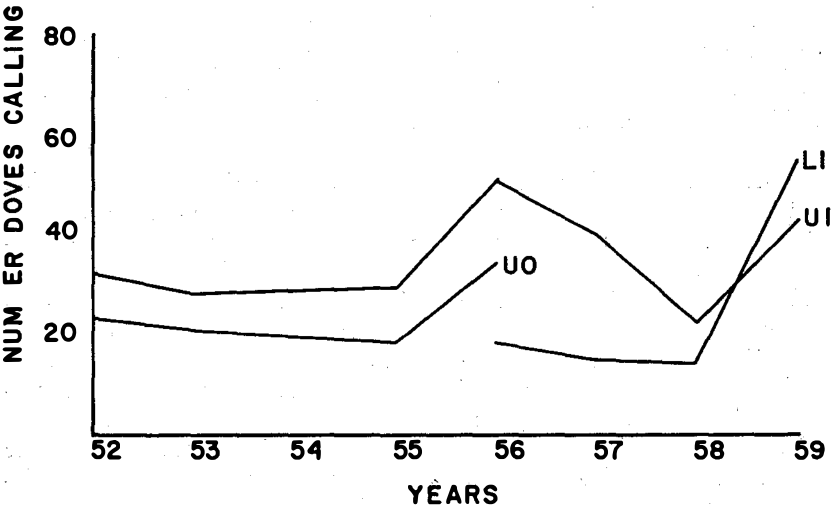

Figure 2. The average number of doves cooing during each year on the census routes. UI indicates the upland route inside of the SRP; LI, the lowland, inside route, and UO the upland route outside of the SRP.

Brooks, 1958, for a discussion of this probem.) Nevertheless, the analysis seemed adequate for the original objective of the study.

RESULTS

The differences between the number of calling doves and quail during the eight years were statistically significant (Tables 2 and 3). The means adjusted for disproportionate numbers and covariance are shown in Tables 4 and 5. Inside the Savannah River Project the quail counts doubled during the study period, while outside the Project the counts remained nearly constant (Figure 1). Within the Project the trend on both the Aiken Plateau and the Coastal Terrace routes was a consistent increase in the population of calling quail. In contrast, the dove coo counts appeared to be extremely variable, fluctuating around a mean of about 30 birds calling per route per year (Figure 2).

The major pattern on the census routes was a higher count of calling birds on the Project Plateau route than on the other routes for both quail and doves in almost every year. The reason for this was, first, there was a marked difference between the outside and inside routes for quail and a clear but less marked difference for doves (Figure 1 and 2). And, second, the number of calling birds on the Project Terrace route was considerably lower than on the Plateau route in 1956 and 1957 for doves and in 1957 for quail; these counts became increasingly similar in 1958 and 1959. The route differences were statistically significant for quail during each year except 1956, 1958, and 1959 and for doves in each year except in 1953 and 1958 (Tables 2 and 3).

There appeared to be a lag in the response of the birds to land abandonment inside of the Project. In 1952 and 1953 the inside and outside call counts did not change greatly in magnitude. The increase in counts of quail especially inside the Savannah River Project did not become evident until 1955.

In addition to demonstrating significant differences in numbers of calling quail and doves among the several years of the study and on the census routes, the multiple regression analysis also resulted in additional information on the variables which influence the call counts. The variables considered in this study will be discussed below.

Station differences—There is a consistent statistical significant difference between the quail and dove call counts made at each individual call count station during each year (Tables 2 and 3). This effect of station is a complex quantity since it is due in part to differences in habitat between stations and in part to the fact that the stations are censused at different times of day. The time of day effect is partly an influence of the time from sunrise (most quail and doves are calling during the

TABLE 2. ANALYSIS OF VARIANCE OF QUAIL COUNTS FOR 7 INDIVIDUAL YEARS AND ALL YEARS COMBINED
Degrees of Freedom and Mean Square Values

	1952		1953		1955		1956		1957		1958		1959		All Years	
Source	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.
Year															6	181.82*
Route	1	22.99*	1	36.96*	1	32.39*	2	6.77	1	41.04*	1	1.24	1	0.09	1	188.40*
Station	19	11.86*	19	4.02*	19	8.26*	19	26.58*	19	26.51*	19	10.94*	19	21.39*	19	35.64*
Observer					4	7.04*	2	0.39	3	5.11	1	4.21	1	1.66		
Month	2	18.85*	2	16.87*	1	0.58	1	17.73	1	0.78						
Temperature	1	0.43			1	24.58*	1	15.23	1	33.74*	1	0.37	1	1.01	1	30.01*
Wind	1	9.56*	1	14.22*	1	5.98	1	26.74*	1	19.32	1	4.91			1	11.55
Error	291	2.14	173	2.14	211	2.84	314	5.03	353	5.15	76	3.65	137	2.88	1709	4.45
R^2		.334		.430		.389		.274		.261		.484		.510		.224

*Significance at 95% level.

TABLE 3. ANALYSIS OF VARIANCE OF DOVE COUNTS FOR 7 INDIVIDUAL YEARS AND ALL YEARS COMBINED
Degrees of Freedom and Mean Square Values

	1952		1953		1955		1956		1957		1958		1959		All Years	
Source	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.
Year															6	36.94*
Route	1	5.97*	1	2.62	1	5.73*	2	94.77*	1	129.81*	1	0.82	1	9.73*	21	183.05*
Station	19	6.67*	19	4.91*	19	3.15*	19	6.35*	19	6.44*	19	3.06*	19	6.82*	19	15.85
Observer	3	0.09	3	4.13*	4	1.08	2	5.17	3	3.32	1	0.10	1	4.95		
Month	2	0.48	2	0.78	1	0.12	1	11.63*	1	0.92						
Temperature	1	0.35			1	19.01*	1	15.79*	1	4.60	1	0.19	1	1.65	1	48.93*
Wind	1	1.90	1	0.17	1	0.04	1	4.58	1	4.12	1	0.39			1	15.60
Error	291	1.21	173	0.76	211	0.95	314	2.52	353	1.76	76	0.79	137	1.52	1709	1.78
R^2		.297		.465		.383		.292		.335		.530		.433		.211

*Significance at 95% level.

first hour after sunrise, Bennitt, 1951; Elder, 1956; and Cohen, *et. al.*, 1960), and partly an influence of temperature (the number of quail calling decreases as the temperature rises, Bennitt, 1951 and Elder, 1956). The importance of these influences was evaluated by comparing the average count per station (the sum of the maximum daily counts for each station each year divided by the number of years) for the three routes. These average values are representative of the conditions during any year since the frequency of counts at the individual stations was consistent from year to year. For both quail and doves there seems to be little relation between the sequence of station and the number of birds calling. Two patterns are evident, but these differ for routes and species. In one pattern the highest counts fall immediately before official sunrise and at the final stations. Calling quail showed this pattern on the inside Plateau route and doves on the inside Terrace route. In the second pattern the highest counts fall mainly in the hour after sunrise. Quail on the outside Plateau route and inside Terrace route and doves on the outside and inside Plateau routes followed this pattern. The findings here support Elder (1956) who reported that the effects of time of day and temperature may be obscured by variations in the habitat at the different stations.

Observer effect—Since individuals differ widely in their ability to hear calling birds (Carney and Petrides, 1957), it might be expected that the counts made by different observers would vary widely. The difference between the highest and lowest quail call counts during each census ranged from 2 to 18 birds and averaged 9 birds, while the difference between highest and lowest dove counts per census ranged from 0 to 21 birds and averaged 6. However, this variation due to observers was statistically significant only in 1955 for quail and in 1953 for doves (Tables 2 and 3). Significance of observer effect corresponded with the number of observers. Two persons counted quail in 1952, 1953, 1958 and 1959, four persons counted in 1955 and three persons in 1956 and 1957. Four persons participated in the dove censuses in 1952, 1953 and 1957, three in 1956, five in 1955 and two in 1958 and 1959. In both years in which observer effect was statistically significant, four persons participated in the census.

Monthly variation—Since the call counts were designed to reduce monthly variation, we would not expect this variable to be important. Only in the two years, 1952 and 1953, when the peak period of calling was being determined was monthly variation statistically significant for quail (Table 2). The month effect was statistically significant for doves in 1956 only (Table 3).

The effect of temperature and wind—Increasing temperature and wind adversely influence the number of birds calling, while rising wind also

TABLE 4. ADJUSTED MEAN NUMBER OF QUAIL CALLING PER YEAR

Source	1952	1953	1955	Years 1956	1957	1958	1959
Over-all mean	1.91	1.15	2.21	2.82	3.67	3.97	3.89
Route 1	2.34	1.85	2.87	3.28	4.02	4.22	3.86
Route 2	1.48	0.45	1.55	1.53			
Route 3				3.65	3.32	3.72	3.92
Observer 1	2.04	1.97	2.38	2.71	3.56	3.65	3.99
Observer 2	1.80	0.37	1.65	2.94	3.50	4.29	3.79
Observer 3			2.79	2.80	3.96		
Observer 4			1.88				
Observer 5							
Month 1	1.72	1.84	2.12	3.14	3.72		
Month 2	2.49	1.32	2.30	2.50	3.62		
Month 3	1.53	0.29					
Station 1	0.96	1.01	1.73	0.07	1.55	3.58	5.42
Station 2	1.27	1.81	2.40	0.78	0.87	6.18	5.17
Station 3	1.71	0.81	2.99	1.31	2.55	5.18	3.92
Station 4	1.21	2.01	2.41	2.78	3.92	5.98	5.17
Station 5	2.33	1.38	2.40	4.66	5.45	6.38	6.92
Station 6	3.33	1.98	4.25	3.07	4.45	5.98	7.04
Station 7	1.46	1.38	2.23	3.96	4.08	4.38	5.42
Station 8	1.58	0.78	2.81	2.78	4.40	2.78	4.67
Station 9	3.21	1.98	3.28	1.96	3.76	2.98	3.42
Station 10	1.71	1.78	2.90	1.66	3.24	1.38	4.31
Station 11	1.21	0.31	1.17	4.48	2.61	3.98	4.29
Station 12	1.21	1.31	2.23	4.72	3.24	3.18	2.92
Station 13	2.33	1.78	1.89	2.19	3.03	2.18	2.67
Station 14	1.58	0.68	0.92	3.25	5.13	3.58	3.17
Station 15	3.46	0.82	2.24	3.01	5.24	3.58	2.17
Station 16	3.71	1.25	1.65	3.07	4.66	5.78	2.42
Station 17	1.58	0.41	1.99	3.78	3.92	3.98	1.17
Station 18	1.83	1.21	1.75	3.60	4.50	2.58	3.29
Station 19	1.58	0.35	1.33	2.96	3.45	2.58	1.67
Station 20	0.96	0.68	1.01	2.31	3.35	3.18	2.61

TABLE 5. ADJUSTED MEAN NUMBER OF DOVES COOING PER YEAR

Source	1952	1953	1955	Years 1956	1957	1958	1959
Over-all mean	1.38	1.24	1.22	1.77	1.39	0.92	2.46
Route 1	1.60	1.43	1.49	2.57	2.02	1.12	2.16
Route 2	1.16	1.05	0.94	1.74			
Route 3				0.94	0.76	0.72	2.76
Observer 1	1.34	1.41	1.32	1.93	1.52	0.87	2.64
Observer 2	1.35	1.86	1.34	1.47	1.54	0.97	2.28
Observer 3	1.37	0.81	1.05	1.91	1.18		
Observer 4	1.46	0.88	1.02		1.32		
Observer 5			1.34				
Month 1	1.40	1.15	1.26	2.03	1.45		
Month 2	1.47	1.13	1.17	1.51	1.33		
Month 3	1.29	1.44					
Station 1	0.62	1.02	0.74	1.75	1.34	0.99	3.02
Station 2	0.81	1.72	1.41	1.40	0.87	1.19	1.77
Station 3	1.06	1.82	2.00	2.99	2.61	1.19	3.77
Station 4	2.49	1.92	1.41	2.28	2.08	2.19	3.40
Station 5	1.12	2.22	1.41	2.81	1.18	1.39	2.90
Station 6	2.56	2.02	2.32	2.22	1.76	2.19	2.90
Station 7	1.68	1.82	1.24	1.75	0.92	0.79	2.65
Station 8	1.81	0.92	1.82	1.70	1.08	0.39	2.77
Station 9	2.31	1.32	0.91	2.10	1.92	1.19	2.52
Station 10	2.06	2.12	1.91	2.52	0.87	2.59	0.87
Station 11	1.12	1.01	1.57	1.40	2.61	0.00	1.52
Station 12	1.24	2.11	1.24	1.99	1.40	0.39	1.52
Station 13	1.74	1.60	0.90	1.52	1.34	0.59	1.65
Station 14	1.43	0.99	0.66	0.99	0.71	0.00	1.52
Station 15	1.06	0.38	2.25	1.34	1.61	0.79	4.65
Station 16	0.87	0.50	1.65	1.68	1.45	0.19	1.77
Station 17	0.37	0.00	2.00	1.86	1.45	0.99	3.27
Station 18	0.37	0.70	1.75	0.93	1.34	0.19	2.90
Station 19	1.37	0.50	1.33	0.63	0.55	0.00	1.77
Station 20	1.49	0.21	1.01	1.34	0.72	0.59	2.04

reduces the audibility of the calls. Temperature was recorded before and after each census and the average of these readings was used in the analysis. Therefore, the comparison was between temperatures on different days, rather than between temperatures during any one day. Within a year the average temperature during the censuses ranged from 2° to 15° F, while the average yearly census temperatures ranged from 69.7° to 74.2° F in the eight years. The effect of temperature was statistically significant when all years were considered together for both quail and doves. In the year-by-year analysis temperature effect was significant only in 1955 and 1957 for quail (Table 2) and 1955 and 1956 for doves (Table 3).

The call counts were usually not made when the wind velocity exceeded 8 mph. On only two occasions, once in 1952 and 1957, did the average wind velocity during a census reach the limit of 13 mph. As a result of this selection for the day of the census, wind was not a significant variable in the quail counts when all years were considered together. However, in 1952 and 1956 the wind effect was statistically significant on quail. Since the coo of the dove is more difficult to hear, wind might play a more important role in influencing dove counts. Short, gusty winds which would not be recorded could introduce considerable variation into the dove counts. Wind was statistically significant for doves when all years were considered together but not significant during any individual year.

The multiple correlation coefficient—The R^2 values in Tables 2 and 3 indicate the percentage of the variation in the call counts accounted for by the regression analysis. For quail this value ranged from 26 to 51% in the eight years, indicating that over 50% of the variation in the call counts was attributable to factors not identified here. This contrasts with Elder's (1956) findings that 20% of the variation in whistling was due to weather (temperature, vapor pressure, and wind) alone. The R^2 value for all years combined was 22%, which may reflect the fact that it was not possible to consider variation due to observer or month in the combined year analysis. If these variables were included the R^2 values would probably fall near the eight year average of 38%. The R^2 values for doves were of the same magnitude as those for quail. From 21 to 53% of the variation was accounted for by the regression analysis in individual years, while the R^2 value for all years was 21%.

DISCUSSION

Quail and mourning doves have not responded equally to the abandonment of land on the Savannah River Project. The first two years after abandonment populations of quail and doves, as indicated by the call counts, remained nearly constant inside and outside the plant. By 1955 the quail counts began the upward trend which has continued throughout the study, while doves have fluctuated around a mean calling population of about 30 birds per route.

Quail and mourning doves have different ecological requirements which help to explain the difference in the response to land abandonment by these two species. First, quail are omnivores and consume both seeds and insects, while doves are primarily granivores. Second, quail nest on the ground, while doves nest in shrubs and trees. The herbaceous stages of old field succession furnish an abundance of food and cover for a ground living species such as the quail but relatively less increase in resources for the dove. In 1952 a large proportion of the abandoned fields was vegetated with a horseweed (*Leptilon canadense*) and crabgrass (*Digitaria sanguinalis*) complex. The vegetation became more diverse in succeeding years and the number of grain-producing plants (*Rumex, Cassia, Lespedeza, Lechea, Diodia,* and others) increased. However, in the eight years tree and shrub habitat suitable for doves did not greatly increase beyond the roadside and hedgerow thickets present in 1952.

The lag in response to land abandonment shown in Figure 1 may be associated with changes in mammal populations as well as changes in the vegetation. Carnivorous mammals, such as foxes and bobcats, which are predaceous on quail increased soon after the Savannah River Project was established but in 1955 declined to a level which has remained stable to the present. The increase in quail populations corresponded with the decline in fox and bobcat populations.

Calling quail and dove populations on the Savannah River Project may be compared with populations also determined by the call count technique in other states. Calling quail populations in Missouri in 1939-1948 (Bennitt, 1951) and Alabama in 1956 (Haugen, 1956) have averaged around 50 birds calling per route and have ranged from 24 to 75 birds in Missouri and 19 to 120 in Alabama. Quail populations outside of the Savannah River Project (30-35 birds per route) were near the average for these states, while the peak populations on the inside Plateau route (over 80 birds per route) were near the maximum records. The dove counts determined in this study were quite similar to those reported in the Mourning Dove Status Report for other sections of South Carolina from 1953-1961 (average of 29 birds per route, Kiel, 1961) but were slightly higher than counts from Georgia (average of 19 birds per route, Kiel, 1961). These comparisons further indicate that conditions on the Project have been favorable for quail permitting them to reach populations close to the maximum found on limited areas in other states but have not been equally favorable for mourning doves.

Two general conclusions can be drawn from the multiple regression analysis. First, the statistically significant variables: time of year, observer, temperature and wind were not organized in any clear cut pattern, instead the importance of these during any one year varied widely. Improved experimental design could reduce some of this variation; however, a certain proportion was unpredictable on the basis of the available information and is probably inherent in the technique. Second, the percentage of the variation accounted for in the analysis as indicated by the multiple correlation coefficient was quite low—less than 50%. Presumedly there are some important variables in the call count technique which were not identified here.

SUMMARY

The response of bobwhite quail and mourning doves to land abandonment for farming on the Savannah River Project was studied by the call count technique. Standardized census routes were operated inside of the Project from 1952, when the Savannah River Project was established, to 1959 and outside of the Project from 1952 to 1956. The call counts showed that the populations of calling quail increased dramatically within but remained constant outside the Project, while dove populations fluctuated widely around a mean of about 30 birds calling per census route. The differential response of these species to land abandonment was partly explained by their ecological requirements. Quail, a ground-nesting, omnivorous species, would be expected to benefit more from the early stages of plant succession on old-fields than would the mourning dove.

The multiple regression analysis of the data permitted an evaluation of the variables which influence call counts. The factors: time of year, observer, temperature, and wind were significant variables but not consistently significant each year of the study. The multiple correlation coefficient indicated that less than 50% of the variation in the counts was accounted for by the variables considered in the analysis. These results suggested that the experimental design of the standard call count census might be improved to reduce the variability in the counts.

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DISCUSSION

CHAIRMAN SCHULTZ: Thank you, Bill. Since neither you nor I have been on the Savannah River Project, we may have a little difficulty in answering some of the questions. However, since I have discussed this study with Dr. Golley, I may know a little bit about it. Dr. James Jenkins of the University of Georgia informed me that he believes that the quail population at Savannah River now is at its peak and he expects, within a few years, to see some sort of decline. Jim told me, in his usual slow fashion, that he has collected 65 quail in the afternoon for the health-safety group at the plant. This sounded like a fairly decent kill.

Are there any specific questions you might have about the Savannah River area that I might be able to answer?

MR. BILL T. CRAWFORD [Missouri Conservation Commission]: I would like to compliment the author on this paper. I think this is a good example of the intent of use of the calling quail count. However, in Missouri in recent years we have felt that the conducting of the spring calling count on quail does not adequately reflect the breeding density in the fall population. At least in the area of the Missouri range, the problems of nesting, the problems of brooding, and the problems of climate probably are the controlling factors on the total quail numbers in the fall. Actually we find very few places where there are not adequate breeding densities in the spring. Therefore, the measurement of the breeding densities in the spring do not reflect themselves general statewide conditions. These other factors more nearly influence the total quail populations in the fall.

CHAIRMAN SCHULTZ: Thank you, Bill. Are there any more comments before we move on to the next manuscript?

MR. JOHN P. RUSSO [Arizona Game and Fish Commission]: I have one question I would like cleared up if you can. I understand that two people simulaneously recorded these quail counts independently of one another. Do you know if there was any discrepancy between the counts made by the two individuals counting on one group, and if such human error or fallacy was taken into consideration?

CHAIRMAN SCHULTZ: Dr. Golley considered that in his statistical analyses. The study, as originally conceived, was a typical wildlife study in which they decided they were going to run a number of censuses with no definite plans other than just inspecting the data. Since he did not establish this study himself, Frank has had difficulty in interpreting some of the results. But he did try to separate the element of human error on the part of observers.

SEASONAL PATTERNS OF STABLE AND RADIOACTIVE IODINE IN THYROIDS OF NATIVE JACK RABBITS[1]

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Iodine is an essential dietary constituent for all higher vertebrates. It is important in the function of the thyroid gland, and its deficiency may cause goiter in adults and cretinism in offspring. Its importance in nutrition of domestic animals has long been recognized. The nutritional iodine requirements in diets of wild animals have not been generally recognized, however, although the influence of essential minerals and vitamins in accounting for peculiar distribution of success or failure of upland game bird plantings was postulated by Leopold (1948).

This is a report on measurements of the radioactive and stable iodine content of thyroid glands of black-tailed jack rabbits (*Lepus californicus wallawalla* Merriam) collected at monthly intervals during the period 1956-1960 from specific locations within the Hanford Reservation in southeastern Washington.

Radioactive iodine is continuously released within prescribed limits to the atmosphere of the Hanford Reservation during routine nuclear industrial operations. Its deposition upon vegetation of the surrounding region averages 10^7 to 10^8 times that in the atmosphere (Nelson, 1961) but is well within limits recommended as safe for grazing animals (Bustad *et al.*, 1957). This concentrated source of I^{131} enabled us to measure its transfer through the food web to the rabbit and to compare the behavior of radioactive and stable iodine in a region classified as marginally goitrogenic because of low stable iodine concentrations in native vegetation (Kalkus, 1920).

Patterns of radioactive iodine accumulation in rabbit thyroids analyzed during the study were markedly different from those of stable iodine.

The seasonal stable iodine concentration pattern in adult rabbit thyroids during 1956-1960 was irregular, as shown in Figure 1. Seasonal maximums occurred during the winter months (October-January) and midsummer (July-August) and a minimum consistently occurred during April or May. At least two factors, iodine content of food plants and reproductive functions, probably contribute to producing this pattern. In New Zealand, species and plant strain differences were found more important than soil iodine or seasonal variation in affecting the iodine content of pasture vegetation (Butler *et al.*, 1956;

[1]Work performed under Contract No. AT-(45-1)-1350 between the Atomic Energy Commission and the General Electric Company.

Butler and Johnson, 1957; Johnson and Butler, 1957). Similarly, seasonal variations in available food plants of the sagebrush community which comprises the study area and forage selection by the rabbits could accomplish significant changes in the stable iodine content of their thyroid glands. Other factors reported to affect the pattern of iodine accumulation in various animals have been previously reviewed (Hanson, 1962). Among these, temperature is considered most important in governing concentration and amplitude of thyroidal iodine variation in livestock, and early studies indicated a linear relationship of thyroidal iodine to temperature in general pattern (Fenger, Andrew, and Vollertsen, 1931; Seidell and Fenger, 1913 and 1914). In our study there was little or no apparent correlation between solar radiation, temperature, or precipitation (Figure 2) and the stable iodine concentration in rabbit thyroids (Figure 1). Recent controlled studies of I^{131} uptake by sheep thyroids showed significant increases at lower temperatures, decreased thyroid secretion during day-lengths of 4 to 12 hours, increased secretion during day-lengths greater than 12 hours, and greater secretion in sheep maintained in continuous light compared to those in 12 to 16 hours of light (Hoersch, Reineke, and Henneman, 1961).

There was no conclusive difference between thyroidal iodine concentrations of males and females, although several investigators have noted a significant decrease in thyroid iodine in female animals during periods of heat, pregnancy, and lactation (Rerabek and Bubenik, 1956;

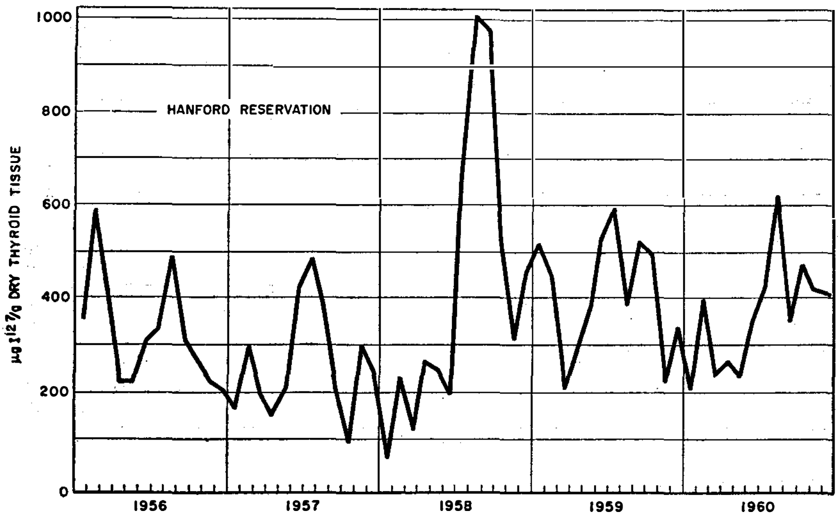

Figure 1. Stable iodine concentrations in adult jack rabbit thyroid glands from the Hanford Reservation during monthly periods of 1956-1960.

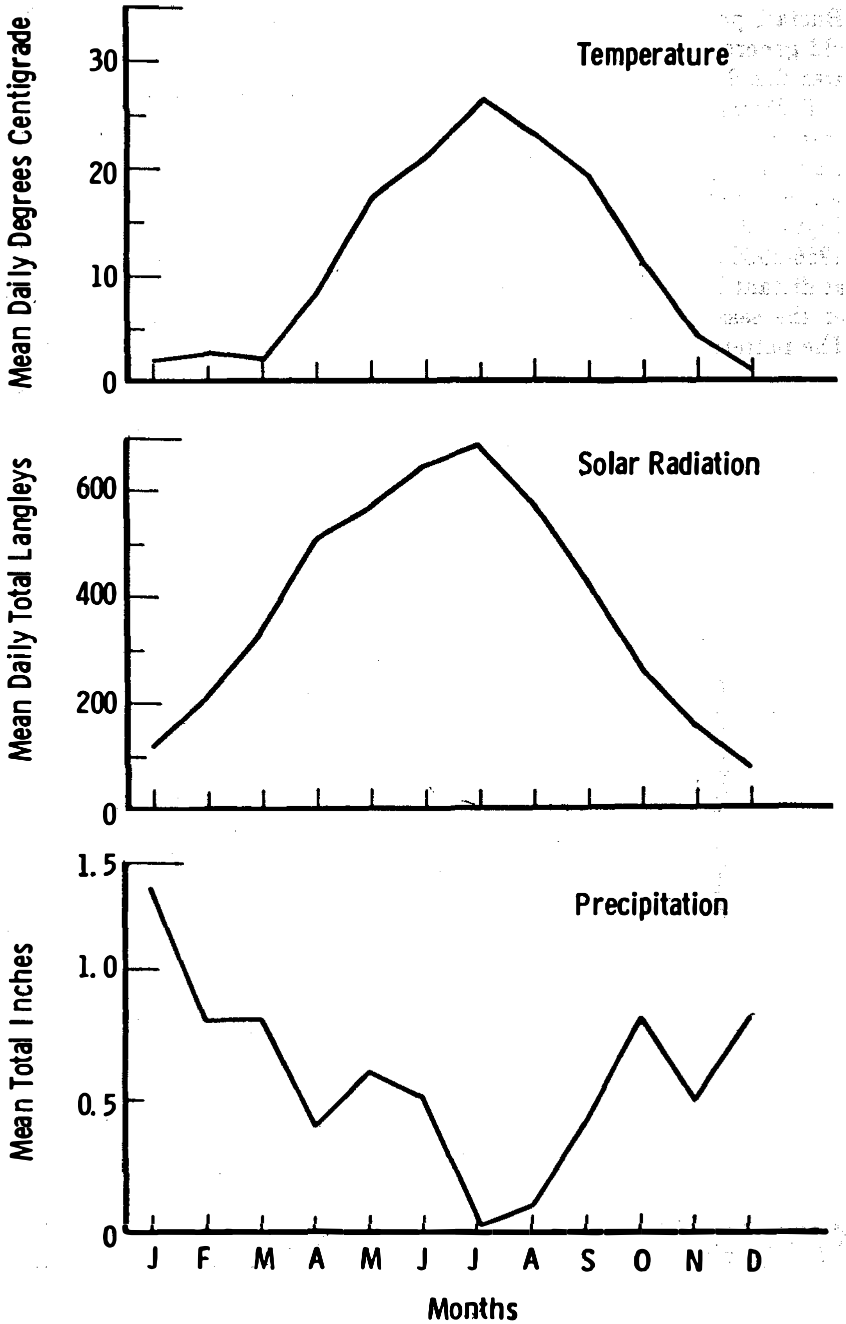

Figure 2. Average temperature, solar radiation, and precipitation occurring on the Hanford Reservation during monthly periods of 1956-1960.

Bustad, personal communication). Young animals one to four months old generally contained less than adult animals, but only occasionally was this difference statistically significant.

Differing from measurements of stable iodine, radioiodine concentrations in adult rabbit thyroids showed a definite seasonal pattern, particularly when expressed in ratio to the rate at which radioiodine was emitted to the atmosphere from Hanford operations, as shown in Figure 3. The pronounced variation in ratios that occurred during 1956-1958 are attributed to I^{131} from nuclear weapons tests conducted at distant locations. The 1959-1960 period is considered representative of the seasonal behavior of radioiodine in Hanford rabbit thyroids. The pattern during this period was grossly inverse to that of temper-

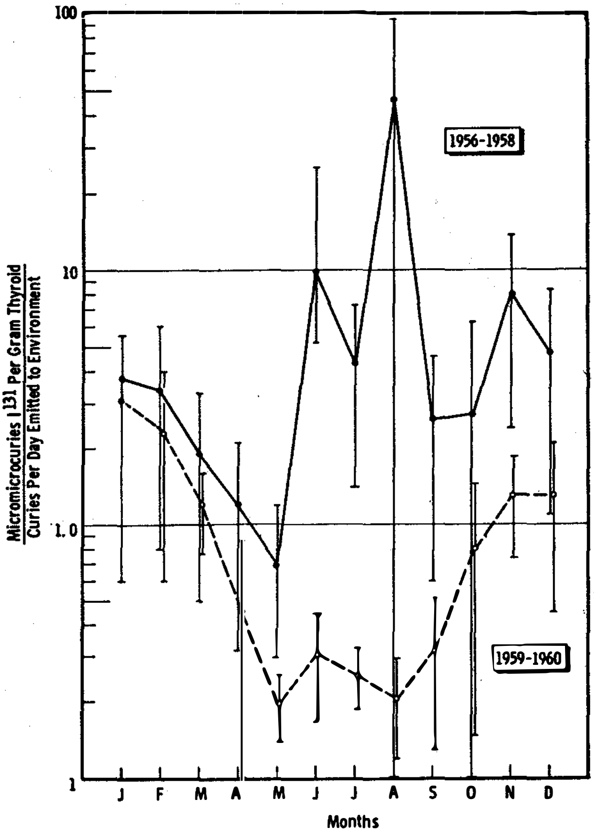

Figure 3. Seasonal patterns of variation in the ratio of radioiodine concentrations in rabbit thyroids to raidoiodine emission rate at Hanford during 1956-1960. Values shown are mean and one standard deviation based on a sample size of six to thirteen during 1956-1958 and four to seven during 1959-1960.

ature (see Figure 2), and the period of consistent decrease (January-May) occurred during the major period of pregnancy and lactation. Minimum rates consistently occurred during May and were followed by a minor "pulse" of slightly greater values during the next few months.

Bustad *et al.* (1957) reported sheep fed five μc I^{131} or less per day under controlled conditions showed a seasonal variation in thyroidal uptake which was nearly identical to that of the native jack rabbits observed in this study. They cited pregnancy and lactation as important factors in seasonal variation and concluded that a lesser degree of variation in young and nonpregnant ewes indicated temperature and photoperiodicity may have been contributory.

Comparison of annual radioiodine concentration patterns in rabbit thyroidal I^{131}/radioiodine emission rate indicated a slight but steady decrease from 1956 through 1960. Expressing the values as ratios of I^{131} emission rate provides the assumption that there was no change throughout the study period in availability of I^{131} emitted from Hanford facilities. If this is accepted, the decrease is difficult to explain. Bustad *et al.* (1957) reported a steady decline in thyroidal I^{131} in sheep fed 0.15 μc per day was due principally to normal physiological changes in the thyroid with age, and possibly an increase in stable iodine content of the animals' ration. The wild population of rabbits studied was in natural balance; however, a shift in the age structure of the population toward an increased percentage of older animals during the study may have weighted the data in the direction of decreased ratios due to physiological aging. Since there were no apparent changes of iodine concentration in thyroid glands, the difference could not be related to a change in the iodine content of food. Bustad and co-workers noted a diminished avidity of sheep thyroids for I^{131} as a sensitive indicator of thyroid damage in controlled studies of sheep fed a minimum of five μc I^{131} per day and in which the maximum I^{131} content of the thyroid was three to five times the daily amount fed. Although we did not examine rabbit thyroids histologically, radiation damage was unlikely because estimated thyroid exposure to rabbits ranged from 5 to 100 rads per year, and total exposure for the five years of observations averaged 175 rads. This value is sixty times less than the dose rates that Bustad and coworkers observed diminished avidity of I^{131} in sheep thyroids and much lower than doses at which they observed no damage.

Ratios of total amounts of radioactive to stable iodine in thyroid glands were highly variable during 1956-1958 but assumed a seasonal pattern and decreased by an order of magnitude during the 1959-1960 moratorium on nuclear weapons tests, as shown in Figure 4. This indi-

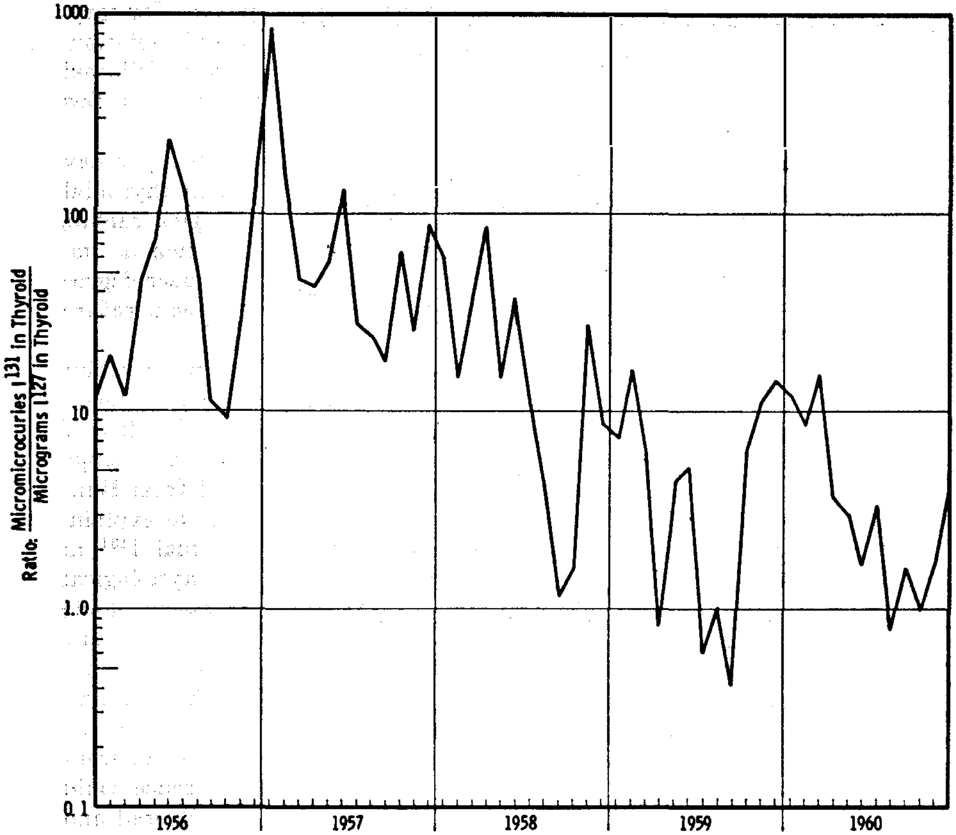

Figure 4. Ratio of radioactive iodine to stable iodine in thyroid glands of jack rabbits from the Hanford Reservation during monthly periods of 1956-1960.

cated a significant contribution of fallout radioiodine to I^{131} thyroid burdens occurred during the nuclear testing period, especially during summer months. Maximum values occurred during winter months and minimums during summer months. Young rabbits usually contained greater concentrations of radioiodine and lesser concentrations of stable iodine than adult animals; however, ratios of total radioactive/stable iodine in young animals' thyroid glands followed the same trend as in adults and were not significantly different.

Uptake of I^{131} by rabbit thyroids was not depressed during periods of maximum I^{127} concentrations, indicating a need by the thyroids for iodine at all times. Bustad, Warner, and Kornberg (1958) depressed uptake of oral doses of I^{131} administered to sheep by 30 to 50 per cent by feeding excess stable iodine to animals that had been on a diet which simulated daily intake by animals on range conditions of marginally goitrogenic areas. This low iodine intake resulted in definite enlargement of thyroid glands of offspring. No evidence of goiter appeared in rabbits collected in this study.

SUMMARY

Seasonal patterns of stable and radioactive iodine in thyroid glands of black-tailed jack rabbits, *Lepus californicus wallawalla* Merriam, from the Hanford Reservation in southeastern Washington were compared during 1956-1960.

Amounts of stable iodine in thyroids varied more irregularly than did those of the radioactive isotope and were generally independent of environmental temperature, solar radiation, or precipitation. Maximum concentration of thyroidal I^{131} occurred during colder months; minimum concentrations occurred during early spring and late summer. Fallout radioiodine increased by ten times the I^{131} burden in thyroid glands.

An apparent downward trend in the affinity of thyroid glands for I^{131} was noted but not considered related to radiation damage because radiation dose rates and total dose to rabbit thyroid glands were several times less than those reported to produce thyroid damage in sheep.

ACKNOWLEDGMENTS

I wish to thank members of the Biological Analyses Operation, Hanford Biology Laboratory, for performing iodine measurements during this study.

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DISCUSSION

CHAIRMAN SCHULTZ: Wayne, I believe that the group would be interested in a statement on the other wildlife species that you and others have looked at in the past year.

MR. HANSON: In cooperation with the Colorado Cooperative Wildlife Research Unit at Colorado State University, we have been conducting a study of the amount of radioactive iodine in the thyroids of mule deer from Colorado. Primarily we were interested in observing the uptake of radioactive iodine deriving from the nuclear weapons test conducted by the Russians beginning on September 1. In this, we find again that the thyroid glands of the Colorado mule deer, and from comparable studies from the Hanford reservation in Washington, from caribou thyroids from Alaska, and from white-tailed deer thyroids from Maryland all show this increase by the power of ten-fold as a result of the Russian tests.

The peak radioactive iodine uptake occurred in late October and early November, which is about two months after the Soviets started testing, and within the last week it has just dropped below background. We are now finishing this study and will release the information very shortly.

CHAIRMAN SCHULTZ: I should comment that this matter of radionuclide concentration in wildlife species has been looked at by others. Dr. William Longhurst and I have recently reported on strontium-90 accumulation in Columbian black-tailed deer during the period of 1952-1960. It was shown quite clearly that strontium-90 concentration in the jawbones of these deer ran from approximately two units in 1952 to a maximum of seventy units in 1959.

WILDLIFE POPULATION FUNDAMENTALS

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Washington State Department of Game, Olympia

Wildlife management is a new science which has made tremendous advances in a relatively short period of time. Yet there are still some conflicting views and poorly explained principles, which make it very difficult to interpret basic management to the general public. This paper will present some revised theories and new approaches intended to make management more easily understood.

NEW LOSS CONCEPT

Heavy annual losses of wildlife have always caused much concern, and there is feeling that they should be reduced. Farner (1945), studying robins, showed that slightly more than half of them die every year, and an average bird lives about a year and a half. Robins, however, are fully capable of living six to eight, and possibly as long as ten, years. A number of recent studies analyzing band returns from waterfowl (Bellrose and Chase, 1950; Hickey, 1952, and Lauckhart, 1956) have shown that about half of all ducks die each year. Usually, from 50 to 60 per cent of the population is lost yearly, and the average wild duck lives only a little more than a year. Still, ducks have a potential longevity of at least ten to twelve years.

Yearly Chinese pheasant loss rates of 70 per cent, or more, were found by Leopold *et al.* (1943) and Buss (1946). This indicates an average life expectancy of slightly less than a year for a pheasant. On the game farm, this same bird will live for about ten years. Statistics on deer herds indicate a yearly loss of about a third of the animals, and an average life of between four and five years. A tame deer recently died near Bremerton, Washington, at the age of eighteen years.

It is actually frightening, when one considers that animals with a potential life span of ten years or more, are only averaging about one year of life. The conclusion usually reached is that reproduction is just keeping pace with the tremendous losses.

Now, I ask that you back off a great distance in time and space and try to view the whole picture of animal populations. Robins have been here for several thousand years; they have been reproducing and dying every year, yet there are about the same number every year. Obviously, the number that die each year MUST equal the number born. High reproduction causes heavy losses and short life.

The ***OLD IDEA, reproduction attempts to replace losses,*** must be abandoned.

It must be replaced with the *NEW CONCEPT, reproduction causes losses.*

Losses are not accidents; they are necessary. If each pair of robins raises two young, half of the population must die before the next nesting season. If they did not suffer such losses, ther numbers would soon cover the earth. It is futile to try to reduce losses; it is like trying to halt the flow of a river. Losses can be stemmed only by reducing reproduction.

Losses might be compared to the wasting of a river into the sea. For example, I might stand at the mouth of the Columbia River and express great concern that the river will run itself dry. The springs and headwater tributaries cannot possibly keep pace with the tremendous loss into the ocean. I might suggest that we stop Portland from pumping water out of the river, to forestall any such catastrophe. Obviously, such fears are absurd, because the springs are not attempting to replace the water lost to the ocean, but they are the cause for the wasting into the sea. In the same manner, it is the springs of reproduction that cause the heavy annual loss of animals.

Dunmire (1960), studying mice (*Peromyscus maniculatus*) on White Mountain in California, found three times as many young were produced per female at 4,500 feet as were produced at 12,400 feet. Yet he found that the high elevation populations survived because the individual animals lived longer. This bears out the point that less reproduction results in less loss and longer life for animals.

This *reproduction causes loss* concept makes it much easier to explain how hunting can take only animals already doomed to die.

NO DANGLING POPULATIONS

This leads to the next logical conclusion, that there are "no dangling populations." In other words, all populations, with very few exceptions, press carrying capacity every year. High reproduction and the battle for life strain the capacity limits.

Carrying capacity is defined as the maximum number of individual animals that can live through the period of greatest stress each year; therefore, a capacity population is the number reaching the next breeding season. The yearly low points in population graphs are all important, as they represent the levels to which the population is depressed by habitat limitations. The variable high peaks of summer and fall populations are confusing, but they have little significance, because they are largely surpluses that will be lost before another breeding season.

The conclusion that all populations press carrying capacity is based on the following evidence:

1. The long view discussed previously indicates that populations have leveled off, with heavy losses taking all of the increase. This stability would not exist with only random (density independent) losses.
2. If game species are not at carrying capacity, hunted populations should be greatly reduced as compared to unhunted populations. This is not generally true.
3. Mathematically, it can be shown that a population that does not reach carrying capacity is doomed. Random fluctuations will eventually take it to zero (Ricker, 1954).

Capacity is determined by habitat quantity and quality. It is relatively stable, since habitat changes usually are gradual. There are exceptions, such as drought or other climatic catastrophes, which may cause sudden or great capacity changes.

Farner (1955) suggests that an animal population may be compared to a variable volume reservoir with a variable inflow and a variable outflow. I would propose that a population is a set volume (carrying capacity) reservoir, with an outflow geared to, and equal to, the inflow.

WHAT LIMITS CAPACITY?

A very important problem, or consideration, is: what limits carrying capacity? This question causes more controversy and disagreement among biologists than any other aspect of the entire complex of population dynamics. It is most confusing, because some species halt their increase, or decline in numbers, when seemingly there is an ample supply of food, cover and all other life necessities, still available.

Social stress, or a control mechanism, associated with overpopulation alone, is suggested by Christian (1950) as a possible adaptation to limit numbers and protect the food supply from depletion. Chitty (1960) carries on this hypothesis by proposing that "all species are capable of limiting their own population densities without either destroying the food resource to which they are adapted, or depending upon enemies or climatic accidents to prevent them from doing so." He does not imply that all populations are so regulated.

It is my belief that evolution could not create such a control mechanism. A new trait originates through genetic variation, or mutation, in one or a few individuals. If the trait has survival value, it will make the individual and its offspring more successful in the battle for survival. However, a population control mechanism would require that some individuals must inherit a decimating trait, or lethal gene, which would cause them to die at a certain population density. Such heredity would be impossible, because the carriers would be continually eliminated from the population. There would be little or no reproduction by this group.

Increased adrenal activity has been found in most animals living under crowded or otherwise stressing conditions, and Christian (1950) has suggested that this stimulation of the pituitary-adrenal axis may be involved in a mechanism of population self-control. It has long been recognized that increased adrenalin production is a survival factor, or stimulant, to carry animals over a difficult period, and it seems logical to assume that those actively battling for survival would exhibit this condition.

Research has also shown that rapidly increasing populations seem to deteriorate in quality (Chitty, 1960). This sets the stage for a die-off and is another aspect of this stress theory of population self-control. It is also possible to explain such a phenomenon through the normal working of natural selection. In any group of animals that are born, there will be some physically and mentally inferior, as there are in human populations. Normally, all these are weeded out by the tremendous losses that usually occur, but with an expanding population, many of these inferior specimens may survive.

For example, we might consider two units of 10 mice each at the start of the breeding season. Group A is a stable population and Group B is a rapidly expanding population. Group A may produce 100 young in the season, but 90 of them are eliminated in the battle for survival before the next breeding season. The 10 survivors are the very best of the 100 produced. Group B, the expanding population, may also produce 100 young, but 90 of these will survive because of the very favorable living conditions. This means that only 10 of the poorest were elminated, and many inferior specimens will still survive to produce more inferior offspring. This reduced selection from erupting populations could cause a gradual deteriation in their quality.

It is my contention (Lauckhart, 1957) that food is the most important capacity-limiting factor controlling bird and mammal populations, and I will attempt to show that plants have evolved their own adaptations to protect them from overutilization by herbivores.

FOOD QUALITY

Animals and plants have evolved together on this earth for millions of years. Animals have continually utilized the most nutritious plants for their food, and thus they have directed plant evolution. The most successful plants have always been those of low nutritional value that were able to retreat below the animals' threshold of malnutrition in order to escape total destruction by animals. This has produced present-day plants, with exposed parts, of low or marginal food value.

Recent experience in the bird habitat planting program in the State of Washington demonstrates this effect of animals on plants. A shrub of the legume family, colutea (*Colutea arborescens*), was selected as a promising candidate for pheasant habitat plantings in semi-arid areas. The first plantings indicated that it was a preferred rodent food, but control measures protected the colutea plants until they were fine healthy bushes. However, when they were left to fend for themselves, the rabbits, mice and pocket gophers moved in and completely girdled all of the lower stems and most of the roots. Today, there are no living colutea remaining from several thousand planted. This is an example where evolution has produced a race that stores too much nutritive material in its bark. This variety of colutea can never survive as a wild plant in this region. Plant geneticists, working to produce the "super" pine and fir tree, must guard against developing one with too much nutriment in its stem or bark.

Lowered food quality is seldom reflected in actual starvation of animals, but it usually depresses reproduction and increases losses from all other causes. Poorly fed adults produce less off-spring, and the few young that do survive are generally weaker and of poorer quality. Parasites, diseases and predators all prey upon animals with lowered resistance due to poor nutrition.

FOOD SELECTION

Recent studies in California have provided a better understanding regarding the selection of plant foods by animals. Experiments by Bath *et al.* (1956) with esophageal fistulas on sheep showed that the animals selected Sudan grass of 15 per cent protein, where clipping showed only 8 per cent protein. Bissell (1959) found that the first deer on the winter range in the fall selected 17 per cent protein material from plants that analyzed only 7 per cent protein from clipping samples taken to simulate deer use.

These studies indicate that grazing and browsing animals can select high protein parts from plants that are generally low in nutritional value. This helps to explain the perplexing pattern of use on some forage plants. An example of such a plant is salal (*Gaultheria shallon*), which grows in profusion in the forests of western Washington. Food habits studies show that some deer live on salal (Brown, 1960), but there are examples where deer died of malnutrition while surrounded by salal. It is now apparent that possibly two per cent of the salal is nutritionally adequate for deer food. Only the animals can detect which twigs or leaves have the required food value or if there is any nutritious forage remaining.

The food value of a plant's twigs, leaves and buds depends on the general health and age of the plant, its exposure to sunlight and the fertility of the soil in which it grows. Young plants grown in direct sunlight on fertile soil are the most nutritious. The addition of fertilizer can make a nonfood into a useable food plant. Experimental fertilization of evergreen huckleberry (*Vaccinium ovatum*) in western Washington (Turner, 1961), resulted in a 37 per cent increase in the crude protein analysis of the twigs and leaves. The present method of testing for utilization of nitrogen fertilizer is to measure the increase of crude protein in the plant.

Many plants on fertile soil sustain wildlife, while the same plants on poor soil are submarginal foods. The listing of food plants by species, is very misleading. If salal is shown as a deer food, it is assumed that there is no food problem as long as some salal remains. These findings also throw doubt on the validity of any type of ocular appraisal of game food conditions. Nutritional quality is something that cannot be seen.

IMPORTANCE OF HABITAT

The importance of food has been emphasized to this point, but this does not mean that other habitat requirements are unimportant. With many species, food without cover is as useless as cover without food, and a lack of water can cancel the value of both.

The maintenance of proper habitat is the key to all wildlife abundance. It is now apparent that most population changes are the result of habitat changes, although the changes are sometimes difficult to detect.

A number of recent studies have contributed to the knowledge concerning the habitat requirements of several species. Hammerstrom *et al.* (1957) and Ammann (1957) clearly depict the close relationship of prairie grouse to grassland maintenance in the lake states. Koford (1958) showed how prairie dogs are related to short grass range and benefit from overgrazing by livestock. Howard (1958) found a similar condition in New Zealand, where the European rabbit scourge seems to be related to overgrazing by sheep. Keith *et al.* (1959) showed that pocket gophers can be controlled in Colorado mountain meadows by herbicide spraying to kill the weeds upon which the gophers feed.

Allen (1960), who studied the wintering of the whooping cranes on the Aransas National Wildlife Refuge in Texas, reported conditions that indicate these birds have already reached the carrying capacity of their winter range. With all of the good habitat occupied by territorial families, a number of adults are forced to winter in very marginal areas. The birds that experiences these poor wintering conditions will probably never contribute much to the preservation of this species.

In order to illustrate more clearly the true importance of maintaining habitat for wildlife, I submit the following example, from personal experience:

There is a small blackberry bramble in the back yard of my Seattle home. It consists of just enough weeds, vines and brush for one song sparrow territory, a habitat niche for one pair of birds. I assume two possible courses of action: (1) I can kill the two sparrows. If I do, I will be branded as a merciless destroyer of wildlife. Also, I will be a law violator; or (2) I can take a brush hook and go out and clear my back yard. In the public view, I am a good, clean citizen who would not hurt anything. I may ask, "What about the sparrows?" Oh, they were not hurt; they can go somewhere else. But we must remember that all of the available territories are already occupied; there are no vacant sparrow homes. In destroying the habitat, I have actually killed the birds. The net result is that the world's population of song sparrows has been permanently reduced. On the other hand, if I killed the two sparrows, it would have had no such permanent effect. With the surplus of birds that is available every year, two other sparrows that had no home, no adequate territory, would soon move in to take the place of those killed. In other words, the killing of two would save the lives of two others. There would be no permanent effect on the surviving population.

To destroy habitat is to kill all of the wildlife using that habitat. Probably the bulldozer kills more birds and animals than the gun. We must orient our thinking to emphasize the real importance of preserving habitat.

SUMMARY

A new approach to animal losses proposes that the old idea that reproduction replaces losses must be abandoned and replaced by the new concept that reproduction causes losses. In any population, the number that die each year must equal the number born. High reproduction causes heavy losses and short life.

This leads to the conclusion that there are no "dangling" populations that do not reach carrying capacity. All populations, with very few exceptions, press carrying capacity every year.

What limits capacity is a most perplexing problem. Social stress as a natural animal control does not seem possible, because there is no way that evolution could have created such a control mechanism. The author proposes that food is the most important capacity-limiting factor.

Plants are low in food value, because animals have continually killed out the most nutritious varieties. Exposed plants apparently escape the herbivores by retreating below the animals' threshold of malnutrition.

Recent studies show that grazing and browsing animals can select more nutritious parts from plants that are generally very low in food value. They have also shown that increased soil fertility can markedly increase the nutritional value of all, or part of a plant.

The maintenance of proper habitat is the key to all wildlife abundance. The destruction of habitat actually kills the wildlife using that habitat. The true importance of habitat must be more clearly understood.

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DISCUSSION

DR. TONY PETERLE [Ohio]: By moving me to the moon, you absolutely confuse my view of wildlife management. I am a bit foggy at this point. You mentioned the work by Chitty and some of the others concerning population stress and densities and effect upon reproduction. I am under the assumption that the population stress is controlled by an endocrine and not by lethal genetic factors. Am I wrong?

MR. LAUCKHART: I don't know that I understand your question, but I could answer what I think you mean: that is, it is your contention that population stress is in the endocrine system and not in the genetic makeup of the animal. I want to bring out the point that the animal started as a single cell millions of years ago and its evolution has progressed from that point to this and every change has persisted because it had survival value. Every change has been a survival change. The endocrine system is totally a creation of evolution and that evolution has produced survival factors. Everything within the endocrine system must have a survival value for the individual or it will be eliminated by evolution.

I have used an example of a coyote that chased a rabbit. The rabbit finally got tired and the coyote caught up with it and ate it. Did the rabbit die of getting tired or was its loss due to predation? It is just a point of view. Is getting tired an adaptation to control the population? If sufficient rabbits get tired, the coyotes will catch enough of them so that the population will not get too high. I think that it is the successful rabbit that doesn't get tired that lives to reproduce. I can't see how evolution could produce rabbits that automatically get tired to control their own numbers. Endocrine fatigue and physical fatigue are probably quite comparable.

DR. E. L. CHEATUM [New York]: I have a great deal of respect and affection for Burt Lauckhart and he knows it. I also would like to compliment him on the many thoughts and ideas that he has expressed which I think would have a great deal of usefulness in getting this one across before a garden club, bird clubs, and many sportsmen's groups, as long as he didn't get too much involved in evolution and in this stress theory as a disease of adaptation, and that is what disturbs me more than anything else here, Burt.

I feel that there is a misconception in Christian's hypothesis in applying Seely's theory of the disease of adaptation and its impact on populations. I would like to put this theory this way: The disease of adaptation is a consequence of stress, not a population control mechanism in a purposeful sense. Thank you.

MR. CLARENCE NEWTON [Nebraska]: I would like to ask if Mr. Lauckhart has an interesting definition of the term "habitat" to use for purposes.

MR. LAUCKHART: No, I don't. I haven't any better definition than any of the others. I think that habitat includes all the requirements that any animal needs to live. Food and water are basic components of habitats. Some species need something special.

DR. FRED H. WAGNER [Logan, Utah]: I would like to say, Mr. Lauckhart, it is my feeling that, as game people and probably more generally as population ecologists, we probably haven't made enough distinction between the means of effecting population balance and the means by which populations are balanced at any given density: that is, the factors that determine the average density at which populations are balanced. I think Verslangesfeld makes this distinction. I think Nicholson and Orfeld do make this distinction but use the same terminology for two different things. I agree with you that there are no dangling populations in the sense that there are no unbalanced populations, but there are many cases where the mean density is determined by density independent factors.

MR. LAUCKHART: Density independent factors are involved, but I think there should be some density dependent ones also.

DR. WAGNER: Right. I think population balance is party a function of density independent factors, but I think the mean density by which the balance occurs is affected by these factors.

MR. LAUCKHART: I see so many complexities to environment that I like to measure carrying capacity as you would measure the contents of a bucket. It is difficult to measure water inside the bucket, but it is easy to pour the water out and see how much it contained. The animals measure capacity for us. If we count the animals, we know what the carrying capacity is.

MR. DAVID R. KLEIN [Alaska]: You mentioned that production causes losses or mortality. I think that we all agree that birth precedes death, but I think this is an oversimplification of the cause and effect relationship to assume that production actually causes death. I don't think it is a valid assumption. This philosophy perhaps would be desirable to instill in the minds of the sportsmen, but I am not sure that we will be successful in selling it to them.

MR. LAUCKHART: I don't know. I still think that we need some over simplifications. Our biggest problem involves selling our program to the public. If the public doesn't understand it, it won't do us much good.

MR. BILL JONES [Denver, Colorado]: Burt, you mentioned that one way to work this thing around was to reduce losses by reducing production. I'd like for you to explain how this theory would work with the B-B gun shooting of the sparrows.

MR. LAUCKHART: If I could make each sparrow raise one young instead of two they wouldn't die so fast. But I don't think controlling reproduction is a solution to anything. I think utilizing losses is our solution. If we had a sparrow that laid one egg we probably would have as many sparrows and they'd all live longer.

CHAIRMAN SCHULTZ: Burt, I happen to live on a 200-acre farm which, incidentally, I don't own. This farm had a nice covey of quail but, about two years ago, in the State of Maryland, two feet of snow fell on the ground. This covey totally disappeared due to the weather. This covey lost the county road map and we haven't seen it in two years. We haven't even heard a bird singing in the springtime. I'm sure they will find that niche sometime. It may take them a while.

REGIONAL VARIATIONS IN PRODUCTIVITY AND REPRODUCTIVE PHYSIOLOGY OF THE COTTONTAIL RABBIT IN OHIO

VERNON C. STEVENS

Ohio Cooperative Wildlife Research Unit,[1] The Ohio State University, Columbus

Various inventory studies and hunter kill estimates have revealed that cottontail rabbits are not equally distributed throughout Ohio. Major population differences appear to be correlated with the four main physiographic regions of the State. Since the causal relationships of such density variations were unknown, a study of rabbit natality rates appeared to be the logical first step towards elucidating these associations. An investigation was initiated to ascertain whether the reproductive rates of cottontails varied in the regions with suspected population differences. In addition, measurements were made of various physiological functions relative to the reproductive process. The gonadotrophic hormone content of the cottontail pituitaries, the functional activity of the thyroid gland, and the variations in adrenal gland function are some of these measurements. The physiological data permitted the localization of differences in reproductive performance.

The present report includes only a portion of the results of the study and the data analysis given is only preliminary; however, the salient findings are included.

STUDY AREAS AND COLLECTION METHODS

The major physiographic regions in Ohio were designated as follows during the study (Figure 1).

Region 1—Glaciated Limestone Region

Region 2—Lake Plain Region

Region 3—Glaciated Sandstone and Shale Region

Region 4—Unglaciated Sandstone and Shale Region

Regions 1 and 2 are located in western Ohio. Although both of these regions have a similar limestone substratum, the soils and topography of Region 2 have been modified by the lacustrine deposits left from extensive flooding of this area during the post-glaciation period. Both areas have very fertile soils and are agriculturally highly productive.

The sandstone and shale region of Ohio is segregated into two distinct portions, the glaciated and the unglaciated. Both Regions 3 and 4 have similar residual soils, but the topography is quite different.

[1]Ohio Division of Wildlife, U. S. Fish and Wildlife Service, The Ohio State University, and the Wildlife Management Institute cooperating.

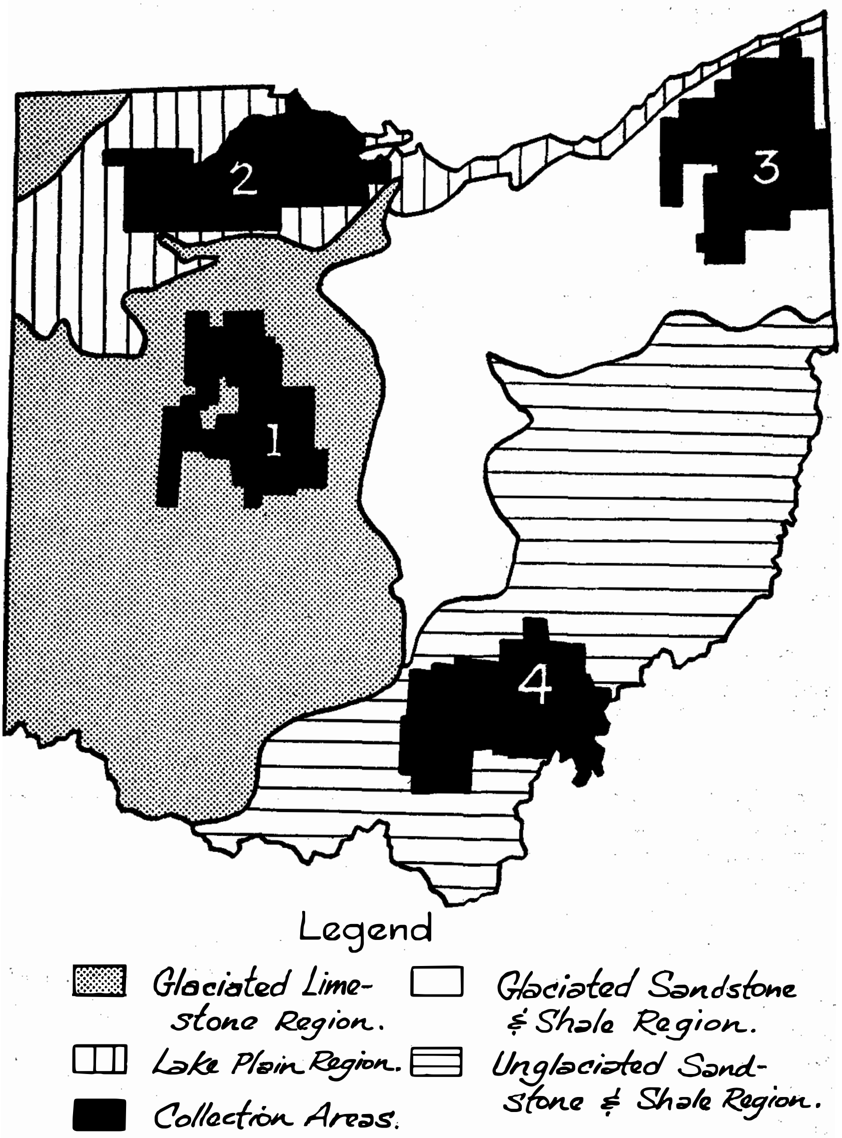

FIGURE 1. THE PHYSIOGRAPHIC REGIONS and COLLECTION AREAS

Soils in Region 3 are more suitable for agriculture than the unglaciated sandstone and shale region because the rather steep topography of the latter allows rapid runoff of rainfall. These soils are also generally very shallow and are low in organic matter. Land utilization in Regions 3 and 4 consists chiefly of timbering, dairy farming, and hay production. Fig. 1 illustrates the physiographic regions and the collection areas.

A study area was established in each of these regions. Each area contained a contiguous tract of several hundred square miles of generally homogenous habitat. A sampling system was devised to facilitate the random and representative collection of cottontails. The townships in each area were numbered and those in which collections were to be made were selected randomly. A collection quota of seven females and five males was set for each area every half-month throughout the year. Although quotas were not always met, a total of approximately 1,600 rabbits collected during the twenty-month study.

Specimens were obtained by both trapping and shooting. Following each collection, the specimens were dissected in the field. Collected materials were either frozen or appropriately preserved.

REGIONAL REPRODUCTIVE RATES

The reproductive rates of cottontails with some embryos surviving were ascertained by determining (1) the number of ovarian corpora lutea (ovulation rate), (2) the number of implantation sites in pregnant uteri, and (3) the number of living embryos found in the reproductive tracts. The incidence of loss of whole litters was also determined for both the pre-implantation and post-implantation period. Females suffering total loss of ova before implantation were detected by noting those which had old retrogressing corpora lutea in their ovaries but had no embryos implanted in their uterus. The loss of entire litters after implantation was estimated by calculating the difference in the frequency of females collected in early pregnancy from the frequency of those collected in late pregnancy. Data included in this report pertain to pregnant females collected during both the 1960 and 1961 breeding seasons.

Ovulation Rates

Ovulation rates were estimated by corpora lutea counts of serially sectioned ovaries. Table 1 indicates the mean number of corpora lutea per female in each region. It is immediately apparent that cottontails in Region 4 ovulated at lower rate than did those of the three other regions. Although there appeared to be rather large differences in the mean values for Regions 1, 2, and 3, statistical methods indicated that these differences were not significant at the 5 per cent level of confidence. Further testing revealed that the difference between Region 4 and the other regions was significant at the 1 per cent level of confidence. The difference in the average number of ova ovulated per rabbit in Region 1 (6.25 $\pm$ .54) and the number ovulated per rabbit in Region 4 (5.17 $\pm$ .34) points out the magnitude of the regional variation.

The Number of Implantation Sites

The number of embryos implanted in pregnant tracts was determined in order to estimate the loss of ova between the time of ovulation and implantation. A comparison of the number of implantation sites with the number of corpora lutea indicates the proportion of ova lost during the pre-implantation period. The mean number of implantation sites per female per region is given in Table 1. Variation in the number of sites was correlated positively with the ovulation rates. Region 4 was again significantly lower than the other regions.

Subtracting the average number of implantation sites from the average number of corpora lutea indicates the average loss of ova before implantation. These values were .50, .29, .30 and .26 for Regions 1-4 respectively. Although Region 1 suffered a higher pre-implantation loss than did the other regions, the mean number of implantation sites was only exceeded by that of Region 2. Losses at this stage of reproduction were expected to be higher in those animals with the highest ovulation rate.

The Number of Living Embryos

The number of living embryos in pregnant tracts was compared in the same manner as the number of corpora lutea and implantation sites. The values per rabbit per region are also given in Table 1. Significant differences in the number of embryos followed the same pattern. Region 4 cottontails again showed lower values than rabbits from the other regions. Approximately one embryo per litter less was found in tracts from Region 4 than in the tracts from the highest region (Region 1).

The average loss of embryos per litter after implantation or post-implantation loss was .41, .62, .60 and .52 respectively for Regions 1-4. It should be noted that although females from Region 1 suffered the highest pre-implantation loss, they suffered the lowest post-implantation loss.

The total loss of ova from the time of ovulation to parturition can be estimated by comparing the number of living embryos with the number of corpora lutea in the ovaries of the pregnant females. This value approximates the total prenatal mortality suffered after ovulation in surviving litters. Average values for prenatal mortality for Regions 1-4 are .91, .91, .90 and .78 respectively. It is important to note that although Region 4 suffered a lower total prenatal mortality than any of the other regions, the number of living embryos per litter was much lower. Lower ovulation rates are obviously the reason for the reduced rates of reproduction in Region 4 females.

The Loss of Whole Litters

The ovaries of females, that had ovulated but in which no embryos were found in their tracts, were carefully examined. An estimate of the days elapsed since the animal ovulated was made by observing the histological appearance of the corpora lutea. Since implantation sites of embryos are not present until seven days following ovulation, females which had ovulated seven days or more prior to collection, but had no embryos implanted, were considered pseudopregnant. Pseudopregnant animals had lost all ova ovulated before implantation due to either infertility, death of early embryos before implantation, or blockage of the oviducts. The frequency of pseudopregnancies was very low during the study. A total of only 13 of 596 rabbits that had ovulated were considered pseudopregnant. This 2.21 per cent loss was distributed uniformly among the regions, and no regional differences in reproductive performance was attributed to loss of whole litters before implantation.

Assuming that the collection methods were not biased towards capturing animals at any given stage of pregnancy, the number of females at any given stage of gravidity were collected with equal frequency. However, the observed frequency of visible pregnancies was considerably lower for females collected in the late stages of pregnancy. This phenonmenon is explained by the realization that females that have aborted or totally resorbed all their young were not visibly pregnant and were not included in the sample of pregnancies when examined. Therefore, the discrepancy between the frequency of females collected in early pregnancy and those collected in late pregnancy represents the proportion of litters that lost their entire litters after implantation.

The frequency of females collected in a 9 day period in early pregnancy (7-15 days) was compared with an equal period in late pregnancy (22-30 days). A difference in frequency of approximately 25 per cent was found between the two groups. This percentage provides a rough estimate of the proportion of females losing whole litters after implantation. Estimates of this loss per region are given in Table 1 and were not considered to be significantly different among the regions.

The comparisons of reproductive rates of the four regions indicate

TABLE 1. REPRODUCTIVE DATA FROM OHIO COTTONTAILS BY REGION 1960-61

	Region 1	Region 2	Region 3	Region 4
	Mean values per litter in females with some living embryos			
No. of corpora lutea	6.25 ± .54	6.16 ± .57	5.96 ± .38	5.17 ± .34
No. of implantation sites	5.75 ± .61	5.87 ± .59	5.66 ± .35	4.91 ± .40
No. of living embryos	5.34 ± .53	5.25 ± .42	5.06 ± .47	4.39 ± .28
No. of ova lost	.91	.91	.90	.78
	Percentage loss of whole litters			
Before implantation	2.3	2.0	2.3	2.5
After implantation	24.0	27.3	25.3	24.0
Total	26.3	29.3	27.6	26.5
Estimated total prenatal mortality	36.9	39.7	39.7	36.3

no significant difference in prenatal mortality from either partial or total loss of litters. A much lower rate of ovulation in cottontails collected in the unglaciated sandstone and shale region of southeastern Ohio results in a significant difference in net productivity.

The Frequency of Non-Breeding

The breeding season began and ended in all four regions nearly simultaneously. During the breeding seasons no evidence was found to suggest infertility as a cause of reduced reproduction. A total of 533 adult females was collected from April 1 to September 1 for both years. Only 16 rabbits or 2.9 per cent of these had not ovulated. There was no significant difference between regions in the frequency of such animals. In addition, there was no appreciable difference in the rate of breeding of subadult females, about 44 per cent in each region.

PITUITARY GONADOTROPHIN CONTENT

Heads were removed from all rabbits collected and immediately quick frozen with dry ice. The pituitaries were removed from these heads in a cold room at 5° C. and an alkaline aqueous extract was prepared. Relative amounts of the gonadotrophins were measured utilizing bioassay techniques. All pituitaries were assayed within at least three weeks following collections. The pituitary content of both Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) was determined, but only one of these determinations could be made on a particular individual rabbit.

FSH Content

The FSH content of the rabbit pituitaries was determined by injecting the pituitary extract into 21-22 day old Sprague-Dawley female rats twice daily for three days. Autopsy was performed on the fourth day (72 hours following the first injection). The criterion used as indicator of the amount of FSH in the samples was the weight of both ovaries of the test rat. This method is a modified version of the procedure described by Steelman and Pohley (1953). An additional index used as an indicator of stimulation was the increase in ovary weight of test rats over the control weights in each assay group.

The ovary weights and ovary increase values were tested for significance of difference between regions taking into consideration the season of the year, the sex and age of the rabbit, the year in which the rabbit was collected, and the pre- and post-treatment weight of the assay rats. The seasonal comparison were made by grouping the data into two month periods throughout the year.

The statistical tests indicated a significant difference among regions in the ovary weight of the test rats. Variations in pituitary FSH content correlated well with reproductive rate. The mean values of ovary weights for each region are given in Table 2. There were also significant differences in pituitary FSH content of male and female rabbits as indicated by the test criteria. Male rabbit pituitaries contained more FSH than did those from females. The age of the cottontails and the weight of the test rats were important factors to consider in the analysis since both of these were significantly related to the rat ovary weight. Pituitaries from cottontails less than one year old contained significantly less FSH than did those from older rabbits. Since the pituitary secretes very little gonadotrophin until several weeks of age, this indication of age variation was expected.

Seasonal variation in pituitary FSH content was significant. The mean values for each two month period are given in Table 3. Cottontail pituitaries collected during the breeding season (March-August) contained higher quantities of FSH than did those collected in the other months of the year.

The ovary increase measurements agreed very well with the ovary weight determinations and the same conclusions were drawn from each criterion.

TABLE 2. REGIONAL VARIATION IN PITUITARY, ADRENAL AND THYROID FUNCTION OF OHIO COTTONTAILS 1960-61

Function	Regional means					
	1	2	3	4	d.f.	F
Rat ovary weight in mg. (Pituitary FSH content)	91.9	90.3	89.9	80.4	3 & 499	3.84**
Rat ovary weight increase in mg. (Pituitary FSH content)	45.5	45.5	44.6	35.2	3 & 499	3.51**
Rat prostate weight in mg. (Pituitary LH content)	26.7	25.3	26.2	23.8	3 & 293	2.98*
Rat prostate weight increase in mg. (Pituitary LH content)	18.8	17.4	18.5	16.3	3 & 293	2.73*
Adrenal weight in mg.	236.9	209.6	203.4	223.1	3 & 791	2.35
Thyroid cell height in microns	6.6	6.9	6.8	6.2	3 & 658	6.95**

*Significant 5% level.
**Significant 1% level.

LH Assay

The pituitary content of luteinizing hormone was determined by injecting pituitary extracts into 24 day old Sprague Dawley hypophysectomized male rats twice daily for four days and noting the increase in the weight of the ventral prostate of the treated rats. Autopsy was performed on the sixth day (120 hours following the first injection). This method was described by Greep, et al. (1941). The ventral prostate weight increase over non-treated controls was also used as an indication of LH stimulation.

Statistical tests indicated that the criteria used as a measure of pituitary LH content varied significantly among the regions. The same pattern as reproductive rates and FSH content was shown in the data regarding pituitary LH content for the four regions. Table 2 contains the mean values for each region. As was seen with FSH, the Region 4 means were lower than those from the other regions, but the data for LH content were only significantly different among the regions at the 5 per cent level of confidence. FSH content data were significant at the 1 per cent level.

The effect of age and sex upon the LH content of the pituitaries was not significant at the 5 per cent level of confidence. Seasonal variations were, however, significant at this level. During the months of the breeding season, the LH levels were higher than in the other months of the year. Season means are given in Table 3.

ADRENAL FUNCTION

Weights of adrenal glands were taken on all collected rabbits. The weight of both glands was used as a general indicator of the activity of the adrenal cortex. At the time of collection adrenals were removed from the rabbit and placed in a sealed vial and frozen. In the laboratory, the glands were thawed, dissected free of surrounding tissues, and weighed to the nearest milligram.

The data regarding adrenal weights were analyzed according to age, sex, season and region as were the other physiological measurements. Results of the statistical tests indicated no significant difference among regions in adrenal weight. The mean values for each region are given in Table 2. There was no correlation between the average adrenal weights and reproductive performance. Significant differences were found, however, when testing season, sex, and age. Male cottontails had much heavier adrenals ($\bar{x} = 251.2$ mg.) than did the female rabbits ($\bar{x} = 192.2$ mg.). Adrenal gland weights increased as the age of the rabbit increased. Seasonal fluctuations in mean adrenal weights are given in Table 3.

TABLE 3. SEASONAL VARIATION IN PITUITARY, ADRENAL AND THYROID FUNCTION OF OHIO COTTONTAILS 1960-61

Function	Seasonal means							
	Jan.-Feb.	Mar.-Apr.	May-June	July-Aug.	Sept.-Oct.	Nov.-Dec.	d.f.	F
Rat ovary weight in mg. (Pituitary FSH content)	84.1	93.4	93.3	98.2	70.3	87.2	3 & 499	8.37**
Rat ovary weight increase in mg. (Pituitary FSH content)	35.9	46.9	45.8	54.5	27.1	43.0	3 & 499	6.01**
Rat prostate weight in mg. (Pituitary LH content)	27.7	32.5	25.5	21.2	20.1	—	3 & 293	2.57**
Rat prostate weight increase in mg. (Pituitary LH content)	16.7	23.8	18.7	14.0	13.4	—	3 & 293	2.76*
Adrenal weight in mg.	157.8	242.3	244.9	204.7	189.5	—	3 & 799	27.26**
Thyroid cell height in microns	6.07	6.14	6.64	6.97	7.41	—	3 & 658	11.67**

*Significant 5% level.
**Significant 1% level.

THYROID GLAND FUNCTION

The functional activity of cottontail thyroid glands was determined by sectioning the glands and measuring the height of thyroid follicle epithelial cells. A minimum of 30 cell heights was measured on each thyroid gland. The average value of these 30 measurements was used as an indicator of the rabbit's thyroid gland activity.

Statistical tests revealed a significant difference among regions in thyroid cell heights. The average values are given in Table 2. There was a direct correlation between thyroid cell height and reproductive performance. Although the difference in the mean values was not large, the thyroid activity of cottontails collected in Region 4 was significantly lower than in other regions.

A significant difference also existed between the seasons of the year. Thyroid gland activity became progressively higher from January to September. Data were available for only this segment of the year. Mean values for the various seasons are given in Table 3. The mean values suggest that thyroid activity correlates well with seasonal temperatures. No valid explanation for the seasonal variations in thyroid function, however, was attempted from the data.

No statistically significant differences were found in thyroid activity according to the age or sex of the cottontails.

DISCUSSION

Comparisons of the various reproductive functions indicate a distinct difference between the fecundity of cottontails in Region 4 and rabbits collected in the other sections of the State. Primarily responsible for reproductive differences is the variation in ovulation rates.

Assay of the pituitary gonadotrophins indicate that the regional differences in ovulation rates are the result of reduced pituitary production of these hormones. The pituitary hypo-function of Region 4 cottontails is obviously responsible for at least part of the discrepancy in reproductive rates among the regions.

Numerous studies have emphasized interactions that may occur among hormones from the pituitary, thyroid, adrenal cortex, and the ovary to modify the responses of target organs of the female reproductive system. Ovarian responses are not the result of independent action of the gonadotrophins only. Meites and Chandrashaker (1949) indicated that reduced thyroid function lowered the response of the gonads to gonadotrophins in some mammals. During the current study, differences in thyroid function among the regions could possibly have been great enough to affect differently the sensitivity of the gonads to the pituitary hormones. These may have been sufficient to influence the reproductive rates.

No major significance was placed upon the role of adrenal function in determining reproductive rates, at least as indicated by adrenal weights. Hormonal interactions are undoubtedly involved in the reduced reproduction of Region 4 cottontails, but the major cause of lowered productivity is believed to be a result of pituitary hypofunction.

SUMMARY

A study was initiated to ascertain whether cottontail rabbits in the four major physiographic regions of Ohio reproduced at different rates and to locate the stages of reproduction that were different. The number of ovarian corpora lutea, the number of implantation sites, and the number of living embryos found in pregnant females were significantly different. The unglaciated sandstone and shale region of southeastern Ohio had the lowest reproductive rate. The loss of whole litters did not vary appreciably among the regions. Total prenatal mortality was not the cause of regional differences in productivity. Variations in ovulation rate appeared to be responsible for productivity differences. Significant regional variation existed in pituitary gonadotrophin content. Thyroid gland activity varied significantly among the regions, but adrenal gland function did not exhibit such differences. Regional differences in pituitary gonadotrophin production was believed to be responsible for the differences in reproductive rates among the regions.

ACKNOWLEDGMENTS

This study was primarily financed by the Ohio Division of Wildlife, Federal Aid Project 103-R. Grateful appreciation is extended to William R. Edwards, Leader, Ohio Farm Game Investigations for technical advice, assistance with study design and analysis, and for handling project financial and personnel administration. To Dr. Tony J. Peterle, Leader, Ohio Cooperative Wildlife Research Unit, I wish to express appreciation for advice and encouragement throughout the study. Appreciation is extended to Jeanette Ernest and the personnel of the Olentangy Wildlife Experiment Station for their assistance in conducting all phases of the laboratory work. The efforts of many Ohio Division of Wildlife personnel who collected cottontails during the study are grateful acknowledged.

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DISCUSSION

DR. E. L. CHEATUM: I would like to first compliment Vern Stevens on this most excellent piece of research and the reporting. I would like to follow this with a question. It appears to me that it is very possible that Region 4 has a basic inferiority in the quality of nutrition that is available to the rabbit population. If this is so, the consequence on the population rate and the production of FSH might be directly correlated with the actual status of nutrition in the animal and have nothing to do with density dependent influences such as stress or anything of that nature. Do you plan to follow up with a critical evaluation of this possibility?

MR. STEVENS: Yes, Dr. Cheatum. I feel that the Ohio Division of Wildlife will try to pursue this thing further. My own opinion regarding the possible environmental factors affecting this, includes about three various factors. There is, of course, some possibility that there are actual genetic differences in the various parts of the state. Another possibility is the dependent relationships which may or may not be the case. One significant point on this fact is that there is more of a significant difference in the population composition of the southeastern Ohio cottontails than in the other age region variation. This supports to a certain extent the possibility of a population control by density or social stress.

But probably the most important factor, in my opinion, responsible for this, is the nutritional quality of the range at various times during the year. There has been a limited amount of nutritional work done. It has not been reported and compiled at this time, but we hope to find some further leads as to possibly what nutritional factors are missing. The particular site of inhibition we have located generally, and this will aid greatly in tryng to find the missing factors.

CHAIRMAN SCHULTZ: Before we have the next presentation, I would like to ask a question. I noticed that the study was done for both the 1960 and 1961 breeding season. I am interested to know if you had the same regional patterns for both years.

MR. STEVENS: Yes, we did. This was a very general analysis, but the same general pattern was true with very, very slight differences in the reproductive performance. Some of the physiological performances though were only made on one year.

CHAIRMAN SCHULTZ: Are there any further questions or comments?

MR. EARL T. ROSE [Iowa]: We have had a similar study conducted in Iowa for about five years, and we find that in our best rabbit range the litter size varies every year quite markedly. It seems from your study that it stays almost uniform throughout your region, and I am wondering why. Maybe you might find that same situation over a longer period of time.

MR. STEVENS: There have been other samplings of rabbits in Ohio and they indicate that there is some yearly variation, but the primary yearly variation that I and others have found is in the length of the breeding season. This, almost invariably, fluctuates from year to year and the total productivity over the state may vary according to this phenomenon. But we haven't found a great deal of variation on individual number of young per litter.

MR. KENNETH L. DIEM [University of Wyoming]: This is a very interesting paper, Mr. Stevens. In light of some other investigations being carried on in some of the small rodent population studies related to some work on estrogens in California and population cycle investigations being carried on in the Southeast and in Wyoming in conjunction with all of this, the findings that you are getting here would indicate that it would be very productive to pursue some of these points in this No. 4 area with regard to the production of estrogens in the plants. These hormones apparently have been thought by a number of people to be very closely related to this same finding that you are finding with the FSH and LH phenomena, and it would seem to me to be very productive.

I wonder if you could tell us at this time if this is in the plan with regard to this nutritional aspect you are suggesting.

MR. STEVENS: There has been some work done in Ohio by the Ohio Agricultural Experiment Station regarding the estrogen content of certain forage plants, not, however, related directly to wildlife or the cottontail rabbits in particular. They have found that certain legume species, in certain areas, have a rather high content of estrogenic substances. However, we find estrogenic substances produced in quite high quantities in lower forms of plant life. There is a possibility that there is a preponderance of such species in southeastern Ohio and this may be involved.

I don't know of any particular efforts we have outlined to do this, but it is certainly one of the things that we have looked at and we have considered; and eventually, if we pursue this to its fullest extent, I imagine it should be considered as a possible factor.

ECONOMIC ASPECTS OF WILDLIFE ABUNDANCE ON PRIVATE LANDS[1]

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We believe that certain aspects of wildlife production and use can well be treated in economic terms, while others are supra-economic. A logical distinction may be made between the *diversity* and the *abundance* of wildlife species, where diversity means number of different kinds, or species, and abundance means the number of individuals. Diversity, or the perpetuation of kinds of animals, cannot be treated in economic terms, because a species is irreplaceable. As a nation, the United States is prepared to spend substantial sums annually for the preservation of animal species threatened with extinction, and other countries do the same. It could be said with considerable justice that most bodies of men in the modern world are as willing to provide protection for threatened species of wildlife as they are for works of art, historical monuments or any other valued and irreplaceable object. Therefore we can consider the perpetuation of a diversity of wildlife as a problem in ethics and esthetics, rather than economics.

Wildlife abundance, on the other hand, lends itself more readily to economic analysis. Such results of wildlife abundance as damage to forest or agricultural crops, support of hunting and trapping activity or the value of meat, hides and fur can be considered in economic terms. On the other hand, such things as the part played by wildlife in public health problems, or the pleasure and knowledge derived from seeing or studying animals, do not lend themselves to economic analysis.

It is of value, at times, to treat those aspects of wildlife abundance which do lend themselves to economic analysis from an economic point of view. Such treatment can lead to new understanding of the relations of wildlife to man in what is, after all, a culture in which many decisions are made on economic grounds.

Some previous studies of wildlife economics have taken one or more of the following approaches:

1. The cost of administering the wildlife resource;
2. The expenditures of hunters and fishermen in pursuit of their sport;
3. The value of meat, fish or fur harvested from wild populations (Leedy and Dambach, 1948; Stains and Barkalow, 1951; Buck-

[1]Contribution from the Montana Forest and Conservation Experiment Station. Appreciatian is expressed to Resources for The Future for financial support and to many correspondents for information.

ley, 1955; Wallace, 1956; Hatter, 1957; Armstrong, 1958; Anonymous, 1961 and many others).

These surveys have demonstrated that hunting and fishing in North America involve a great number of people who annually spend a great deal of money in these pursuits. This information helps us to grasp the general value of wildlife in the economy of a state or nation.

The present study differs from those mentioned above in focusing attention on the area of production rather than the area of consumption. The land is the producer of wildlife as well as of food and fiber. Therefore we attempt, in this report, to define certain aspects of wildlife production (abundance) to which economic values can be attributed, and to discover the results when wildlife then is viewed as one part of a problem in the economics of production. In this study we have confined our attention to private lands, because we recognize the landowner-operator of private land as a key figure in the perpetuation, enhancement or deterioration of wildlife habitat. And it is evident that without habitat in adequate extent and quality there cannot be an abundance of wildlife.

Over seventy-five per cent of the land of the continental United States is in private ownership. This includes the most fertile land of the continent, and therefore land of high potential for wildlife production. Realization of this potential would result in high wildlife abundance; failure to realize it has led to a rather steady decline in abundance of most farm wildlife species. The reasons for this steady loss of habitat are of course to be found in the pattern of land utilization.

In the United States most private land is in the hands of people whose principal objective in owning the land is to realize the maximum profit upon the capital they have invested. This profit may be entirely monetary, or may include various amenities. In managing his land, the owner must constantly make decisions. These decisions are usually made on economic grounds: one course of action will require a certain investment and yield a certain return, whereas a different course will require a different investment and yield a different return. Seeking to maintain a rising standard of living from the capital he has to invest, the owner makes his decision.

The landowner has duties as well as rights. He must pay taxes, refrain from damaging the property of his neighbors and yield to such governmental rights as zoning and eminent domain. But these duties are relatively few, compared to other times and other places. On the whole, the landowner is free to operate as his economic interest dictates.

If we look back on the past thirty years of private land ownership in this country we find that great strides have taken place in the quality of land management. Thirty years ago our farmlands were seriously eroded and depleted. Generations of landowners, through a lack of understanding, had reduced our once rich soil to a point where it had lost its structure and fertility and was exposed to erosion by wind and water. Millions of acres were destroyed and abandoned. Almost all of our farmland showed various degrees of deterioration. Its potential productivity for wildlife was as seriously impaired as its productivity for food and fiber.

We have made great progress since that time. Through the efforts of soil and water conservation programs improved methods of cultivation, water disposal systems, cropping systems, terracing, fertilizing and a host of other activities have brought a revolutionary change in our agriculture. Productivity of much soil has been greatly improved and its potential for wildlife production has improved correspondingly. This change in our agriculture has had favorable implications for wildlife abundance. Why should we then be concerned for the future?

From the standpoint of the farmer, the adoption of soil conservation programs was not purely for the purpose of conserving the resource. He was interested mainly in improving his income, in the long run. And his conservation programs have certainly accomplished this for him. Along with this enhancement of soil fertility and productivity, there has been another trend, equally important for the well-being of the farmer. If we examine farm trends from an economic viewpoint, we can recognize certain shifts. Farms are growing larger. There are fewer farms and the remaining farms are growing by consolidating smaller farms. This leads to the removal of fence rows as fields become larger. Farms are becoming more specialized in production. The idea of the diversified, self sufficient farm has been discarded. The farmer can now often buy eggs, milk, vegetables cheaper than he can raise them. There are, consequently, less field borders, fewer ecological niches for wildlife. Farms are rapidly becoming more mechanized. Machines can operate more efficiently on large fields. It is inefficient to work around odd areas such as swamps, potholes, winding streams, hollows and so on. So these areas are drained or filled in. There is greater use of such technical tools as insecticides and herbicides which may eliminate wildlife or cover or food or all three. Although these changes in agriculture are generally being made within the framework of the family farm rather than through an increase in the extent of corporation farms, the household wants of the farm family are also changing. Increasing land costs are bringing a greater separation in the ownership and management of land. The farm is becoming less a family evironment than an industrial production environment. The family, in many cases, is living in town and a hired man is occupying the farmstead. More land is being held for investment or speculative purposes. There is greater reluctance to tie up the chance for sale by long run investment or agreement to such programs as the soil bank. High land costs and high operating costs make it imperative to secure the maximum return from the land, and this pressure tends to increase. In this industrial revolution in agriculture the successful operator must move with the times or lose out to a more aggressive neighbor.

When we look at the problem through the eye of the landowner-operator we recognize that his farm can be split into two units, a business unit, which produces his income, and a household unit, which constitutes the home and surroundings in which he and his family live. In the operation of his farm as a business unit he is primarily interested in maximizing profit from his investment of land, labor, capital and management. From the standpoint of his family or his household he is interested in achieving a certain standard of living. From this standpoint he is a consumer like all the rest of us. Inherent in the household standard of living is the establishment and maintenance of a certain quality of farm environment. However, the satisfaction of these household needs is primarily derived from the income produced by the farm. While the farm family has traditionally received part of its satisfaction from the condition of the surroundings, its interest has been changing and is now just as firmly based on the purchase of all the latest gadgets as are the desires of urban families. Family tastes for the latest conveniences are as fully molded by Madison Avenue on the farm as are those in any other sectors of the economy.

If, in making his day-to-day management decisions, the landowner is guided primarily by economic considerations of investment and return, he deals in this process only with economic values. This is entirely true with regard to his business unit, described above. In his household unit it becomes more entirely true the more completely the wishes of his family center on things which can be purchased with money. Although a century ago the "cash crop" produced by the average farm was but a small part of its total production, and most things produced on the farm were diverted into the household unit,—i.e. consumed by the farmer and his family, and his livestock, this is no longer in any general sense true. Today in the United States the cash crop accounts for most farm production.

From the standpoint of farm production and income, wildlife is not usually included in management decisions. Wildlife may occasionally be considered as harmful, and hunting might then be considered as a means of minimizing loss due to wildlife. On the other hand, and much more commonly, hunting might be considered as a net loss to the farmer in terms of crops trampled, livestock disturbed, injured or killed, extra time required to deal with hunters, close gates, gather livestock, clean up litter, or even in terms of danger to life and limb of the family. Hunting may result in actual loss or merely nuisance value. In any case, hunting seldom figures as a net gain from the income standpoint—the business unit of the privately owned land.

From the household point of view, wildlife may have any of several values. The family often likes to observe wildlife and know that it is around. The family may also enjoy the social advantages of having friends in to hunt. They may also satisfy some sense of social obligation to further the heritage of widespread hunting by permitting some hunting on their land. If the pressure for such hunting becomes too strong, however, it may start to represent a nuisance value to the household. It may interfere with the activities of the family and friends. It may even endanger the lives and property of the family. At this point the disadvantages greatly outweigh any advantages that wildlife hunting might represent.

At one level wildlife might be considered a gain for both the business and the household aspects of the farm. At another level, and more commonly, it may be considered a liability by the business unit but still be of sufficient value to the household unit to be encouraged or at least tolerated. There appears to be a fairly wide zone of tolerance. When hunting and fishing become a liability to both the business unit and the household, then the NO HUNTING signs start to go up.

If there is conflict between the two farm functions, the business unit usually proves the stronger. The trend toward an urban-oriented standard of living lays greater stress on the income returns from the business unit. The trend toward separating the household from the farm might almost eliminate household considerations from farm operations.

It is the increasing importance of the business unit, and the fact that wildlife does not figure in business unit decisions (since it usually has a negative or neutral value to the business unit) that has caused the steady loss of wildlife habitat on private farmland. As the farm becomes a more efficient economic unit, the farm-scape becomes more homogeneous. Interspersion of habitat elements grows less; ecologic niches are removed, and with them the species that they supported.

As wildlife has been decreasing, sportsmen have been increasing. The result has been that the modern hunter typically is mobile, searching over a considerable area for a likely hunting ground. The increased pressure on the areas which still produce an abundance of wildlife increases the nuisance value of hunting, and still more land is posted. The increase in the posting of private land is of great concern to sportsmen's groups, and to state departments of fish and game (Berryman, 1957 and 1961).

Because of this, valiant efforts are being made to improve landowner-hunter relations, and so maintain free hunting on private land. However, since this can do no more than raise wildlife from a negative to a neutral value in the eyes of the landowner, it will never give wildlife a significant place in his management decisions. If every hunter asked permission, closed gates, cleaned up trash, avoided frightening livestock and gave the landowner a nice Christmas present, wildlife habitat would continue to dwindle as the landowner improved his economic position (with government help) by making his fields larger, filling brushy draws, cleaning up his fencerows, silting or draining his potholes and straightening his stream channels. The failure of these well-meant efforts to improve landowner-sportsman relations, and so perpetuate free hunting, stems from the fact that they are directed toward the landowner primarily in his household function, whereas his continuing destruction of habitat is carried on in his business function.

It has seemed to us that the best hope for a stemming or perhaps reversal of the trend of continual decline in wildlife habitat, and wildlife abundance, on private (and espcially farm) land, would be based on an actual economic return to the landowner for the production of wildlife. This is, of course, no new thought. Over thirty years ago, Aldo Leopold spoke for the Committee on American Wildlife Policy as follows (Leopold, 1929; 199), "Instead of trying to persuade the farmer not to post (which is futile and negative) the public ought to urge him not to stop at posting, but to also practice management and sell the privileges of hunting the excess game crop."

Recently, we undertook to survey the situation in the United States, with regard to landowner income from wildlife, converting all information obtained to a value per acre.

It may be argued that no true value can be placed on wildlife. From the legal angle it may be argued that inasmuch as the wildlife is the property of the state, that it is illegal for the landowner to receive payment for it. We are not attempting to place any value on wildlife as such but only on the increase in land values for lease or sale because of the production of wildlife. This may seem like a fine distinction but it is a significant one. It is true that there is no real market value for wildlife. But, investigation has shown that there is developing a distinct market value for the wildlife production of land. This is a direct product of scarcity and increasing pressure. The value of land which produces wildlife is being bid up. There is no general market price but many local market prices. Where centers of hunter concentration and centers of wildlife abundance coincide the highest prices are found, but payment for hunting privileges is by no means confined to such areas. In our attempts to assess this situation we have had correspondence with more than one thousand people throughout the country. Our survey, which is still in process, reveals these points:

1. The better the hunting, in terms of game kill per acre per year, the higher the price paid for lease or sale of the land. Game concentration spots yield the highest product. Aquatic areas are game (waterfowl) concentration spots.
2. In areas where there is not much public land, even areas of low productivity (forest and range land) yield an income from game.
3. The clear pattern which emerges for aquatic (high) and forest and range (low productivity) wildlife lands, is not followed by agricultural (medium productivity) lands; income from wildlife production on farmland lies, on the average, well below that for either of the other two land categories.

These statements are supported by a substantial body of data, from which a few examples may be given. A full report will be presented when the survey is completed.

Goose hunting is apparently the most produtive, to the landowner, of all. In Wisconsin and Florida goose-hunting areas lease, at present writing, for about $10.00 per acre per year. In Missouri, where demand is greater, over $1,000.00 per acre has been offered for a good goose-hunting area, and single goose pits lease for $150.00 to $500.00 for the season. The value of all the land within a half-mile or more of a waterfowl refuge has at least doubled, and some of it has increased in value five or six times in the last fifteen years. Another example of this rapid climb in value comes from Oklahoma, where a tract near a waterfowl refuge sold for $15.00 an acre in 1946, re-sold for $75.00 an acre in 1950 and re-sold once again in 1953 for $137.00 per acre, an eight-fold increase in eight years. In thinly-populated South Dakota a tract near a waterfowl refuge sold recently for $86.00 per acre; while in Alabama a spot near goose concentrations is leased for $120.00 an acre a year.

All good waterfowl areas are highly desirable, relatively scarce and consequently expensive. Extremely high values are not difficult to find; but it must be remembered that many of the best areas are already in the hands of hunters and are not for sale. Since they do not change hands, no information on current market value can be obtained directly for them. If the true value of all private duck-club lands were known we are sure that it would prove to be substantial. We are currently obtaining an estimate of this through a survey of membership and assessment charges. Preliminary though our present data may be, however, they are sufficient to indicate that a lease value of between $10.00 and $100.000 per acre per year would be a realistic estimate for the majority of private waterfowl lands in the continental United States. The information we have also indicates that the best areas are under private control. Waterfowl hunting of high quality is no longer free in most places. Most of our correspondents have indicated that the lease cost of waterfowl areas is rising rapidly. Many clubs have been bid out of leases by other clubs.

Our conclusion, which is surely shared by anyone familiar with the situation, is that the serious waterfowl hunter must make a substantial annual lease or investment payment for his hunting-ground. Why is it, then, that the national survey shows that only a little over three per cent of all waterfowl hunters reported paying for lease or access rights (Anonymous, 1961)? We suggest that this small percentage of license-holders controls the best waterfowl habitat, and that the vast majority of waterfowl hunters are only casual hunters who must content themselves with the sport that may be obtained in relatively unproductive areas. A relatively few hunters, we venture, bag most of the ducks.

Turning to the other end of the scale of productivity, forest and range land, we have found that even for these areas hunting leases occur, and with increasing frequency. The lease value per acre per year is naturally lower than that for waterfowl lands. Most often the landowner begins by letting the hunting pay for patrol. A charge is made to obtain funds with which to regulate the conduct of hunters, in other words, to raise wildlife value from negative to neutral. Often it next occurs to the landowner to obtain for hunting rights an annual sum equal to his taxes. These lease values vary from a few cents to one dollar or more per acre per year, and appear to average between thirty and sixty cents. In California 157 clubs, averaging twelve members, lease an average of 3,280 acres of range land at a cost of about $1600.00 a club for an average fee of about 36 cents an acre but varying from 6 to 65 cents an acre. In Missouri deer hunting land leases for about 37 cents an acre per year. The Extension Service there is encouraging farmers to lease their lands for deer hunting. Our correspondent remarks that soon deer hunting land will be leased to the same extent that waterfowl areas are, and that then only the National Forests will be open to free and widespread hunting. In New York deer hunting land is leased for around 22 cents per acre per year. Some land leases for 30 to 40 cents and some as high as 80 cents a year per acre. Texas, where there is little public land, has many examples. Large tracts of land rent for 50 cents an acre per year and smaller tracts for $1.50. Range land within 50 miles of Houston is said to rent for $5,00 an acre per year for hunting. Land which produces no appreciable amount of game sells for around $25.00 an acre. If it produces both turkeys and deer it sells for $45.00 an acre. If, in addition, it has water, it sells for around $100.00 an acre. As the hunting pressure increases the price is bid up, and in some areas hunting on these range and forest lands has become an important source of income.

Farmland lies in wildlife productivity somewhere between the waterfowl concentration areas and the infertile-soiled, often poorly watered acres of extensive forest and range areas. It might be supposed from this that the value of a hunting lease on farmland would lie somewhere between the high values found for waterfowl areas and the low ones found for forest and range. But, to the contrary, our information clearly indicates that any leasing of farmlands is rare. Therefore the average value received by the owners is even below that found for forest and range land. The striking fact here is that even where the farmer owns some very high producing wildlife areas where game is concentrated, he may realize none of the wildlife benefits to himself in the form of annual income, an income he would have if he were to lease the land to some hunting group. But he usually does not capture this potential return. In an Oklahoma example some lands were sold or leased to clubs some of which in turn made a charge for daily or seasonal hunting. Other lands were not for sale; the farmers kept these lands for crop production. In some cases they permitted hunting on these crop lands, in other cases not. But in almost every case they did not make a business of charging the market value for hunting on these crop lands. There are many similar examples.

The growing potential income from farmland hunting could become an important source of additional revenue for many farmers. Much more important, from the viewpoint of wildlife well-being, it could act as a spur to habitat improvement. We suggest that if the farmer were taught to charge for hunting, and wisely counseled, that the result could be a substantial increase in wildlife abundance across the nation. This suggestion might seem to run counter to two commonly accepted principles: that the game is publicly owned, and that we should strive to maintain widespread free hunting on all lands.

This proposal would not relinquish control of game from the state to the landowner. The state would still control the game. The state would continue to set seasons, establish bag limits, make and enforce the rules. There is already much consideration by the state for private landowners, especially with respect to setting seasons. The charge levied by the landowner would not be made for the game as such but for the benefits accruing to the land by the wildlife which is produced on land in which the owner has invested.

With regard to free hunting, we must acknowledge that when a hunting right is purchased the hunting cannot be called free. But we must point out that hunting is no longer free anyway. According to the 1960 survey, the average annual expenditure per hunter was about $80.00 (Anonymous, 1961). Like all averages, this is misleading, because there is no average hunter. Many rural hunters spend much less than this amount; most urban hunters spend much more. When we are talking about charging for hunting privileges we suppose that such charges would be paid principally by urban hunters, since the rural hunter obtains his hunting free on the basis of personal acquaintance.

Typically, the urban hunter spends substantial amounts for costs connected with hunting, and among these costs that for transportation is appreciable. The national survey (Anonymous, 1961) showed that thirty per cent of the sportsmen travelled over 750 miles per year, and that half of these travelled over 1500 miles. We suggest that the development of good hunting close to home could cut down substantially on the amount of travel now undertaken in the search for a hunting ground. In other words, if some of the money now spent for transportation were diverted to the landowner, the hunter would not be spending more but the landowner would be receiving more, and might consequently take a brighter view toward the preservation and improvement of wildlife habitat.

It should be apparent from the recent studies that we are no longer dealing with what Berryman (1961) calls the "One-gallused hunter" who is not able to afford even a small charge for hunting. We are dealing with a man in an affluent society who is now spending a considerable amount for his hunting pleasure.

Some hunters are already paying for the hunting privilege, as we have seen, especially on waterfowl areas. However, in 1960 only about 3% of all waterfowl hunters paid (from $23 to $31) for hunting on an annual lease basis or in daily charges. Almost 7% of the big-game hunters hunted under a lease system, paying from $14 to $20. The highest prices were paid by the 2.7% of the hunters hunting upland birds. They averaged $64 for an annual lease (Anonymous, 1961).

We suspect that although these percentages are small, the hunters involved are hunting on some of the best lands and obtaining the highest kills. Because of bag limit restrictions, this is more possible for upland game and waterfowl than for big game, but even there the tendency is probably the same. In other words, as hunting opportunity grows poorer, there is more competition for it and it acquires an increasing cash value.

We propose that this tendency be combatted, not by trying to make free what hunting opportunity remains, but by increasing the amount of hunting opportunity. The greatest unrealized potential is on farmland. If we replace "free" in free hunting, with "reasonable cost," and if the revenue so raised goes directly to the man on whose land the game is produced, we could be well on the way toward wildlife abundance in the United States.

From the standpoint of the landowner this might mean that he would remove some land from the production of his specialized crops and convert it to wildlife production. It might cause him to rearrange his fields to provide more wildlife niches without appreciably reducing his crop acreage. He might decide not to drain a swamp or plow up an odd area. He might choose to establish a pond or swamp or plant hedgerows. He might adopt some other method of controlling weeds or insects than the pesticide used before. All these decisions would be justified on sound economic grounds. If the alternative to draining a swamp for crop production is zero, there is no sound basis for any other decision but to drain it. But if the wildlife value of land repsents an income return to the landowner, then it becomes a positive force in his decision making and this value of land could well be the highest value of some land, particularly if changing the present condition of the land represents a considerable investment, such as that for drainage.

Of course, a direct payment from the hunter to the landowner is not the only way that income can be obtained for a wildlife crop. Some states lease the hunting privilege, but since they are able to pay only a few cents an acre a year, this renders the wildlife value more neutral than positive. Another approach is to give the landowner incentive payments under the Agricultural Conservation Program. But these payments do not cover the full cost of wildlife developments. On the whole, it would appear that if substantial income is to be obtained for wildlife well-being on farmland, it must come from the hunters who harvest the wildlife crop.

From the national standpoint the question might be raised as to whether or not we can spare the farmland for hunting and fishing. In the face of tremendous and mounting farm surpluses it would be difficult to argue that we could not. In fact, it has been proposed by the President as one means of relieving the surplus problem and the high costs involved in storage.

But even without devoting large amounts of land to wildlife we recognize that increased numbers of wild animals can be produced on farms. Animal numbers can be considerably increased if the cover is well distributed in small amounts over many areas. No one farmer would have to reduce his crop acreage very much.

Broadly, our proposal is not a new or predominately original one. It is recognized by increasing numbers of people throughout the country. The need for such a proposal is recognized in the recent report of the Outdoor Recreation Resources Review Commission (Rockefeller *et al.*, 1962) when it states: "A full-scale program to meet the problem of shrinking public hunting and fishing opportunities has never been attempted on a national basis. The commission suggests, as a starting point, that the Bureau (of Sport Fisheries and Wildlife), in cooperation with the States, sportsmen's organizations, and landowners, undertake research and action programs to promote greater public use of private lands and waters for hunting and fishing. This will entail new legal and economic measures for adequate compensation to property owners and protection of the rights of both the landowner and the using public" (p. 133).

We recognize many difficulties in the initiation and operation of such a program, but these seem trivial indeed when compared to the losses suffered every year under our present "free-hunting" system. We propose that payment for hunting on private land be made a public policy, to be encouraged by public agencies, with the purpose of providing a real incentive for the perpetuation and enhancement of wildlife habitat.

SUMMARY

A distinction is made between wildlife *diversity* and wildlife *abundance,* the former meaning the number of different species and the latter the number of different individuals. Wildlife diversity cannot be considered in the usual economic terms, because a species is irreplaceable. Certain aspects of wildlife abundance can be treated in economic terms. In this paper consideration is given to the economic value to the landowner of the wildlife on his land. A current survey indicates that the value of good waterfowl habitat is in the $10 to $100 per acre per year range. Most of it is leased. Value of private forest and range land is in the $0.10 to $1 per acre per year range. Leasing is most common where public lands of the same type are few.

There is little leasing of farm land. Because there is no cash income for wildlife to the farmer, wildlife does not have a positive economic value. Consequently, in the business operation of the farm, wildlife is not considered. The result is loss of farm wildlife habitat and decline in farm wildlife abundance.

It is proposed that vigorous efforts to provide cash income to the

farmer be made, as a way of enhancing wildlife habitat and increasing wildlife abundance.

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MINNESOTA PRAIRIE MANAGEMENT TECHNIQUES AND THEIR WILDLIFE IMPLICATIONS[1]

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This paper reports on the wildlife management aspects of an investigation to determine the effects of four treatments—spring burning, fall burning, grazing and mowing—on the flora and fauna of prairie habitat in northwestern Minnesota.[1]

The tall grass prairies of northwestern Minnesota lie in a tension zone between the deciduous forest on the east and the short grass prairies to the west in the Dakotas. In some places the transition from forest to prairie is clearly defined and in others it is diffuse. The topography of the landscape at this transition in northwestern Minnesota is gently rolling. Originally marshes, potholes and wet prairies were common throughout the region. These prairies near the woodland edge were inhabited by Indians prior to about 1900. According to Buell and Facey (1960) prairie fires, which frequently swept the up-

[1]Financial support was provided by the Minnesota Division of Game and Fish (P-R Project W-11-R), the National Science Foundation (Grant No. 7019), through the Lake Itasca Biology Session, and the University of Minnesota Graduate School.

land areas in the spring and fall, helped to maintain the grassland in the face of westward invasions by trees and shrubs.

When settlers began farming in this area agriculture brought about marked changes in the landscape. Farmsteads were established with plantings of trees to serve as windbreaks and a network of roads developed. Fires were reduced in extent and frequency. In much of the area cultivated crops were successful and consequently many prairies were broken for agricultural purposes.

At the present time the agricultural operation in this area is relatively intensive. Most of the tillable land is being cropped and a recently accelerated program of planned drainage along with newly-bulldozed deep highway borrow pits is rapidly eliminating the marshes and potholes. Where drainage is difficult a few tracts of native prairie remain. Some of these are owned by farmers or other individuals and are usually grazed or mowed. Others have been acquired by the Minnesota Department of Conservation or other organizations interested in preserving natural areas. The proposed program of wetlands acquisition by the U. S. Department of the Interior may place many more of the remaining prairie tracts under government ownership and presumably assure their protection from the plow.

It is apparent that these publicly owned natural prairies must be managed to preserve their original status for research and aesthetic values as well as to provide the desired conditions for such wildlife as prairie chickens (*Tympanuchus cupido pinnatus*) and waterfowl. We hope that this report will provide information which may be useful in the formulation of sound management plans.

It is a pleasure to acknowledge the cooperation of the Minnesota Division of Game and Fish, and the Museum of Natural History and the Department of Entomology and Economic Zoology of the University of Minnesota. Special thanks are expressed to Morris Patterson, Refuge Manager, Minnesota Division of Game and Fish, for assistance with the land management operation as well as to Louis Polack and Gilford Rogers, farmers near the Waubun Prairie Research Area, who provided equipment and assistance throughout the study.

METHODS

This report is based on field studies conducted during the five summers of 1957 through 1961. A detailed description of the site and of most of the methods used in this study has been published (Tester and Marshall, 1961). Summary statements will be given here.

A total of 70 acres of relatively undisturbed native prairie was selected for study from the approximately 250 acres of unplowed land which lies within a 640 acre tract known as the Waubun Prairie Re-

reach Area. The area is located eleven miles southwest of the town of Mahnomen in Section 33, Township 143 North, Range 42 West of the 5th Principle Meridian. The tract was acquired by the Minnesota Department of Conservation in 1954 and has been reserved for basic research and experimental land management.

Seven ten-acre plots were selected on the study area on the basis of topography and history of land use, particularly mowing. The selection of the treatments for each plot was made subjectively and was based on the location of the plots with respect to potholes and roads, and the nature of use of adjacent agricultural land.

Two plots were used as controls and are designated Control I and Control II. One plot (Fall Burn) was burned on October 28, 1957. Two plots (Spring Burn I and Spring Burn II) were burned on April 11, 1958. One plot (Graze) was grazed during the summers of 1958 and 1959.

The hay crop on one plot (Mow) was to be harvested each year in September. The harvest proceeded as planned in 1957. However, in March 1958, a wildfire burned most of this plot and in September, 1958, the harvest was only partially completed. This plot was dropped from the study.

Discussions on the effects of mowing will be based primarily on the differences between the two groups of plots which were observed before treatments started. Control II and Spring Burn II were in a part of the prairie which was of lower elevation and which had more soil moisture. This site had not been mowed since 1951. The remaining five plots were in an area which had been mowed annually in late summer before 1957.

The non-woody upland vegetation was studied by means of rectangular quadrats 1.0 by 0.5 meter in size. The effects of grazing on woody vegetation were evaluated by means of 60- by 60-foot quadrats in 1958 and 1959. In 1959 ten 2- by 60-foot transects were added to the study. Data in quadrats and transects were recorded by 0-2 foot, 2-4 foot, and 4+ foot height classes for aspen (*Populus tremuloides*) and willow (*Salix* spp.). In addition to these quantitative methods, photographs were taken periodically from permanent stations during the study and subjective evaluations of certain conditions were made in the field.

Censusing of song birds was accomplished by the territory-mapping technique. Indices of population density of small mammals were obtained by snap-trapping. Indices of the population density of Orthoptera and Coleoptera, the two groups of insects likely to be most abundant in a prairie (Smith, 1940), were obtained by sweep sampling.

Many other larger species of animals live on or range over Waubun

Prairie. Censusing these forms was beyond the scope of this investigation and unfortunately most game species must be included in this category of animals. However, evaluation of the management practices in terms of greater prairie chicken, waterfowl, and predators is made on the basis of "preferred" habitats as reported in the literature.

REACTION OF COMMUNITY TO TREATMENTS

Data on litter, dominant grasses, and certain animals will be briefly summarized here to provide background for the management discussion which follows. The woody plants and shoreline vegetation not previously reported on will be treated in detail.

Litter.—The most pronounced changes in the community in response to the treatments were in the depth and areal cover of the litter. We believe that these changes in the vegetational component of the community were responsible to a large extent for observed shifts in the animal populations.

In 1957 litter was sparse on those plots which had been mowed annually and was dense in those plots which had not been mowed since 1951. Burning in fall of 1957 and spring of 1958 reduced litter cover markedly in the Burn plots. Light grazing in 1958 did not have a noticeable effect on litter in the Graze plot. In 1959, grazing on this plot was moderate to heavy and caused pronounced changes in litter. Most areas were heavily trampled, and litter was only a few centimeters deep, but small patches of untrampled litter were present throughout the plot.

The data indicate that protection after burning or mowing would result in an accumulation of litter in two or three years which is similar in depth and percentage of cover to that in an area such as Control II which had been undisturbed for eight years. These findings support those of Ehrenreich (1957) and Dix (1960) who studied litter accumulation rates on Iowa and North Dakota prairies, respectively. It appears that on prairies in the north-central states a condition of equilibrium is reached two to six years after protection from burning or mowing begins — in this condition the annual increment of new litter seems to be balanced by the decomposition of old litter.

Upland grasses and forbs.—Approximately 100 species of grasses and forbs were present on the upland areas. The dominant species in the community were big bluestem (*Andropogon gerardi*), little bluestem (*A. scoparius*), Indian grass (*Sorghastrum nutans*) and needlegrass (*Stipa spartea*). Following treatment changes in the contribution of these species to the cover were small. No attempt was made in this study to determine the actual amount of forage produced under the various treatments since we considered areal cover to be the phytosociological character which would provide the best measure of each species with regard to the community.

In general the cessation of mowing on four plots allowed the mid- and late-summer aspects of the vegetation to mature and produce seed for the first time in many years. However, no striking changes in species composition were noted during the course of the investigation. Weaver (1954) states that the removal of vegetation by mowing after maturity has no harmful vegetational effect. If mowing occurs before maturity the competitive abilities of some species may be reduced (Curtis, 1959).

Both spring and fall burning resulted in an advance of 10 to 20 days in the development of plants on the Burn plots. In addition new growth on these plots was more luxuriant and removal of the thick mat of litter seemed to "release" many of the forbs such as yellow stargrass (*Hypoxis hirsuta*), stiff goldenrod (*Solidago rigida*), frostweed aster (*Aster ericoides*), and pasque flower (*Anemone patens*). Many species produced more abundant seed crops after burning. This response has also been observed by Evans and Grover (1940), Ehrenreich (1957) and Aikman (1955).

Burning did not bring about any noticeable shifts in species composition. Dix (1960) found a similar situation in comparisons of burned and unburned prairies in North Dakota. Fire can be used to control or reduce the density of certain undesirable species not considered native to prairie as shown by Curtis and Partch (1948) and Aldous (1934). Literature regarding effects of burning on yield and/or cover is contradictory. Increases after burning are reported by Aikman (1955) and Kelting (1957) whereas Hervey (1949) and Hopkins *et al.* (1948) found smaller yields. Ehrenreich (1957) found no difference in total yields on burned and non-burned prairie in Iowa.

Usage of the forage on the Graze plot was light in 1958 and moderate with small areas of heavy use in 1959. Much of the growing vegetation was removed by the cattle. However, no change in species composition in this plot was observed. We believe that the low to moderate utilization of the forage and the intermittent grazing program used account for this lack of change. Launchbaugh (1955) found that periodic moderate grazing allowed for vegetational composition similar to that in ungrazed areas and Weaver (1954) states that grazing by wild animals had little effect on the composition of grasslands because it was both widespread and intermittent. Heavy, prolonged grazing, on the other hand, causes reduction in cover of native grasses, increases in undesirable species and compaction of soil (Ehrenreich, 1957; Kucera, 1956 and 1958; Weaver, 1954).

Woody plants.—Only those woody plants which are considered to be "invaders" on natural prairie will be discussed here. On Waubun Prairie these are limited to six species of willow (*Salix bebbiana, S. discolor, S. gracilis, S. humilis, S. interior,* and *S. rigida*), which will be treated as a group, and quaking aspen.

Numerous investigators have reported on the invasion of prairies by trees and shrubs. Moss (1932) found aspen invading grasslands in the prairie provinces of Central Canada when fire was kept out and Bird (1961) states that aspen replaces prairie in the parklands of western Canada if there is sufficient moisture and if fires are not "too frequent." Prairies in Wisconsin (Dix and Butler, 1960) and Iowa (Moyer, 1953) are currently being invaded by willow, aspen and other woody species. Mixed hardwood and brush stands found on the prairie soils of northwestern Minnesota have been described by Ewing (1924) and aspen and aspen-oak groves in the same area are discussed by Buell and Facey (1960).

Ecesis of aspen seedlings on prairie is difficult because of the dense sod and shading by the grass (Bird, 1961). However, once a plant is established it has great potential to spread into surrounding areas by means of rhizomes or propagating roots (Buell and Buell, 1959).

Quaking aspen clones are scattered over Waubun Prairie. The age of these clones varies from 1 to ca. 20 years (M. L. Partch, unpublished data). We have observed development of new thickets from seed on sites which have been undisturbed for as short a time as two years. Figure 1 illustrates the establishment of aspen by natural seeding on a site which had been mowed annually prior to 1957. The stems in the 1958 photograph had developed in two growing seasons. By 1961 numerous plants exceeded 60 inches in height.

Prairie willow (*Salix humilis*) occurred only as isolated plants scattered on the upland. The other species of willow were generally restricted to wet areas or the borders of potholes.

Annual hay harvesting precludes the ecesis of aspen and willow on sites that can be mowed. If three to five or more years elapse between hay mowings aspen and/or willow may become established and grow to such size that the stems cannot be cut off with a hay mower. In this event the farmer usually mows around the clone each year. This allows the woody plants to increase in size and density but restricts their spread.

Burning has a wide range of effects on willow and aspen. The effect is primarily determined by the date, duration and intensity of the fire. Aspen is fairly susceptible to fire with plants being killed in some cases or with bark damage which occurs under less severe burns allowing the entrance of wood-rotting fungi or disease (Strothmann and Zasada, 1957; Stoeckeler, 1948).

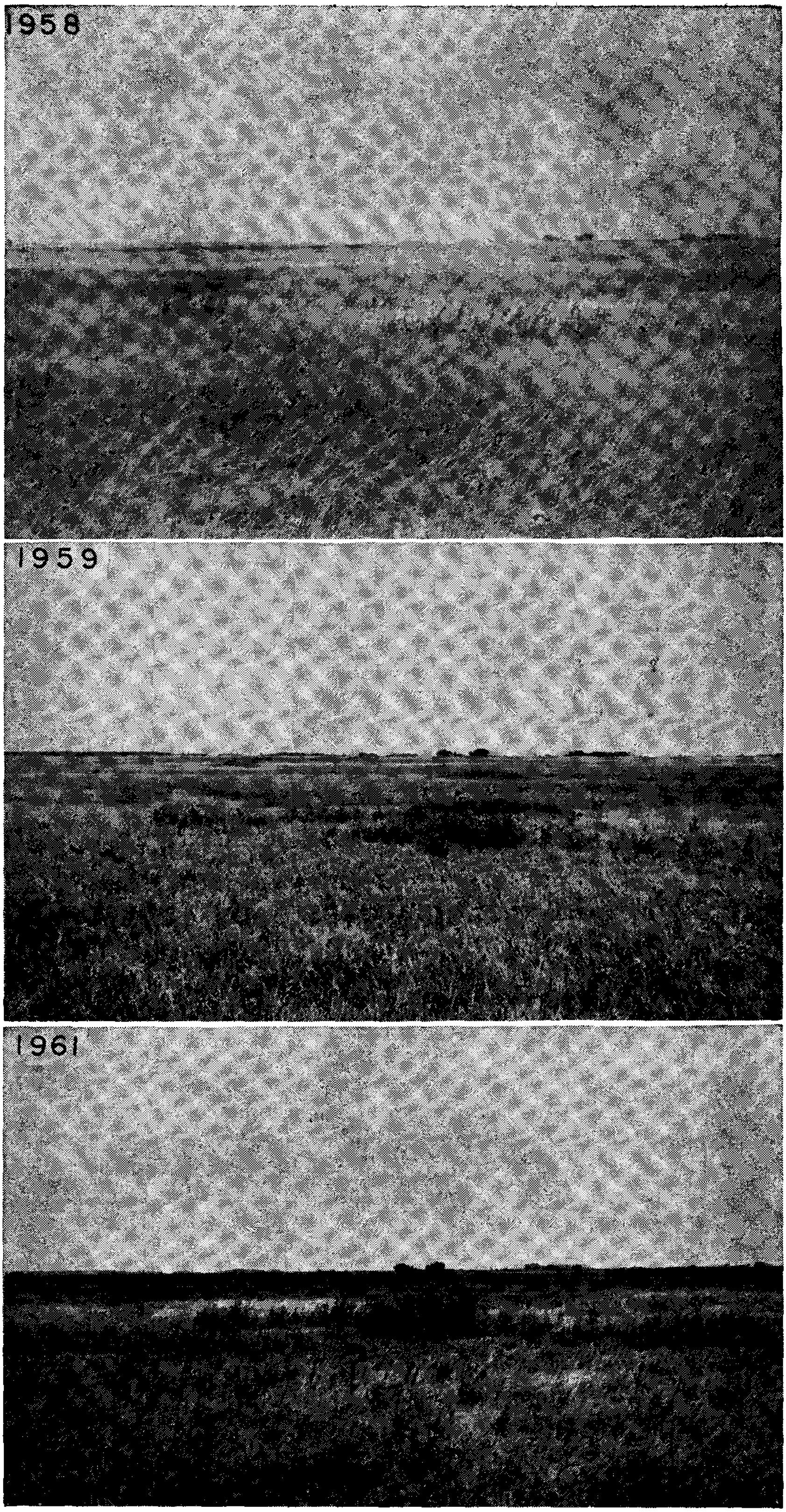

Fig. 1. Establishment of an aspen clone on native prairie.

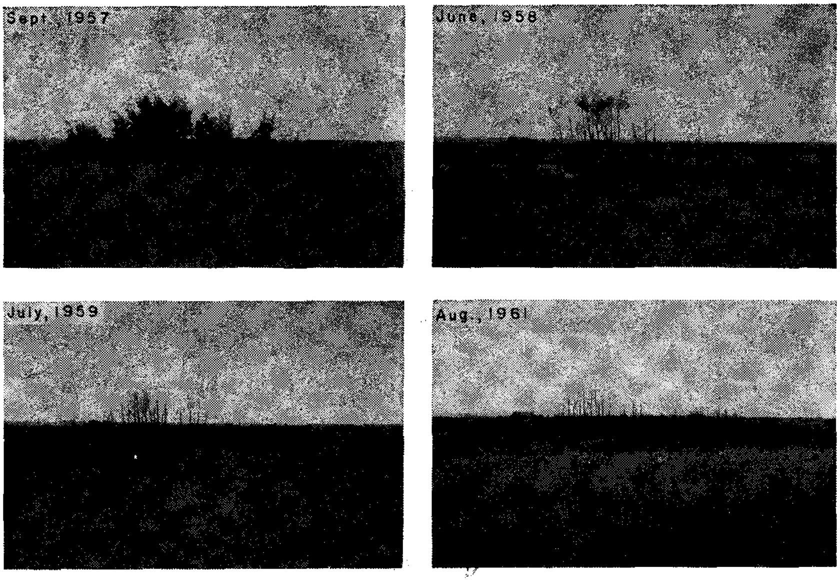

Fig. 2. Changes in an aspen clone due to burning on April 11, 1958. See text for explanation.

Aspen clones were present on both Spring Burn plots on Waubun Prairie but none was located on Fall Burn. Several small plants less than 35 centimeters high were scattered in the burn plots, but numbers were too small to be of use in evaluating the effects of fire.

The changes in the aspen clone on Spring Burn I are illustrated in Figure 2. This stand was located near the center of the 10-acre plot which was burned when fuel was abundant and very dry. A wind estimated at 15-20 miles per hour by the Beaufort Scale at the time of burning resulted in a fire which was hot and fast.

The photograph of September 5, 1957, shows the thicket before burning. The next photograph, June 5, 1958, was taken about two months after the fire and shows that all the aspen smaller than 11 feet in height were killed and that leaves on larger trees were present only above 11 feet. These leaves dried up in approximatly six weeks and the photo one year later on July 4, 1959, shows that all of the trees are dead. On this same photo new aspen sprout growth can be seen behind and to the right of the dead trunks. Two years later, as illustrated in the photo of Aug. 27, 1961, this new growth is over six feet high in places and the thicket again appears as a prominent feature of the landscape.

Figure 3 illustrates the effects of fire on the aspen thicket located 10 feet in from the west edge on Spring Burn II. Fuel and wind

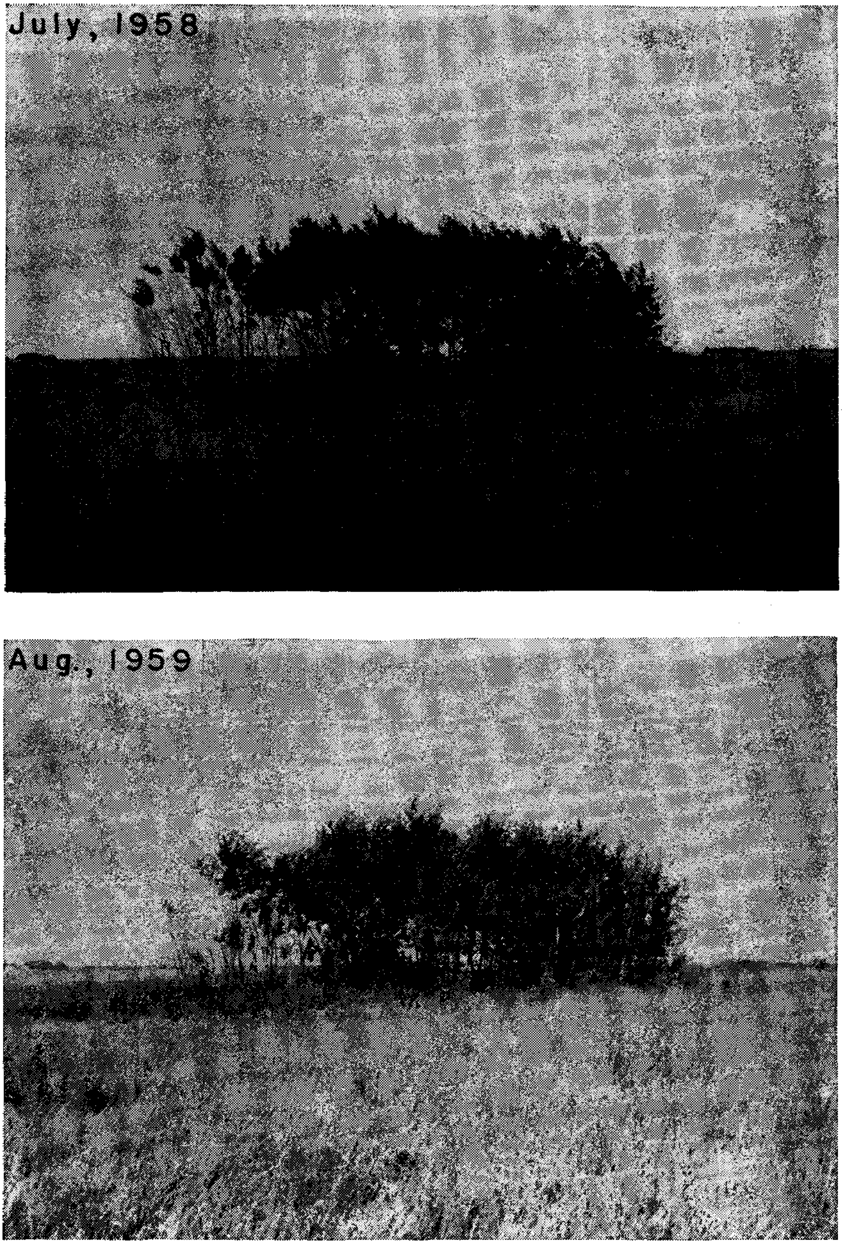

Fig. 3. Effect of fire on an aspen clone. See text for explanation.

conditions for this burn were nearly identical to those on Spring Burn I. The clone was located close to the edge of the plot from which the fire was started. Fuel within the thicket was not as abundant as in the surrounding grassland and since the fire had just burned a few feet from its starting point it did not carry through the stand with uniform intensity. Only about 15 per cent of the trees were killed and these were mostly on the west edge.

A few clumps of willows were located around potholes and in each of the thickets on the Burn plots. In every case the parts of the plants above ground were killed by the fire but abundant sprouting occurred during the first growing season. Ewing (1924) also found that in wet habitats fire kills the tops of willows but does no apparent harm to underground parts.

The Graze plot contained three thickets of aspen and willow. Data on the effect of grazing on woody plants in the 60- by 60-foot plots and the 2- by 50-foot transects are given in Tables 1-4. In an ungrazed thicket one would expect an increase in the number of stems in each height class due to normal growth and regeneration during the summer. Grazing or browsing on the woody plants would be revealed if this increase did not appear in the data or if fewer stems were present after grazing. Statistical tests cannot be applied to the data in Tables 1 and 4 because no thickets were present in the Control plots for comparison or for determining expected values required in the Chi-square analysis.

Table 1 reveals that, under the light grazing which occurred in Quadrats 1 and 2 in 1958, numbers of aspen shoots increased particularly in the 0-2 foot class. Under moderate grazing in 1959 some of the aspen in these two quadrats was utilized and the numbers of shoots reduced. Quadrat 3 was grazed heavily during both seasons and the aspen in all three size classes showed a marked reduction in number after grazing.

The effects of moderate grazing compared to heavy grazing in 1959 are demonstrated more clearly in the 0-2 foot height class of the transect data (Tables 2 and 3). The location of each plant was recorded when the transect was run before grazing. During the "After" run we determined the effects of the grazing on known stems. The data in the tables are adjusted for growth of new plants and increases in height of plants present before grazing. Analysis revealed a Chi-square of 8.68 between the numbers of 0-2 foot aspen before and after moderate grazing and a value of 34.40 in the transects subjected to heavy grazing. The probability of a greater difference occurring under moderate grazing is 0.13 whereas the difference observed under heavy grazing is significant at the 0.01 level. We have concluded on the basis

TABLE 1. EFFECTS OF GRAZING ON NUMBER OF ASPEN STEMS IN 60- BY 60-FOOT QUADRATS, WAUBUN PRAIRIE, 1958-1959

Quadrat No.		Height of Stems 0-2 ft.		2-4 ft.		4+ ft.		Grazing Intensity
		Before	After	Before	After	Before	After	
1	1958	46	81	89	89	26	35	Light
	1959	64	70	94	67	43	34	Moderate
2	1958	36	67	73	81	43	46	Light
	1959	119	77	91	82	53	57	Moderate
3	1958	511	252	35	10	3	....	Heavy
	1959	243	87	44	20	....	....	Heavy

TABLE 2. EFFECTS OF MODERATE GRAZING ON NUMBER OF ASPEN STEMS IN 2- BY 50-FOOT TRANSECTS, WAUBUN PRAIRIE, 1959

Transect No.	Height of Stems 0-2 ft.		2-4 ft.		4+ ft.	
	Before	After	Before	After	Before	After
1	4	1	7	8	2	2
2	3	2	3	2	2	2
3	0	0	4	3	2	3
4	13	6	8	10	1	1
5	7	3	6	5	1	0
6	1	1	2	3	5	4
Chi-square (5 d.f.)	8.68		1.89		1.70	

Chi-square (.05) = 11.07, (.01) = 15.09

TABLE 3. EFFECTS OF HEAVY GRAZING ON NUMBER OF ASPEN STEMS IN 2- BY 50-FOOT TRANSECTS, WAUBUN PRAIRIE, 1959

Transect No.	Height of Stems 0-2 ft.		2-4 ft.		4+ ft.	
	Before	After	Before	After	Before	After
7	28	10	4	2	2	2
8	20	4	1	1	2	1
9	29	15	11	7	2	2
10	11	5	2	0	1	1
Chi-square (3 d.f.)	34.40		4.45		0.5	

Chi-square (.05) = 7.81, (.01) = 11.34.

TABLE 4. EFFECTS OF GRAZING ON NUMBER OF WILLOW STEMS IN 60- BY 60-FOOT QUADRATS, WAUBUN PRAIRIE, 1958-1959

Quadrat No.		Height of Stems 0-2 ft.		2-4 ft.		4+ ft.		Grazing Intensity
		Before	After	Before	After	Before	After	
1	1958	127	241	28	63	2	6	Light
	1959	231	283	76	84	7	13	Moderate
2	1958	105	329	115	140	7	13	Light
	1959	782	451	203	177	1	3	Moderate
3	1958	56	39	....	....	....	....	Heavy
	1959	65	23	....	....	....	....	Heavy

of these findings that annual heavy grazing might control aspen invasion of grassland.

Willow stems were counted in the 60- by 60-foot quadrats in both years (Table 4). Numbers of stems were less after moderate grazing in Quadrat 2 in 1959 and after heavy grazing in Quadrat 3 in both years. Observations in Quadrat 3 after grazing revealed that the grass was eaten to an average height of 7-10 centimeters and the only plants which were not heavily utilized were several species of goldenrod (*Solidago* spp.) and willow. Although these data cannot be tested further, we feel that they indicate that cattle will utilize some willow on heavily grazed areas.

Effects of grazing on aspen and willow have been reported from other localities. Baker (1918) found that if all new aspen suckers are destroyed by mowing or heavy grazing for three successive years food materials in the roots become exhausted. With no opportunity for replenishment suckering usually ceases. Annual grazing by sheep completely suppressed aspen development in areas in central Utah (Sampson, 1919) and in aspen groveland in Montana (Lynch, 1955). In southeastern Alberta (Kieth, 1961) observed that cattle prevented willow and aspen growth on some sites where conditions were otherwise favorable. Bird (1961) states that in the parklands of Canada trampling and browsing of young aspen by livestock or big game may prevent regeneration. Snowshoe hares (*Lepus americanus*) and bison (*Bison bison*) may have been important in controlling the spread of aspen in prairie (Moss 1932).

Shoreline vegetation.—Some information was obtained during this investigation on the effects of the treatments on vegetation growing at the edges of the potholes. The dominant species occurring here were cattail (*Typha latifolia*), hardstem bulrush (*Scirpus acutus*), cord grass (*Spartina pectinata*), and marsh groundsel (*Senecio congestus*).

It was not possible to mow the shoreline vegetation because machinery could not traverse the soft mucky ground. In other areas, where the ground will support machinery, mowing twice per year has been effective in controlling cattails and some other species (Martin *et al.*, 1957; Martin and Uhler, 1939).

In the Burn plots no changes were noticed in the vegetation around the small potholes which were completely dry at the time of treatment and carried the fire. Apparently not enough fuel was present along the margin of the larger ponds to carry the fire. Martin *et al.* (1957) also found that burning was generally ineffective by itself in control of emergent aquatic species.

Grazing, in contrast to mowing or burning, has pronounced effects on the marsh edge community. The Graze plot on the study area bordered a ten-acre pothole. Light use on the plot in 1958 resulted in limited feeding on and a few trails through the cattail and bulrush. In 1959, when grazing was moderate to heavy, the cattle trampled the marsh edge extensively (Figure 4) and ate substantial amounts of cattail but avoided feeding on bulrush and the other dominant spe-

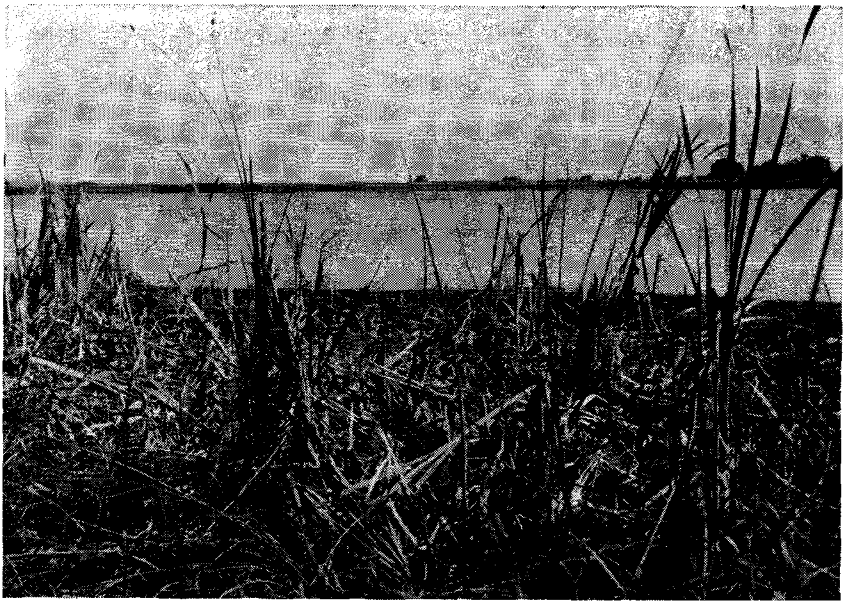

Fig. 4. Effect of moderate to heavy grazing on shoreline vegetation.

cies. New growth of cattail was often completely eaten. Kieth (1961) found similar effects on grazed marshes in Alberta but mentions that cattle preferred softstem bulrush (*Scirpus validus*) to cattail. In western South Dakota stock ponds Bue *et al.* (1952) found grass type shorelines existing under light grazing and mud shorelines under heavy grazing.

Responses of animals.—The responses of passerine birds, small mammals and two orders of insects on Waubun Prairie to mowing, burning and grazing have been reported (Tester and Marshall 1961) using correlation analysis. The animal populations responded in various ways to the changes in vegetational cover. Some species or groups of related species increased, some decreased or even disappeared from a particular locality, while other populations appeared to be unaffected. Some were affected immediately following application of a treatment and others exhibited a time lag. Summary statements for the components studied are quoted directly:

"There were important changes in the distribution and abundance of breeding pairs of bobolinks (*Dolichonyx oryzvorus*), savannah sparrows (*Passerculus sandwichensis*), and LeConte's sparrows (*Passerherbulus caudacutus*). On the basis of correlation analysis these changes appeared to be most closely associated with changes in litter."

"Changes in populations of the meadow vole (*Microtus pennsylvanicus*) were positively associated with increasing litter. Those of the prairie deer mouse (*Peromyscus maniculatus bairdii*) were negatively associated with increasing litter. Numbers of the masked shrew (*Sorex cinereus*) seemed to be independent of the vegetative characteristics measured."

"Analysis of the data for the two groups of insects indicated that while grasshoppers (Orthoptera) were most abundant where light or moderate amounts of litter were found, large beetle (Coleoptera) populations appeared, on the other hand, to be associated with sparse litter."

MANAGEMENT IMPLICATIONS

On the basis of the findings from this and other studies we feel that proper management of the land for prairie chicken and waterfowl is also the best method for maintaining prairie for research and aesthetic values in this ecotone region. When the habitat requirements of a particular game species are considered the management must be more precise than when only vegetational composition is considered. These requirements and management methods will be discussed for greater prairie chickens, waterfowl production and furbearers.

Greater prairie chicken.—The greater prairie chicken is the upland game species most likely to be benefited by the proper management of grassland areas in this region. This bird requires large sweeps of open prairie unbroken by windbreaks or fence rows. Small areas within this general expanse of grassland must have very short cover which might be the result of burning, grazing, mowing or flattening by snow. These areas are used by the birds as "booming" or courting grounds in the spring (Ammann, 1957; Hamerstrom *et al.,* 1957). The species of grass may not be as important as height, density, growth forms, spacing and growth rate (Hamerstrom *et al.,* 1957); however, Swope (1953) found that prairie chickens appeared to increase on western range land when grazing intensity was reduced and certain grasses increased. Mohler (1952) states that heavily grazed pastures were deficient in tall grass cover and litter and were avoided by prairie chickens.

Nests are most common in mixed vegetation rather than pure stands of grass with some preference being shown for areas with small clumps of brush (Bent, 1932; Hamerstrom, 1939).

Little is known about the relationship between brood behavior or movements and vegetational cover. The need for paths or travel lanes on the ground has been considered by Grange (1948), Baker (1953), Hamerstrom *et al.* (1957), and Hammond (1961). These workers concluded that dead grass or litter must not be too thick or dense and that clump-forming grasses provide optimum cover with bare areas between clumps being used for travel. Baker (1953) states that such bare areas are required for drying-off (sunning) when the grass is wet. Heavy litter may also act as a barrier to feeding (Grange, 1948).

Roosting and loafing habits were studied by Mohler (1952), who found that the birds preferred a dense cover of mixed native grasses with some stems over two feet high and with a dense understory of litter eight inches or more deep. In winter prairie chickens often roost in the snow (Monson, 1934; Bent, 1932) but Hamerstrom *et al.* (1957) found them to use stands of coarse sedges and grasses such as cattail and reed canary (*Phalaris arundinacea*) provided the vegetation is standing up through the snow. This type of vegetation is most common along pothole margins.

Although the diet of prairie chickens varies seasonally, by far the majority of the food is composed of seeds of wild and cultivated plants during the entire year (Martin *et al.,* 1951; Ammann, 1957; Mohler, 1952; and others). Buds and twigs of trees are utilized during the winter (Hamerstrom *et al.,* 1941; Schmidt, 1936). Adult birds may utilize large amounts of animal food at certain times or in certain localities depending upon availability. Young prairie chickens on the other hand are known to require a high proportion of animal food in their diet (Baker, 1953; Hamerstrom and Hamerstrom, 1957). Grasshoppers (Orthoptera) and beetles (Coleoptera) have been shown to be the most important components of the animal food in most parts of the range of the greater prairie chicken (Martin *et al.,* 1951; Baker, 1953; Judd, 1905).

Waterfowl.—Assuming adequate breeding populations, production of waterfowl in the prairies is related to the nature of shoreline cover and its influence on loafing spots and territories; to nesting cover; and to the movement of broods from the nest site to water and between water areas. Numerous studies have shown that breeding pairs are likely to be more abundant on ponds which have a medium amount of shoreline cover (Bue *et al.,* 1952; Glover, 1956; Kieth, 1961). This provides for easy accessibility of loafing spots and an unobstructed view. Bare, muddy shorelines and those solidly filled with emergents such as cattail and bulrush had fewer breeding pairs.

Relationships between nesting and vegetational cover have been reviewed recently by Kieth (1961). The amount and structure of the live and dead vegetation appears to be more important than its species nest and nest cover in many instances. Mallards (*Anas platyrhyncos* composition. Dead vegetation forms an important part of the actual *platyrhyncos*), pintails (*Anas acuta*) and other early nesting species make more extensive use of old vegetation than do those such as the lesser scaup (*Aythya affinis*) which nest later in the season.

Hammond (1961) has studied the effects of haying on waterfowl nesting and has concluded that fewer nests can be expected on mowed areas than on unmoved areas, assuming the location of the areas with respect to water is similar. Nest densities were often 3 to 4 times greater on unmowed than on adjacent mowed areas.

Burning generally removes nearly all of the cover from an area and consequently one would expect a minimum number of nests to be present. Pintails have been found nesting in sparse cover and on recent burns (Bent, 1923; Milonski, 1958; Kieth, 1961). Glover (1956) found three nests of blue-winged teal (*Anas discors*) in an area five weeks after burning in Iowa.

The effects of grazing have been observed by numerous workers who conclude that heavy grazing is detrimental to waterfowl nesting and that light grazing may be beneficial (Bennett, 1937; Bue *et al.*, 1952; Glover, 1956; Kieth, 1961). Data are not conclusive with regard to the effect of light grazing but in general these investigators seem to feel that it is not detrimental to duck nesting.

Duck broods may move long distances overland from the place of hatching to water and frequently make extensive movements between water areas (Evans *et al.*, 1952). Kieth (1961) and Mendall (1958) have reported loss of ducklings due to exposure during the first few days after hatching. It is not difficult to imagine ducklings only a few hours old dying from heat exhaustion or exposure to the sun while trying to travel through the dense litter present on the Control plots at Waubun Prairie.

Predators.—Some nest predators have been found to occur more commonly in certain habitat types. For example, Hammond (1940) found that skunks (*Mephitis mephitis*) were more active on mowed areas. Kieth (1961) and Bennett (1938) reported that skunks preferred hunting in heavy ungrazed cover. These observations appear contradictory except that the skunks may be using the mowed areas or areas of sparse vegetation as travel lanes while they move from one area of heavy cover to another. The presence of crows (*Corvus brachyrhychos*) in an area may be determined by the availability of aspen trees which are used as nest sites (Kieth, 1961).

RECOMMENDATIONS

The results of the present study and information obtained from the literature, as presented above, may be used to make certain recommendations for managing native prairie so as to guarantee its maintenance over a period of time.

The ideal management practice for areas such as Waubun Prairie would be a rotation system whereby approximately one-fourth of the area could be burned each year and where portions of the shoreline vegetation could be moderately grazed each year. This rotation should follow a four-year sequence: burn, no treatment, graze, no treatment. The system would be feasible if an area could be divided roughly into quarters, which would be fenced and provided with firebreaks.

In this study temporary measures of controlling fire and grazing were used. Firebreaks were mowed in late summer and backfires were started from them to widen the gap before the major fire was set to burn with the wind. Cattle were controlled by the use of an electric fence on temporarily installed wooden posts. Accurate cost records were not kept but the burning was done in two hours and utilized 11 man hours per 10-acre burn. There was no income from the grazing or mowing because of the experimental nature of the study. In many cases, where larger areas are being managed on a long-time program, some income from both grazing and mowing might be realized.

This type of rotation management would result in a habitat in which most of the cover requirements of prairie chickens and breeding waterfowl would be available on the same area within their seasonal home ranges. In addition the supply of insect food for young prairie chickens would be maintained at a high level.

If only one of the management methods can be utilized on a given area, spring burning appears to be the best. However, during the year following the burn, waterfowl and prairie chicken nesting will probably be at a minimum due to a lack of cover if the entire area is burned. The area will be suitable for these species during the succeeding three years. Insect food supplies will be adequate with this type of management as with the rotation system.

We do not think that annual grazing or even periodic grazing would be a suitable method in itself since light to moderate grazing will not control the invasion of woody species, and moderate to heavy grazing would be required to attain the desired effects on litter and shoreline vegetation. Grazing at this latter intensity could well result in destruction of certain components of prairie vegetation which are considered desirable.

Haying likewise would not be a suitable management tool because it would have virtually no effect on the shoreline vegetation, would result in lack of winter cover each year, would eliminate much nesting cover, and would not control existing thickets of woody species although it may prevent new invasion.

There is, of course, the possibility (not studied in this project) that herbicides could be used to control woody vegetation. However, this would not have any effect on the litter, grasses, or forbs. We believe that the use of herbicides would not result in maintaining the prairie in its optimum condition.

There is an exceedingly interesting philosophical point in connection with these conclusions. If one reviews the history of our prairies one can only conclude that from time immemorial they have been subjected to periods of drought (due to climate variations), repeated burning (due to natural causes and Indian activity) and repeated overgrazing at intervals (due to mass movements of the buffalo). This is the warp and woof of the environment in which the prairie chicken and prairie waterfowl evolved through time. They were found in tremendous numbers during settlement of the prairie. Is it startling then that fire and grazing are essential to maintaining their habitat?

SUMMARY

A field study to determine the effects of four treatments — spring burning, fall burning, grazing, and mowing — on the flora and fauna of native tall grass prairie was carried on at the Waubun Prairie Research Area in Mahnomen County, Minnesota, from 1957 to 1961. A total of 70 acres of relatively undisturbed native prairie was selected within the 640-acre tract. On five 10-acre plots mowing, grazing, or burning was carried out. Two plots were left untreated and used as controls.

The effects of the four treatments on litter, upland grasses and forbs, upland woody plants, and shoreline vegetation are discussed. The invasion of the prairie by aspen and willow and the effects of burning, grazing and mowing on this invasion are considered in detail.

Based on these data as well as published information on the ecology of both prairie chickens and breeding waterfowl, suggestions for management are made. In brief a four-year rotation of spring burn, no treatment, graze, and no treatment is recommended. We believe such a schedule will maintain the original status of prairie habitats in this ecotone between forest and grasslands.

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DISCUSSION

CHAIRMAN SCHULTZ: Thank you, John. If I am correct, I should mention that the details of this study are available in a publication by the Museum of Natural History, University of Minnesota.

MR. WILLIAM RUTHERFORD [Colorado]: John, does the one-shot removal of woody species, which seems to be the treatment most often applied—that is, burning or spraying with herbicides—actually promote rather than discourage the invasion of woody species?

DR. TESTER: I don't think the one-shot treatment promotes the invasion, and it would definitely not control the invasion unless it is operated on a rotation basis as recommended here. If one burns an area that is being subjected to an invasion by willows or aspen every four years, you will control it because you will kill off the big four-year-old trees. You will have new ones coming in, but if you burn again four years later they will not grow back. So one can maintain the prairie by this type of rotation, but definitely not with just one burning.

MR. RICHARD HUNT [Wisconsin]: I assume your chickens are resident on the area?

DR. TESTER: Yes, they are.

MR. HUNT: If you were not making these for the resident species, would you recommend a fall burn instead of a spring burn? My reason for this is that I suspect we have some early nesting mallards in some of our prairies in Wisconsin, and I think the fall burn would discourage this.

DR. TESTER: Dick, this would be the only benefit that I could see for fall burning. If the conditions are such that you can burn before the early nesting species gets started, I would still recommend the spring burn. I think there are numerous disadvantages to the fall burn, which I didn't mention, such as subjecting the soil to loss of moisture due to evaporation. When all the litter and vegetation are removed, the moisture in the soil will be pulled out in the wintertime. This wouldn't happen if you conducted a spring burn. Perhaps you'd have erosion problems in some cases, although not on a good prairie site.

MR. R. S. DRISCOLL [Oregon]: Have you evaluated the effects of spring burning on the vegetation composition or production?

DR. TESTER: Yes. Let me say that I am in the process of working with the data. A certain amount of it has been published in the Museum bulletin. I'll just mention that another publication will be coming out on the effects of these treatments on the individual plants in the area.

DR. DANIEL Q. THOMPSON [Wisconsin]: John, what was the picture in these potholes in pre-settlement days? Have you been able to gather any information on that?

DR. TESTER: In regard to what, Dan?

DR. THOMPSON: To willow and aspen invasion around potholes.

DR. TESTER: Oh, yes. I think one can safely say that this area has been subjected to invasion by woody species for hundreds and perhaps thousands of years, but that the invasion was controlled to a very large extent by wildfires which were set both by lightning and by the Indians. This is reasonably well documented in several papers by Dr. Murray Buell.

DR. THOMPSON: I would say that that is pretty much the picture on the Wisconsin marshes in regard to the invasion of willow.

TECHNICAL SESSIONS

Tuesday Morning—March 13

Chairman: RICHARD S. CROKER
Chief, Marine Resources Branch, California Department of Fish and Game, Sacramento, California

Discussion Leader: RICHARD H. MANVILLE
Director, Bird and Mammal Laboratories, Bureau of Sport Fisheries and Wildlife, Washington, D. C.

COASTAL AND MARINE RESOURCES

THE AVAILABILITY OF WATERFOWL FOODS IN COASTAL MARSH IMPOUNDMENTS IN LOUISIANA[1]

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AND ROBERT H. CHABRECK
Louisiana Wild Life and Fisheries Commission, Grand Chenier

Marsh impoundments along the Louisiana Coast have proven very valuable in waterfowl management. The impoundments are important because they provide a means of directly controlling the water level and salinity in the marsh areas and thus indirectly controlling the vegetation. Since adequate habitat for wintering waterfowl must provide not only a place of rest, but also an abundance of food, it was important to learn as much as possible about the ecology of plants in impoundments and the amount of food available for waterfowl consumption.

The Louisiana Wild Life and Fisheries Commission began an intensive waterfowl management program in the coastal area in 1954. As a part of this program impoundments were constructed on certain marsh

[1]A joint contribution of Louisiana State University School of Forestry and Wildlife Management, and Louisiana Wild Life and Fisheries Commission.

refuges. In 1956, nine impoundments were completed on Rockefeller Wildlife Refuge in southwestern Louisiana, encompassing a total of 18,200 acres.

Chabreck (1960) reported that a detailed ecological study, begun on these impoundments in 1958, revealed that good duck food producing plants made up 50 per cent of the vegetative composition within the impoundment as compared to only five per cent in the adjacent control areas.

Aerial inventories during the 1958-59 wintering season, by Morton M. Smith, waterfowl biologist of the Louisiana Wild Life and Fisheries Commission, showed the peak duck population on the Refuge to be 443,000 birds. Approximately 80 per cent of these were using the impoundments, while the remaining 20 per cent were seen in ponds, lakes, and flooded marshes outside the impounded areas.

In an effort to learn more about the food available to the large number of wintering waterfowl using the impoundments, a study was begun in October 1959, and marsh floor and vegetative samples were taken from two impoundments on the Refuge.

The objectives of the study were to determine the amounts of seeds on the marsh floor and the amount of available vegetative food other than seeds, before the fall arrival of waterfowl, during mid-winter, and immediately after their departure in the spring. Another phase of the study was to determine the depth at which seeds were found in the marsh floor.

DESCRIPTION OF THE AREA

Rockefeller Refuge lies in Cameron and Vermilion Parishes, Louisiana, and encompasses an area of 84,000 acres. The entire refuge consists of prairie marsh, capable of supporting low levees, and borders the Gulf of Mexico on the south and the Grand Chenier ridge complex on the north.

Marsh elevations average 1.1 feet above mean sea level. Tidewater enters the refuge from the Gulf of Mexico through five separate channels, then spreads out to all parts of the refuge outside the impounded areas. The average tidal variation is one foot; however high tides frequently inundate the marshes with salt water.

Construction of the two impoundments selected for sampling, Lake 3 and Lake 14, was begun in 1954 and completed in 1956. Lake 3 contained 3,700 acres and was managed as a permanently flooded, brackish water impoundment. Information obtained regarding water level and salinity in the study areas, showed that the water level in Lake 3 ranged from 6 to 14 inches in October and December, 1959, and March 1960. Salinities recorded in this impoundment during the sampling periods, expressed in parts per thousand, were: (1) 7.3 in October 1959; (2) 7.2 in December 1959; and (3) 4.9 in March 1960. This area is usually covered with water, but late in the summer of 1960, unusually dry conditions existed and very high salinity readings of over 10.5 parts per thousand were recorded.

Lake 14 contained 2,400 acres and was managed as a manipulated water level impoundment. This area was drained in the spring of 1959 to encourage the growth of wild millet (*Echinochloa walteri*). Lake 14 falls within the brackish water classification; however, after draining in spring followed by periods of heavy rainfall, the salt content was low enough to place the marsh in the fresh water group of that period. The water level during the study periods ranged from 2 to 6 inches. Salinity, expressed in parts per thousand, was: 3.8 in October 1959; 1.7 in December 1959; and 1.6 in March 1960.

Dominant vegetation in Lake 3 during this study consisted of the more salt tolerant species. Wire grass (*Spartania patens*) made up 51.1 per cent; widgeon grass (*Ruppia maratima*), 41.5; salt grass (*Distichlis spicata*), 4.7; while other plants made up the remaining 3.7 per cent of the vegetative composition of this impoundment. Of the plants present, widgeongrass was the most common waterfowl food producing plant in this area.

Dominant vegetation in Lake 14 during sampling periods was wild millet, wire grass, and sprangletop (*Leptochloa fascicларis*), making up 41.5, 23.3 and 11.8 per cent of the vegetation composition, respectively. Millet was the most abundant waterfowl food producing plant in this area during the study.

STUDY PROCEDURE

The dates of the sampling periods were as follows: (1) October 12-13, prior to the arrival of most waterfowl at the Refuge; (2) December 18-21, while waterfowl were in the areas; and (3) March 5-8, immediately after departure of most waterfowl. Marsh floor samples were collected from both lakes while vegetative samples were taken only from Lake 3. A total of 126 marsh floor samples and 24 vegetative samples were collected.

Sampling Devices:

At the time of sampling the depth of water in the lakes ranged from 2 to 4 inches. The marsh soil was saturated and almost fluid. A sampling device was needed to remove a core 6-inch in diameter and 10-inch in depth with as little disturbance as possible to the contents.

A sampler was constructed of 6-inch (inside diameter) aluminum irrigation pipe, with walls one-eight inch thick. To facilitate insertion of the pipe into the marsh floor, the lower end of the pipe was sawed at an angle and a handle attached. The length of the pipe at the longest point was 30 inches. A plug was placed in the pipe at a depth that would yield a 10-inch sample. A spade was made that could be inserted into a slot at the bottom of the pipe; thus providing a method of cutting off the sample and at the same time holding the contents in the pipe upon removal from the marsh floor.

The vegetative samples were collected with the aid of a one-foot square quadrant, two inches deep and sharpened to a cutting edge on the bottom by an outside bevel.

Field Procedure:

At the time of the first sampling period in October, parallel lines were established in both lakes and marked off with stakes. Sampling points were not marked; therefore, while samples were collected on the lines each time, the actual points were different.

Samples were collected systematically along these lines, after the first point on each line was established by random selection. A marsh buggy, used for transportation while taking all samples, also provided a method of measuring uniform distances between sampling points. Each revolution of the buggy track covered 33 feet (one-half chain); thus, by attaching a piece of rope to the track as a sighting point, the revolutions were counted and uniform sampling points set up.

Four sampling lines were established in Lake 14 and five marsh floor samples were taken 7 chains apart on each line during each of the three sampling periods. Twenty marsh floor samples were extracted at each sampling period from Lake 14, yielding a total of 60 in all.

In collecting marsh floor samples, the biologist would leave the marsh buggy and insert the sampler into the soil to the point indicated by the gauge. Then he reached down the sampler, located the slot, inserted the spade, and cut off the sample. The sampler was then removed from the marsh floor, a 6-inch by 18-inch plastic bag held under the lower end of the pipe and the spade removed, allowing the contents to slide into the bag.

Vegetative samples were collected at every third point in Lake 3, at a distance of 21 chains apart. Three samples were collected on each of the two lines each period, yielding a total of 18 vegetative samples upon completion.

In collecting the vegetative samples, the one-foot square quadrant was firmly imbedded in the marsh floor and all stems and other vegetative matter contained therein pulled from the floor manually.

As it was collected, each sample was placed in a plastic bag and a tag attached bearing the name of the lake and the sample number.

Laboratory Procedure:

The marsh floor samples were either processed within a few days or placed in cold storage. Those which were to be cut into sections were frozen and stored at 10° F while those that were analyzed whole were stored at 35° F.

Each sample, or part of a sample, was washed under a water faucet through a series of four screens with mesh sizes varying from two to 32 meshes per square inch. The material retained by the screens was placed on labeled paper toweling and dried for 24 hours in an oven.

During drying, the samples became compacted; therefore, it was necessary to rub them briskly to break the debris from the seed. Processing was continued by shifting them through a series of six graded sieves with meshes ranging from 0.787 to .0098 inches. A South Dakota Seed Blower was used to separate the light chaff from the seeds.

The final separation of seed from the samples was done by hand with the aid of forceps and a flourescent-lighted magnifier. This phase of the separation required approximately four hours per sample. Seeds were sorted according to species, and placed in a small coin envelope, marked with the sample number and the name of the species.

The 14 frozen samples were cut into 2-inch sections and each section processed as previously described.

Vegetative samples were washed, manually separated according to species, and placed in paper bags to dry at room temperature for two weeks. When dry, each species was weighed and the results expressed in pounds per acre.

DISCUSSION AND CONCLUSIONS

Seeds from 22 species, comprising 11 plant families, occurred in the marsh floor samples. The families and their associated species were ranked in order of abundance (Table 1), based on 120 samples, each of which covered a 6-inch circular area to a 10-inch depth. Also shown were the pounds per acre of each species occurring each sampling period in Lake 3 and Lake 14. When seeds of a species amounted to less than 0.01 pounds per acre, a "T" denoting trace occurrence was shown.

Based on pounds of seeds per acre (Table 1) and frequency of occurrence (Table 2), seeds from six plant species were considered of major importance as waterfowl food in the study areas. They were saw grass (*Cladium jamaicense*), bullwhip (*Scirpus californicus*), cyperus (*Cyperus* sp.), millet, dodder (*Cuscuta* sp.), and widgeon-grass. All of these species occurred in both impoundments and in over 50 per cent of the samples.

TABLE 1. PLANT SPECIES[1] AND POUNDS OF SEEDS PER ACRE BY SAMPLING PERIODS ON LAKES 3 AND 14

	Lake 3			Lake 14		
	1959	1959	1960	1959	1959	1960
Classification	October	December	March	October	December	March
Cyperaceae						
Cladium jamaicense	227.95	305.31	161.37	343.28	334.41	330.27
Scirpus californicus	333.39	423.15	474.72	55.09	67.43	74.19
Scirpus robustus	1.39	4.02	.62	.41	.35	.98
Cyperus odoratus	4.45	2.44	2.60	107.34	17.06	19.46
Eleocharis parvula	T[2]	T	T	T	T	T
Carex sp.	T	T	T	T	T	T
Gramineae						
Echinochloa walteri	1.24	.29	.06	12.80	22.35	11.42
Setaria magna	.11	.87	....	.71	1.03	....
Leptochloa fascicularis	.07	.05	.01	.13	1.73	1.36
Distichlis spicata	....	T	T	T	....	....
Panicum dichotomiflorum	....	....	....	T	T	....
Brachiaria platyphylla	....	....	....	T	T	....
Zosteraceae						
Ruppia maritima	4.73	6.59	2.40	.75	.04	.33
Convolvulaceae						
Cuscuta sp.	.03	23.08	16.38	6.07	....	.14
Polygonaceae						
Polygonum sp.	T	T	....	T	T	T
Alismaceae						
Sagittaria lancifolia	T	....	....	T	T	T
Geraniaceae						
Geranium sp.	....	....	....	T	....	....
Leguminosae						
Desmondium purpurea	....	....	T	....	....	....
Sesbania exaltata	T	T	T	....	T	T
Aquifoliaceae						
Ilex decidua	....	....	....	....	T	....
Compositae						
Sonchus sp.	....	....	....	T	....	....
Amaranthaceae						
Amaranthus spp.	T	T	T	T	T	T
Total	573.36	765.80	658.16	526.58	444.40	438.15

[1]All plant names from Fernald (1950).
[2]Refers to trace or less than 0.01 pound per acre.

Average Pounds of Seeds Per Acre

Inasmuch as samples were collected in a dense stand of widgeongrass in Lake 3 and in a dense stand of millet in Lake 14, a high seed yield of these species was anticipated. Singleton (1951) stated in his study on production and utilization of waterfowl food plants on the east Texas Gulf Coast that wild millet showed a yield of 813.3 pounds of seed per acre. However, the average pounds of millet per acre occurring in the soil in Lake 14 was 15.5, ranking this species fourth

TABLE 2. PERCENTAGE OF OCCURRENCE AND AVERAGE POUNDS PER ACRE OF SEEDS OF MAJOR WATERFOWL FOOD SPECIES IN LAKES 3 AND 14 BASED ON 120 SAMPLES

		Pounds per Acre	
Species	Percentage of Occurrence	Lake 3	Lake 14
Sawgrass	100.0	231.57	335.98
Bullwhip	98.4	410.42	65.57
Cyperus	87.3	3.16	49.95
Millet	66.6	.53	15.32
Dodder	55.8	13.16	2.07
Widgeongrass	57.9	4.57	.37

(Table 2) among the major waterfowl foods. In Lake 3, widgeonsgrass seeds averaged 4.6 pounds per acre and ranked fourth among major species in that impoundment.

Vegetative surveys conducted on the Refuge showed that in the summer of 1958, widgeongrass made up only 0.1 per cent of the vegetative composition of Lake 3, while by the summer of 1959 it made up 41.5 per cent. The fact that widgeongrass spreads rapidly from rhizomes may account for the dense stands appearing in this area in which seeds did not occur in large amounts.

The surveys showed that millet made up over 40 per cent of the total vegetation in Lake 14 and in 1958 and 1959; thus the situation that applied to widgeongrass in Lake 3 does not apply here. Factors that may have influenced the amounts of millet seeds present were: (1) Millet seeds were observed floating on the top of the water at sampling periods and may therefore have been widely dispersed by wave and wind action before they finally sank to the marsh floor. (2) Singleton stated that in plots where millet completed with salt grass (*Distichlis spicata*), low seed yields occurred in spite of the good growth of millet in the area. While salt grass did not appear in large amounts in Lake 14, wire grass and other species were competing with wild millet. (3) Collection of millet seed in a nearby marsh revealed that many of the large heads failed to produce seed in what appeared to be an excellent stand. The low production may have been caused by a drought during the critical growing period. Further study to determine the factors that influence seed production in millet seems advisable.

Sawgrass and bullwhip seeds occurred in far larger amounts than did seeds of other species. Average pounds of major seed species per acre were determined (Table 2) by considering samples for the three periods collectively. In Lake 3, the average pounds of sawgrass per acre was 231.6 and bullwhip, 410.4; in Lake 14, sawgrass averaged 336.0 and bullwhip, 65.6 pounds per acre.

According to the personnel at the Refuge, neither bullwhip nor sawgrass has occurred in dense stands in these areas for approximately 10 years. In view of this fact, the amounts of these seeds was exceptionally high.

Ensminger and Nichols (1957) stated that large stands of sawgrass and bullwhip on the Refuge were salted out by intrusion of salt water into the marshes. Studies by Kimble (1958) and Chamberlain (1959) showed that sawgrass was the seed species most commonly found in the gizzards of ducks in the Grand Chenier area. Both authors mentioned that dense stands of sawgrass had occurred in the past in this area and expressed the belief that many birds had probably been feeding in areas that were formerly predominantly sawgrass marshes.

Since both sawgrass and bullwhip have hard seed coats, they deteriorate slowly and remain on the marsh floor for an extended time. This undoubtedly accounts for the appearance of these seeds in duck gizzards analyzed by Chamberlain and Kimble and in the marsh floor samples of this study.

In Lake 14, cyperus seeds averaged 50.0 pounds per acre (Table 2) and ranked third among major species in the area. Dodder seeds, ranked third in abundance in Lake 3, averaged 13.2 pounds per acre. The surveys at the Refuge showed that cyperus made up less than 5.0 per cent of the vegetative composition in the area. Dense stands of dodder were observed on the impoundment levees and from there out into the impoundment for short distances. However, this species was seldom seen elsewhere in the impoundments.

According to the Refuge survey, wiregrass made up over 50 per cent of the vegetation in Lake 3 and over 20 per cent in Lake 14 during 1959 and 1960. Seeds of this species did not appear in the samples from either lake, probably because this plant seldom produces viable seeds on wet sites, but spreads from rhizomes.

In view of the vegetative composition of the impoundments shown in the surveys and the results of this study, there appeared to be little relationship between the vegetative composition of the areas studied and the species and amounts of seeds available in the soil at the dates samples were collected.

It is, therefore, recommended that in evaluating any marsh area for waterfowl that a full knowledge be gained as to the recent history of vegetation in the area. Only then can a complete and accurate evaluation be made of the area for waterfowl.

Seasonal Amounts of Seeds Available:

As shown in Table 1 a general decline was noted throughout the wintering season in the seeds of most species; however, several exceptions were noted. Some species had more seeds available in December than in October. This probably resulted from the fact that many of the seeds, though mature, had not yet fallen to the marsh floor when sampled in October.

Bullwhip showed a gradual increase throughout the wintering season. A small amount of bullwhip was growing in the study area, however, the increase probably resulted from insufficient coverage in sampling. Since marsh vegetation often grows in isolated stands, seeds may occur in irregular amounts in the soil. Greater accuracy may have been obtained by taking more samples and decreasing the size of individual samples to two inches in diameter. One sample, six inches in diameter, collected in Lake 14 in October contained 21,860 cyperus seeds, thus greatly influencing the pounds per acre of that species during the period.

Since both impoundments supported tremendous numbers of ducks throughout the winter and the amount of seeds available decreased during the winter, it was assumed that most of the seeds removed were eaten by ducks. Although approximately 100 pounds of seed per acre were removed from both areas, this amounted to less than 20 per cent of the seeds available.

Widgeongrass samples demonstrated the greatest mean difference between periods of any of the species found in the samples. Even so, analysis of variance of the difference between and within periods failed to reveal any significant difference at the 5 per cent level. Therefore, no analysis of variance was attempted on the number of seeds of the remaining species.

Vertical Distribution of Seeds in the Soil:

One of the major objectives of this study was to determine the depths at which seeds occurred in the soil. Determining the vertical distribution of seeds was considered important not only from the standpoint of availability for waterfowl utilization, but also to learn the possible effects of fire in the area.

Results of this portion of the study (Table 3) showed that all major species occurred at each of the depths sampled: 0-2, 2-4, 4-6, 6-8, and 8-10 inches from the surface. The highest precentage of millet, widgeongrass, and cyperus seeds were found in the 0 to 2-inch level; while highest percentages of bullwhip, sawgrass, and dodder seeds appeared at the 2 to 4-inch level.

Sawgrass and bullwhip seeds occurred in fairly large amounts at the lower levels. The heavier weight of these seeds as compared to those of other appearing in these areas, may partially account for their appearance in large amounts at lower depths. These seeds do not deteriorate rapidly, but accumulate in the soil over a period of time; this, too, could account for their appearance in large amounts at the lower levels. Since the marsh soils contain large amounts of undecomposed particles of vegetation, the soil is not tightly compacted. Shifting of the upper soil layer during wave action may permit the heavier seeds to settle deeply. Hurricanes are known to tear up the marsh floor. Grubbing by geese and burrowing by muskrats may also permit heavier seeds to penetrate more deeply into the marsh floor.

Seeds in the top few inches of the soil would be more readily utilized by waterfowl. However, Bellrose (1959) reported ducks puddling out pockets in the marsh soil while feeding, thus utilizing seeds beneath the surface.

TABLE 3. AMOUNT AND DEPTH OF SEEDS IN LAKES 3 AND 14[1]

Depth (Inches)	Sawgrass		Bullwhip		Millet		Widgeongrass		Cyperus		Dodder	
	Pounds per acre	Per cent	Pounds per acre	Per cent	Pounds per acre	Per cent	Pounds per acre	Per cent	Pounds per acre	Per cent	Pounds per acre	Per cent
0- 2	114.98	36.1	41.43	26.5	3.86	68.2	1.96	63.9	13.53	70.3	.14	19.4
2- 4	117.37	36.9	55.73	35.6	2.05	15.8	.65	21.2	3.80	19.7	.32	44.5
4- 6	38.85	12.1	28.75	18.4	1.25	9.7	.20	6.5	1.25	6.5	.24	33.3
6- 8	33.87	10.6	18.79	12.0	.44	3.4	.08	2.6	.31	1.6	.01	1.4
8-10	13.68	4.3	11.81	7.5	.38	2.9	.18	5.8	.36	1.9	.01	1.4
Total	318.43		156.51		12.98		3.07		19.25		.72	

[1]Based on 14 marsh floor samples.

TABLE 4. AVERAGE POUNDS PER ACRE OF MAJOR WATERFOWL FOOD SPECIES AT DEPTHS OF 0-10 AND 0.4 INCHES AND PERCENTAGE OF EACH AT 0-4 INCHES

Species	Average Pounds 0-10 inches	Average Pounds 0-4 inches	Percentage 0-4 inches
Sawgrass	283.76	176.21	62.1
Bullwhip	237.99	173.73	73.0
Cyperus	25.56	23.00	90.0
Millet	8.03	6.74	84.0
Dodder	7.61	4.86	63.9
Widgeongrass	2.47	2.10	85.1

In order to determine amounts of seeds of major species more readily available for waterfowl utilization, the pounds of each per acre within the top four inches of the soil (Table 4) was determined. Sawgrass seeds averaged 176.2, bullwhip, 173.7, and cyperus 23.0 pounds per acre. Pounds per acre of millet, dodder, and widgeongrass were 6.7, 4.9, and 2.1, respectively.

Widgeongrass and Spike-Rush Vegetation:

Pounds of widgeonsgrass and dwarf spike-rush vegetation per acre occurring each period in Lake 3 were determined. These results were based on 18 samples at air dry weights. Pounds of each per acre before the arrival of waterfowl were: widgeongrass, 175.8; and dwarf spike-rush, 138.7. By the second period at mid-winter, widgeongrass had decreased to 28.5 pounds per acre, and no dwarf spike-rush was found in the samples. In the third period, during March 1960, no widgeongrass occurred; while 29.4 pounds of dwarf spike-rush was found per acre.

Results showed a consistent decrease in the amount of widgeongrass from period to period. Dwarf spike-rush disappeared entirely from samples in the second period then reappeared by the third period, apparently resulting from the rapid growth of this species during the early spring.

The reduction in these plants was attributed primarily to waterfowl usage. Not only were birds observed feeding in the area, but the discarded remains of both species were seen uprooted and floating on the water. On the leeward shores the debries often piled up four inches deep and 20 feet wide. Neely (1960) stated dwarf spike-rush is a favorite food of ducks and that they pull it up, eat the roots and leave the tops to float on the surface of the water.

Animal Material:

According to Kimble (1958), analyzation of duck gizzards showed that snails ranked sixth among all foods eaten by ducks and were second in importance among the animal foods.

The presence of large numbers of snails (*Littoridinops* sp.) was noted in the samples, but because of their thin shells, many were broken in the washing and separating processes. Figures indicating quantities present would therefore not be accurate.

SUMMARY

The purpose of this study was to determine the amounts of food available for wintering waterfowl in two impoundments, Lakes 3 and 14 on Rockefeller Refuge in southwestern Louisiana.

This was accomplished by collecting a total of 120 marsh floor samples and 18 vegetative samples from the two impoundments and analyzing the contents.

The results showed that seeds from 22 species comprising 11 plant families occurred in the marsh floor samples. Based on pounds per acre and frequently of occurrence in samples, the seeds present in greatest amounts were: sawgrass, bullwhip, cyperus, millet, dodder, and widgeongrass.

Bullwhip and sawgrass seeds occurred in larger amounts in both impoundments than did seeds of the other major species. Bullwhip seeds amounted to 410.4 pounds per acre in Lake 3 and 65.5 pounds per acre in Lake 14. Sawgrass seeds amounted to 231.6 pounds per acre in Lake 3 and 335.9 pounds in Lake 14. Since neither of these plants has occurred in dense stands in either area for several years, the seeds had probably remained dormant in the soil. Seeds of these species were found in great amounts as deep as 8 inches in the soil.

Although samples were collected in a dense stand of widgeongrass in Lake 3 and in a dense stand of millet in Lake 14, the amount of seeds of these species were surprisingly low. Widgeongrass seeds averaged 4.6 pounds per acre in Lake 3, while millet seeds averaged 15.5 pounds per acre in Lake 14.

There was little relationship between the vegetative stand composition on the areas at the time of sampling and the seeds that were available in the soil.

A general decline was noted throughout the wintering season in the seeds of most species; but several exceptions were noted. Since both impoundments supported tremendous numbers of ducks throughout the winter, it was assumed that the seeds were eaten by ducks. Although approximately 100 pounds of seeds per acre were removed, this amounted to less than 20 per cent of the seeds available.

Over 70 per cent of the seeds of major species occurred within the top four inches of the soil; however, all species of major importance were found as deep as ten inches.

Results of vegetative samples showed a considerable decrease in widgeongrass from October to March. This was attributed primarily to waterfowl usage, since many birds were observed feeding in the area

and the discarded remains of this plant seen uprooted and floating on the water.

ACKNOWLEDGMENTS

The writers gratefully acknowledge the efforts of Dr. Leslie L. Glasgow, Dr. Bryant A. Bateman and Dr. Robert J. Muncy of the L.S.U. School of Forestry for many helpful suggestions and assistance during the field work and in preparation of the manuscript.

Special thanks also to Mr. Neil Hotchkiss and Mr. F. M. Uhler, Patuxent Wildlife Research Center, for identification of seeds and to personnel at Rockefeller Refuge for valuable assistance in collecting field data.

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DISCUSSION

DISCUSSION LEADER MANVILLE: Mr. Chabreck has considered some interesting techniques, some very revealing basic information on waterfowl food. We will now throw open his paper for your discussion.

MR. VERNE DAVISON: Mr. Chabreck, you didn't give the figures on the decline of the sawgrass seed and the bullwhip seed from October. Is there still lots of that?

MR. CHABRECK: Yes, sir. For the sake of time I didn't go through all of those, but it averaged about 400 for the bullwhip, but there was a progressive decline of sawgrass. The bullwhip showed an increase in the second period but a decrease in thet final marsh sample.

MR. JOHNSON: In the printed version of Mr. Chabreck's paper, he made passing reference to fires. Personally, I am interested as to the state of fires in these marsh lands and their effect on the waterfowl food.

MR. CHABRECK: We believe that fires are actually beneficial in the marsh. In fact, we have found numerous examples to substantiate this, but, of course, the main factor depends on the season that you burn. Burning during midwinter after all annual grasses have lodged would be probably beneficial to waterfowl and make more of the seeds available. Much, of course, depends on the water level. If you burn with the marsh too dry, you run the risk of soil fire. But fire has proven very valuable in the maintenance of goose range, particularly for the blue and snow goose.

CANADA GEESE OF COASTAL ALASKA

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The Canada geese are a complex group and frequently a taxonomic enigma. Nowhere throughout their range have they puzzled taxonomists more than in Alaska. Through systematic banding, collecting and extensive field studies since 1948 the relationship of various subspecies to each other is now being clarified. Eventually we might hope for agreement among taxonomists on both the number of subspecies and a reasonable delineation of their breeding ranges.

The A.O.U. Checklist (1957) shows nine living and one extinct subspecies of ***Branta canadensis,*** whereas Delacour (1951) recognizes 10 living and two extinct subspecies. His designation of ***B.c. taverneri*** for western and central Alaska has not yet been accepted by the A.O.U., although two new subspecies, ***B.c. maxima*** and ***B.c. fulva,*** were accepted. Peters (1931) lumped all the large, dark geese breeding along the Pacific coast from Cook Inlet, Alaska, south through Vancouver Island as White-cheeked Canada geese, ***B.c. occidentalis,*** with the type specimen collected at Port Townsend, Washington, more than a century ago. This subspecies was split in Delacour's revision with the type specimen for ***B.c. fulva*** collected at Graham Island, Queen Charlotte Islands, British Columbia, in 1917.

Although there is agreement on the validity of two subspecies for this group of very similar geese, there is little accord on vernacular names and some confusion concerning distribution. Gabrielson and Lincoln (1959) refer to them as the White-cheeked (Western) Canada Goose, ***B.c. occidentalis,*** and the Queen Charlotte Canada Goose, ***B.c. fulva.*** Delacour (1954) refers to them, respectively, as the Dusky Canada Goose and the Vancouver Canada Goose. For the sake of both clarity and brevity they will be referred to in this narrative simply as *fulva* and *occidentalis.* Nesting studies and associated banding and specimens recently collected now yield facts on which to delineate more clearly their respective distribution and migration patterns.

Basic to this study are 1,129 recoveries from 3,943 *occidentalis* banded on the Copper River Delta between 1951 and 1960 (Table 1) and 164 recoveries from 3,593 *fulva* banded in and near Glacier Bay between 1956 and 1960 (Table 2). A detailed production study on the Copper River Delta in 1959 by Charles Trainer and Peter Shepherd and summarized by Hansen (1961) is also basic to this report.

DISTRIBUTION AND MIGRATION

Recovery of banded birds demonstrates very clearly that *occidentalis* and *fulva* are different populations. Their ranges are separate

TABLE 1. SUMMARY OF 3,943 WESTERN CANADA GEESE BANDED ON THE COPPER RIVER DELTA, ALASKA, SHOWING AREA OF RECOVERIES
(Parenthetical Number Is Percentage of Bands Returned in That Year)

Area of Recovery	Number of bands recovered 1952	1953	1954	1955	1956	1957	1958	1959	1960	Total
Local[1]	5(14.3)	8(7.2)	20(9.8)	6(6.3)	4(4.2)	9(5.0)	5(3.5)	13(9.9)	7(5.0)	77(6.8)
Southeast Alaska	1(2.9)	1(0.9)	1(0.5)				1(0.7)			4(0.3)
Queen Charlotte Is., B. C.		4(3.6)	4(1.9)	2(2.0)	6(6.9)	10(5.6)	9(6.4)	6(4.6)	5(3.6)	46(4.1)
Vancouver Is., B. C.	1(2.9)	24(21.6)	10(4.9)	4(4.1)	16(17.8)	29(16.2)	13(9.2)	20(15.3)	20(14.3)	137(12.1)
Washington Coast	2(5.6)	9(8.1)	37(18.1)	8(8.2)	8(8.9)	15(8.7)	15(10.5)	7(5.3)	25(17.8)	126(11.2)
Oregon Coast		1(0.9)	1(0.5)	1(1.1)	1(1.1)	2(1.2)	2(1.4)	2(1.5)	1(0.7)	11(1.0)
Columbia River		3(2.7)	4(1.9)	4(4.1)	3(3.3)	6(3.6)	5(3.5)	4(3.1)	6(3.3)	35(3.1)
Willamette Valley	26(74.3)	61(55.0)	126(61.8)	72(74.2)	51(56.7)	107(59.8)	91(64.1)	78(59.5)	75(53.6)	687(60.9)
California			1(0.5)		1 (1.1)	1(0.6)		1(0.8)		4(0.3)
South Dakota							1(0.7)		1(0.7)	2(0.1)
Total	35	111	204	97	90	179	142	131	140	1,129

[1]A local return is a bird taken within 100 miles of the banding site.

TABLE 2. SUMMARY OF 3,593 QUEEN CHARLOTTE CANADA GEESE BANDED IN SOUTHEAST ALASKA SHOWING AREA OF RECOVERIES
(Parenthetical Number Is Percentage of Bands Returned in That Year)

	Number of bands recovered					
Area of Recovery	1956	1957	1958	1959	1960	Total
Local[1]	6(54.5)	10(55.6)	14(48.3)	35(76.1)	42(70.0)	107(65.2)
Remainder of SE Alaska		2(11.1)	9(31.0)	9(19.5)	10(16.7)	30(18.4)
Washington Coast	1(9.1)			1(2.2)		2(1.2)
Oregon Coast	1(9.1)					1(0.6)
Columbia River					1(1.6)	1(0.6)
Willamette Valley	3(27.3)	6(33.3)	6(20.7)	1(2.2)	7(11.7)	23(14.0)
Total	11	18	29	46	60	164

[1]A local return is a bird taken within 100 miles of the banding site.

and distinct except for a minor segment of the latter subspecies which extends into the winter territory of *occidentalis.* As with Canada geese elsewhere, there appears to be "grouping" within each subspecies. That is, discrete aggregations have been identified whose migratory pattern differs in time and distance from the major portion of the subspecies. Hanson and Smith (1950) demonstrated this for *B.c. interior* from the James Bay Region. The recognition of discrete populations of *B.c. moffittii* determined from band recoveries has been of major importance in establishing special restrictive Canada goose regulations in the Pacific Flyway for several years.

Breeding Range—The breeding range of *B.c. occidentalis* extends along the coast from the vicinity of Bering Glacier on the southeast to Cook Inlet on the west, a distance of about 275 air miles. The population reaches its greatest abundance on the Copper River Delta where densities of 108 nests per square mile have been found in the optimum area. In Prince William Sound and on the lower Susitna River at the head of Cook Inlet these geese breed only in small numbers and are much more solitary in their nesting habits although a lot of nonbreeding geese wander this far west. A few geese nest near the confluence of the Bremner with the Copper River about 50 miles from the coast, and a few isolated pairs can be found about the same distance inland on the Susitna River drainage. Breeding adults and bright, downy young have recently been collected at both the eastern and western extremities of this range and in each case they have been identified as *B.c. occidentalis.* How far their breeding range extends down the west coast of Cook Inlet and the Alaska Peninsula is problematical. A small flock of Canada geese has been reported several times in July by one of the Fish and Wildlife Service pilots at Kameshak Bay, about 200 miles southwest of the lower Susitna River. These appeared to be flightless birds, probably subadult nonbreeders which had wandered beyond their natal area as Canada geese have been found to do elsewhere. There have been no positive nesting records this far down the Alaska Peninsula, although Delacour (1951) describes three specimens, which approach *B.c. leucopareia* in color and conformation, taken at Pavlov Bay (400 miles southwest of Kameshak Bay), indicating "an intergradation with *occidentalis.*" He also mentions specimens taken 30 miles inland on the Copper River which show integradation with *B.c. taverneri.* If the latter, in particular, are indeed true intergrades, they very likely are progeny of an aberrant wanderer from the interior which mated with an *occidentalis* near the coast. In seven summers of intensive aerial surveys I have observed no geese between the Tanana River on the north and the breeding range of *occidentalis* 50 miles inland on the Copper River, a distance of about 150 miles intersected by one of the highest and most rugged mountain ranges on the continent. Delacour gives no indication in either case of the date or circumstances under which these intergrade specimens were collected. They could have all been the product of one mating if they were collected in the same area at the same time or their departure from the average could represent morphometric variation. The physiography of the country and long distances between known nesting populations today indicate as unlikely the overlapping of breeding range between *occidentalis* and any interior subspecies other than an accidental occurrence.

The breeding range of *B.c. fulva* appears to terminate at Cross Sound near Glacier Bay on the northwest about 300 miles southeast of the breeding terminus for *occidentalis.* Although nonbreeding geese utilize a few of the bays near Yakutat to complete their moult, some of the guides and hunters from this village insist that broods have not been found on this long expanse of glaciated coast line. There are a few other guide reports to the contrary but they have not been verified. On both the islands and mainland of the Alexander archipelago south of Cross Sound and Lynn Canal, *B.c. fulva* nests in a more or less solitary fashion. There are very few bays and meadows where as many as 50 downy young geese can be found in a group. Most are single family units or in aggregations of from two to four or five broods. The breeding range of *fulva* terminates on the south in the vicinity of Dixon or possibly into British Columbia. The likelihood of an overlap in range and intergradation of *fulva* with *B.c. moffitti* is as remote as the possibility between *occidentalis* and *taverneri* farther north, and for the same reason, physiographical isolation.

Migratory Pattern and Winter Range—Geese start to leave the Copper Delta by late September and their exodus is complete by the end of October. These geese by-pass coastal Alaska almost completely after departing the Copper Delta. Only four bands have been recovered from *occidentalis* in Alaska south of their nesting area, one each from Yakutat and Sitka and two from near Craig. Their first stop-

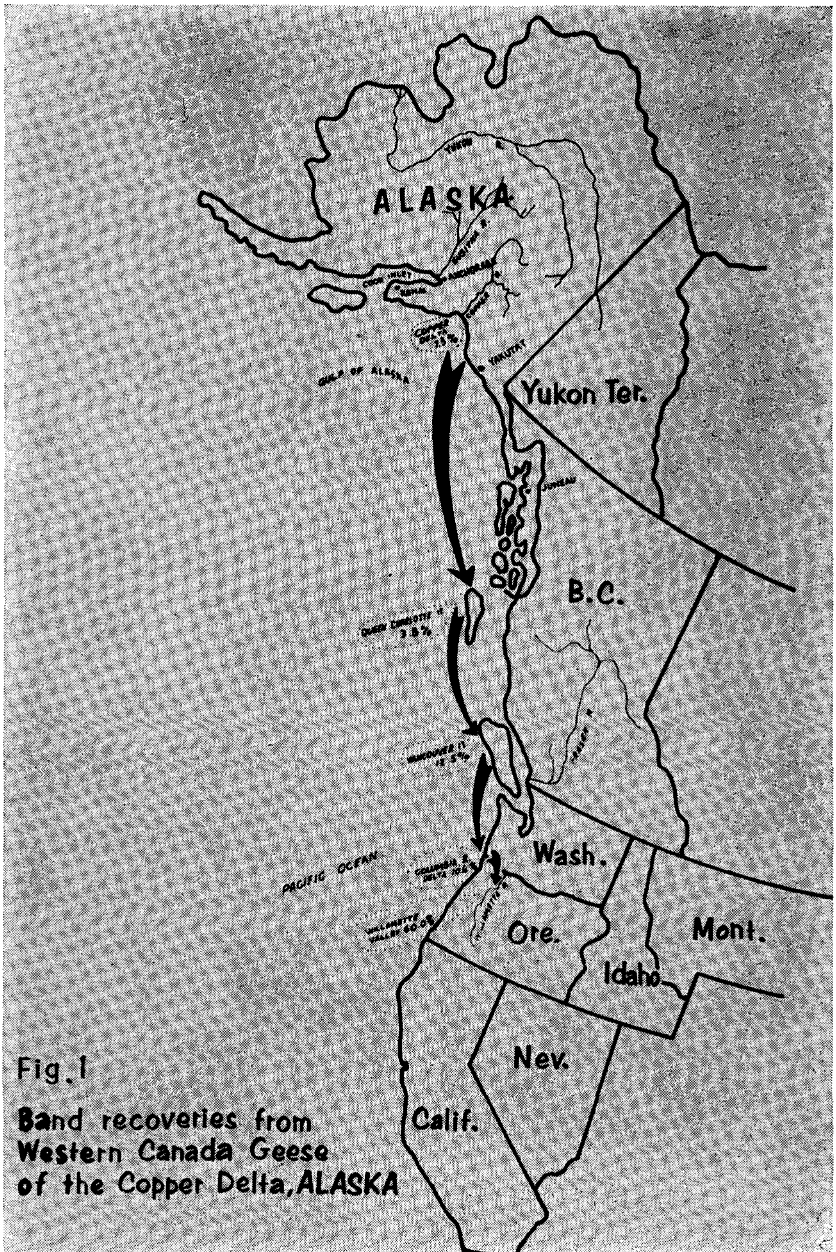

Fig. 1
Band recoveries from Western Canada Geese of the Copper Delta, ALASKA

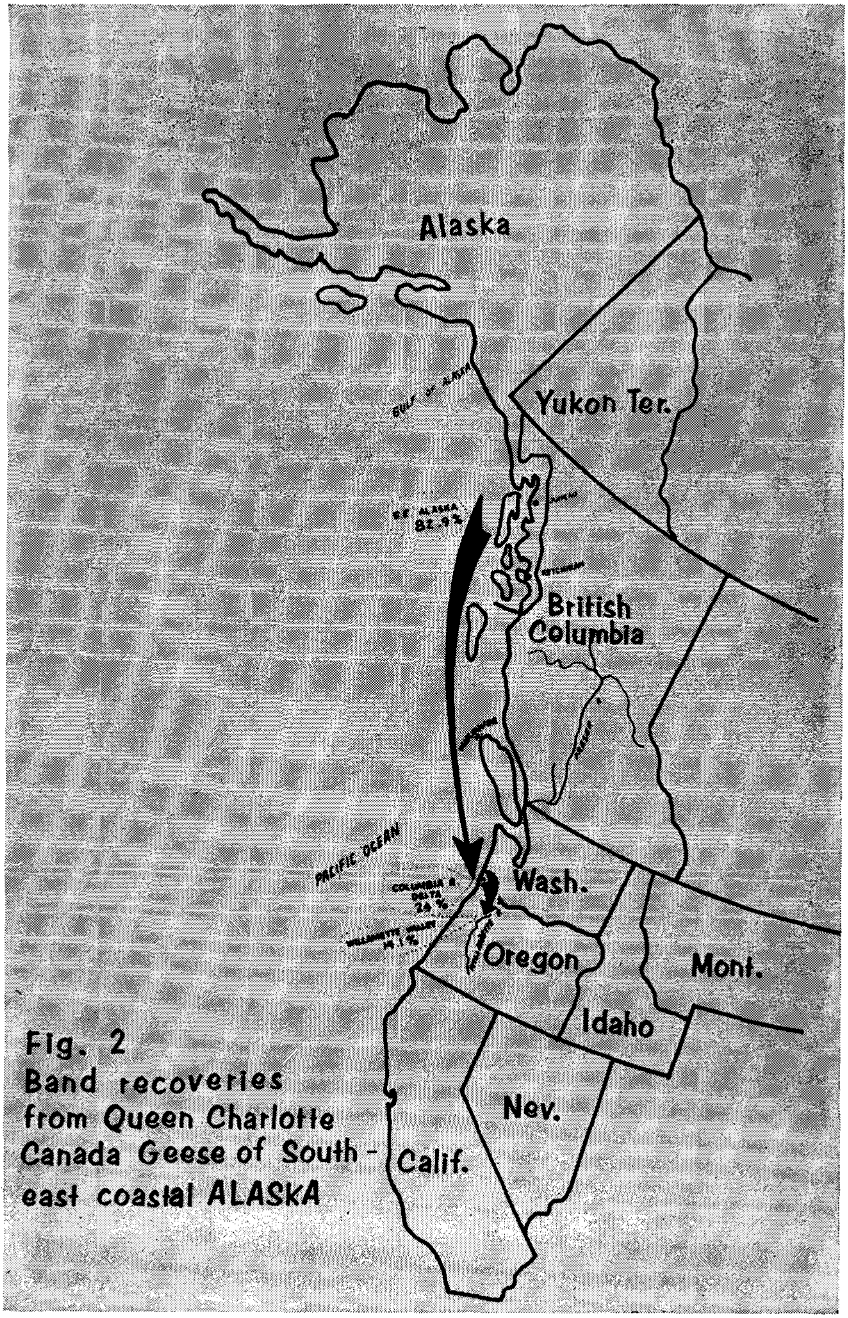

Fig. 2
Band recoveries from Queen Charlotte Canada Geese of South-east coastal ALASKA

ping place is the Queen Charlotte and Vancouver Islands off the north coast of British Columbia where they have started to arrive by early October. A few *occidentalis* regularly winter among these islands, an occasional band having been recovered as late as January 16. From Vancouver Island they move directly to Gray's Harbor and the Willapa Bay area near the mouth of the Columbia River. A few spend the winter here but the majority continue up the Columbia and Willamette Rivers to winter in a relatively small area in and adjacent to Benton County, Oregon (Fig. 1). A small segment of *occidentalis* is nonmigratory. A few flocks totaling perhaps 1,000-1,500 geese regularly spend the winter among the islands of Prince William Sound.

In contrast, *fulva* is a rather sedentary species. Only 17 per cent of the recoveries have been made on the coast of Washington and in the Willamette Valley. About 62 per cent came from within 100 miles of Glacier Bay and another 20 per cent only 50 miles farther. The few *fulva* that migrate to Oregon from southeast Alaska go directly to the Gray's Harbor-Willapa Bay area. No recoveries of this subspecies have been made between Alaska and the Washington Coast (Fig. 2). Whereas the bulk of *occidentalis* have arrived in the Willamette Valley by mid-November, most of the Oregon bands from *fulva* were not recovered until after the middle of December. Furthermore, *fulva* tends to occupy a much more restricted area in Yamhill County north of the Benton County concentration area.

The most recent literature on these two subspecies is not quite in accord with range as determined from band recoveries. Delacour (1954) ascribes both races as being sedentary with only a few of each going as far as Oregon. Gabrielson and Lincoln (1959) give September as the month *fulva* migrates south, with some proceeding as far as northwestern California. No bands from *fulva* were returned from farther south than Benton County, Oregon, but four bands from *occidentalis* were recovered in California, two from Del Norte County, one from Shasta and one from the San Francisco Bay area. In Yocom's (1962) census figures compiled for the California Coast from Humboldt Bay northward, Canada geese do not appear prominently. Most of the flocks were from 5-35 geese, infrequently recorded. Unless there are specimens to prove otherwise, evidence from the current study indicates that these are *occidentalis* rather than *fulva*.

POPULATION ESTIMATE

Neither ***B.c.*** *occidentalis* nor ***B.c.*** *fulva* is a numerically large group in comparison with most other susbspecies of Canada geese. Because the former is subjected to a heavily concentrated hunting pressure on its wintering ground, however, it assumes a role of major importance.

Also, the margin for error in the allowable harvest is proportionatly less than for a larger population. At present there is no good estimate of the total number of *fulva*. An accurate inventory either during the breeding season or on the wintering areas would be almost impossible to obtain. From several years' field experience with both subspecies, I would estimate that *fulva* has fewer geese in the aggregate than *occidentalis* at the present time. The winter inventory from Oregon includes a few fulva, but only about 300 annually. Probably the best population figures available for *occidentalis* are from the winter inventory in Oregon and Washington. In Washington about 1,000 large, dark geese are counted in the coastal counties each winter. Apparently this number varies but little from year to year. In British Columbia the wintering population is less precisely known, but the average number counted between 1955 and 1960 was 1,000 with little variation between years. A few may be missed on the isolated coast line of Vancouver Island. Therefore, the total post-hunting season population of *occidentalis* would be the Oregon count plus about 2,000 (Table 7).

Hanson (1949) determined that most wild geese from the Horseshoe Lake flock reached maturity at two years of age while Elder (1946) found that only 25 per cent of semi-domesticated Canada geese on the Bright Land Farm in Illinois bred at this age. While banding geese at Glacier Bay National Monument in Alaska, Robards recaptured idle, flightless *fulva* as late as four years after they had been banded in the same area as yearlings or older (Table 6). It was not determined what these geese represented in the flock of moulters. If we assume that every goose was only a yearling (13-14 months old) when banded, then 10.3 per cent of the banded population was recaptured in an idle status as 3-year-olds, 5.8 per cent as 4-year-olds, and 3.6 per cent as 5-year-olds. It is not known what percentage of these geese attempted to nest in their third year nor how many represented nesting failures or loss of mates from previous hunting seasons.

Olson (1954) conducted a production study on the Copper Delta in conjunction with the banding program. On an extensive 88-square-mile study area he reported a mean density of 6.4 successful nests per square mile. Nesting success was 80 per cent with an average of 4.4 young per brood. When this nesting density and success was extended to the total estimated habitat of 180 square miles, the production was calculated at 5,070 geese.

Hanson and Smith (1950) showed that adult geese (2½ years or older) in the Horseshoe Lake flock comprised from 31.7 to 46.7 per cent of the total post-hunting season population in 1945-1947. The average ratio of males to females in this population component was

100:61. The adult female cohort ranged from 12.4 to 15.9 per cent (av. 14.3 per cent). Based upon the sex and age ratios from the Horseshoe Lake flock, the 1954 winter population of 9,570 Copper Delta geese would have contained 1,370 adult females. From the nesting success and average brood size derived from Olson's study these geese would have produced 4,822 young, within 250 of the calculated number.

In 1959 another production study, oriented differently, was conducted on the Copper Delta (Hansen 1961). On a 2.08-square-mile intensive study plot Trainer and Shepherd, biologists assigned to the study, found 224 Canada goose nests. Of the 222 they followed to completion, 194 hatched for a success of 87.4 per cent, or 94 successful nests per square mile. Of 1,017 eggs produced in the 194 successful nests, 83.5 per cent hatched, an average of 4.4 young per brood. Only 5.4 per cent of the eggs appeared to be infertile. Most of the other loss resulted from tide floods during incubation. This study area was purposely situated where the nesting density was known to be high, but it far exceeded the best areas observed in 1954. The area contributing 94 nests per square mile covered only 12 square miles in the middle of the delta adjacent to the open coast.

In order to determine the relative nesting density elsewhere in relation to the study plot an inventory was conducted during the peak of nesting between May 21 and June 6. Sloughs were traversed at high tide by outboard skiff from the high-density, shoreward area inland. The skiff was cruised at the same, constant, medium speed on all census runs with one person operating the motor and the other acting as observer. During this particular time of year few flocked nonbreeding geese were present. Nearly all of the geese were observed as pairs, and single geese were counted as a pair. Due to the tendency of geese to flush at considerable distances from an observer traveling on land, and because it was possible to cover much larger areas faster, this technique was selected over one of sampling smaller areas afoot. In the area of greatest nesting density an average of 6.1 pairs of geese were counted per minute of outboard time. One mile inland from the study area the density had dropped to 3.2 pairs per minute while at three miles and more only 0.1 pair was counted per minute of outboard time.

Based upon the nesting success on the intensive study area, the 12 square mile nucleus, or "hub," produced about 4,960 geese, minus juvenile mortality. There are so few predators or other decimating factors after incubation has been completed that juvenile mortality was considered to be negligible both in 1954 and in 1959. Since 1954, good aerial photos have been available and our knowledge of the size and ecology of the Copper Delta is more complete. Based upon measurement of the ecological zones from the photos and relating the relative density figures to them, the production calculated for the remainder of the delta was about 3,360 geese for a total production of 8,320 in 1959. In both 1954 and 1959 the winter inventory in the Willamette Valley was the same, 7,580. At a rate of 4.4 young per brood, it would have taken an adult female component of 19.7 per cent of the 1958-59 wintering population to produce 8,320 young. This is reasonably close to the 12 to 17 per cent range from the Horseshoe Lake flock considering that a higher than normal carry-over, which should have accrued from the 1956-57 hunting restrictions, would have matured in this year class.

In 1954, a production of 5,070 young added to 9,570 geese from the previous winter inventory would constitute a fall population of 14,640. The harvest plus crippling loss in 1954 would have been 5,980 geese to leave a winter population of 8,660 in 1955. In 1959, a production of 8,320 added to the previous winter inventory figure of 9,580 would have been a total fall population of 17,900. Unfortunately, the subsequent winter inventory was obscured by intrusion of outside geese. The rate of band recoveries in 1959 indicates a light harvest, however, in comparison with other years having a comparable season and bag limit. Kebbe (pers. comm.) estimates that the harvest of geese in the Willamette Valley averages about 5,000 annually. From these rough calculations, the fall population of *B.c. occidentalis* in the years 1952 through 1960 would have fluctuated from a low of about 10,000 geese to a high of 20,000.

HARVEST AND MORTALITY

The rate of band returns indicates a rather heavy harvest on *occidentalis* and a very light harvest of *fulva.* This is a direct reflection of the hunting pressures to which each subspecies is subjected. The life tables illustrating the pattern of mortality are based on the format described by Bellrose and Chase (1950) and used previously to report on the black brant and cackling goose (Hansen and Nelson, 1957).

The direct (first year) band recovery rate of adult *occidentalis* varied from a low of 6.3 per cent to a high of 18.3 per cent with an average of 11.0 per cent. The direct recovery rate for juveniles varied from 12.0 per cent to 24.1 per cent with an average of 18.6 per cent (Tables 3 and 4). These fluctuations were caused, at least in part, by manipulation of the season and bag limit in the Willamette Valley of Oregon. In 1955 the bag and possession limit on Canada geese was reduced from three to two in Yamhill, Polk, Benton, Linn and Lane Counties, with an 80-day season extending until January 9. In 1956 the bag limit remained at two but the season was shortened to 64 days

TABLE 3. LIFE TABLE FOR 616 ADULT WESTERN CANADA GEESE BANDED ON THE COPPER DELTA, ALASKA

Year of Banding	Number Banded	Number of Bands Returned								
		Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	Total
1952	7		1	2	1					4
1953	145	24	19	10	2	2	2		1	60
1954	60	11	2	3	2	1		2		21
1955	103	7	6	8	5	4	5			35
1956	64	4	12	6	5	5				32
1957	75	5	4	5	1					15
1958	48	3	4	4						11
1959	39	5	1							6
1960	75	9								9
Total	616	68 of 616 banded	49 of 541 banded	38 of 502 banded	16 of 454 banded	12 of 379 banded	7of 315 banded	2 of 212 banded	1 of 152 banded	193
% of bands recovered		11.0	9.1	7.6	3.5	3.2	2.2	0.9	0.6	38.1
Mortality series		28.9	23.9	19.9	9.2	8.4	5.8	2.3	1.6	100.0
Cumulative		28.9	52.8	72.7	81.9	90.3	96.1	98.4	100.0	
Survival series		71.1	47.2	27.3	18.1	9.7	3.9	1.6		
Mortality rate		28.9	33.6	42.1	33.7	46.4	59.8	58.9		

TABLE 4. LIFE TABLE FOR 3,327 JUVENILE WESTERN CANADA GEESE BANDED ON THE COPPER DELTA, ALASKA

Year of Banding	Number Banded	Number of Bands Returned									
		Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	Total
1951	16	3	1		1			2		1	8
1952	141	34	11	9	2	1	2		1		60
1953	337	75	17	10	2	5	7	1	1		118
1954	696	149	24	11	12	9	5	4			214
1955	310	38	15	17	11	1	1				83
1956	341	41	31	12	14	2					100
1957	338	77	21	9	4						111
1958	308	58	18	10							86
1959	415	60	16								76
1960	425	84									84
Total	3,327	619 of 3,327 banded	154 of 2,902 banded	78 of 2,487 banded	46 of 2,179 banded	18 of 1,841 banded	15 of 1,500 banded	7 of 1.190 banded	2 of 494 banded	1 of 157 banded	940
% of bands recovered		18.6	5.3	3.1	2.1	1.0	1.0	0.6	0.4	0.6	32.7
Mortality series		56.9	16.2	9.5	6.4	3.0	3.0	1.9	1.2	1.9	100.0
Cumulative		56.9	73.1	82.6	89.0	92.0	95.0	96.9	98.1	100.0	
Survival series		43.1	26.9	17.4	11.0	8.0	5.0	3.1	1.9		
Mortality rate		56.9	37.6	31,6	36.8	27.2	37.5	38.0	38.9		

TABLE 5. LIFE TABLE FOR 3,593 QUEEN CHARLOTTE CANADA GEESE BANDED IN SOUTHEAST ALASKA

		Number of Bands Returned					
Year of Banding	Number Banded	Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	Total
1956	168	11	2	4	2	1	20
1957	402	16	7	6	5		34
1958	529	19	11	9			39
1959	1,045	24	18				42
1960	1,449	29					29
Total	3,593	99 of 3,593 banded	38 of 2,144 banded	19 of 1,099 banded	7of 570 banded	1 of 168 banded	164
% of bands recovered		2.8	1.8	1.8	1.2	0.6	8.2
Mortality series		34.1	22.0	22.0	14.6	7.3	
Cumulative		34.1	56.1	78.1	92.7	100.0	
Survival series		65.9	43.9	21.9	7.3	0.0	
Mortality rate		34.1	33.4	50.1	66.6		

terminating on December 15. In 1957 the bag and possession limit remained at two but the season was lengthened to 95 days, ending on January 14. The effects of these manipulations are indicated both in the reduced rate of direct or first-year band recoveries and in the larger population counted in the subsequent winter inventory (Table 7). However, the change in band recovery rate did not always fluctuate in the same direction nor magnitude within a given year.

The only explanation for the high first-year recovery rate of juveniles in 1952 with a bag and possession limit of two geese was weather patterns which delayed the birds enroute. They then became more vulnerable late in the season. No bands were recovered prior to November 22 and 50 per cent were recovered after December 20. In all the other years combined about 15 per cent of the juvenile band recoveries were made before November 22 and only 30 per cent after December 20. The lower than average juvenile recovery rate in 1959 with a bag and possession limit of three, a late 94-day season and a very high initial population could reflect the relative degree of security for the geese in the form of adequate food and favorable weather patterns.

Goose hunting statewide in Oregon was reported to be better than average in 1959 (Kebbe, 1960). Perhaps hunting in the Willamette Valley was an exception to the general trend as reflected by the low band recovery and the very high winter inventory immediately following. Unfortunatly, an accurate count of *occidentalis* was obscured in this one year by the influx of an undetermined number of smaller Canada geese (probably *B.c. taverneri* Delacour) from the Columbia River. It is also possible that this atypical movement of small geese relieved the hunting pressure on *occidentalis*. At any rate, Shepherd reported the highest spring population of resident geese on the Copper Delta in 1960 he had observed in several years' experience in the Prince William Sound area.

TABLE 6. CANADA GEESE RETRAPPED AT BANDING SITE, GLACIER BAY, ALASKA

Year	Number banded	1st yr. after banding		2nd yr. after banding		3rd yr. after banding		4th yr. after banding	
		No.	%	No.	%	No.	%	No.	%
1956	168	24	14.3	3	1.8	5	3.0	6	3.6
1957	402	38	9.5	36	9.0	28	7.0		
1958	529	91	17.2	73	13.8				
1959	1,045	217	20.8						
Total	2,144	370 of 2,144 banded		112 of 1,099 banded		33 of 570 banded		6 of 168 banded	
% of geese retrapped		17.2		10.3		5.8		3.6	

By coincidence, the recovery rate was lower than average throughout the remainder of the Flyway in 1955 and 1956 as well as in the Willamette Valley so that the low overall rate was not due entirely to the curtailment in Oregon. It is interesting to note that when the 1955 and 1956 age classes were harvested lightly during the restricted years, the band recovery rate jumped to higher than average levels in subsequent years when the restrictions were relaxed. The net result, however, was a smaller total band recovery from the 1955 and 1956 age classes than from those preceding and following.

It is important in management of long-lived birds with a delayed initial breeding age to have assurance that restrictive hunting measures can save a significant number of birds until they reach maturity. The first year mortality rate of juvenile *occidentalis* was twice that of adults, 56.9 per cent vs. 28.9 per cent. Practically all the *fulva* were banded as yearlings or older and their mortality rate closely paralleled that of the adult *occidentalis* (Table 5). This would indicate that of those geese carried through their first hunting season, a significant number can expect to reach breeding age.

In summarizing a reward band experiment on mallards, in Illinois, Bellrose (1955) concluded that stipulated cash reward bands were

TABLE 7. CANADA GOOSE SEASON, WILLAMETTE VALLEY, OREGON, 1952-1960

Year	Length of season (days)	Date season ended	Bag limit (daily & poss.)	No. *occidentalis* banded		Direct returns (per cent)		Winter inventory immediately following the season[1]
				Ad.	Juv.	Ad.	Juv.	
1952-53	70	Jan. 1	2	7	141		24.1	5,080
1953-54	75	Dec. 30	3	145	337	16.6	22.3	7,570
1954-55	80	Jan. 3	3	60	696	18.3	21.4	6,660
1955-56	80	Jan. 9	2	103	310	6.8	12.3	8,370
1956-57	64	Dec. 15	2	64	341	6.3	12.0	12,220
1957-58	95	Jan. 14	2	75	338	6.7	22.8	14,450
1958-59	95	Jan. 13	3	48	308	6.3	18.8	7,580
1959-60	94	Jan. 8	3	39	415	12.8	14.5	25,200[2]
1960-61	90	Jan. 8	3	75	425	12.0	19.8	16,770
1961-62	75	Jan. 3	3					13,780

[1]Add 2,000 geese from Washington and British Columbia for Flyway total.
[2]Includes an undetermined number of small Canada geese.

returned more consistently than taken reward bands. Unless cash were involved, "once the nature of the reward had become known, there was little incentive to report such a band." Unless a banded goose piques the imagination of a hunter to a much greater extent than does a banded duck, one might expect a similarity in band return patterns between ducks and geese. It appears not only, that once the nature of the reward is known incentive wanes, but also that once a hunter's curiosity is satisfied he is less likely to continue reporting bands. For instance, the direct rate of return on *fulva* decreased quite regularly from 6.5 per cent in 1956 to 2.0 per cent in 1960. About 65 per cent of these geese were taken locally by Juneau and Sitka hunters in an area where no other subspecies is commonly found. Thus, all bands reported came from geese banded locally in Glacier Bay. Interest in reporting goose bands declined because hunters no longer expected to learn anything new about their origin.

MANAGEMENT IMPLICATIONS

B.c. occidentalis has demonstrated a responsiveness to regulatory changes within its winter range. If the season and bag limit in a relatively small part of the Willamette Valley can be manipulated in a manner to obtain predictable results, this would be a valuable management tool. Discounting the vagaries of weather, it appears that this goal is possible with *occidentalis*.

Very few large, dark geese appear in Oregon before November 1, the majority arriving in the Willamette Valley between November 15 and 25, at which time band recoveries increase proportionately. Table 8 is a composite summary of the band recoveries and kill frequency rate of *occidentalis* in the Willamette Valley for the years 1952-1959,

TABLE 8. KILL FREQUENCY OF CANADA GEESE IN WILLAMETTE VALLEY, 1952-1959

Period		Total hunting days	Bands recovered		Kill index[1]		No. geese per thousand killed each period	
			Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Oct.	11-20	56	01	02	0.02	0.04	04	09
	21-31	98	01	04	0.01	0.04	02	09
Nov.	01-07	63	05	01	0.08	0.02	17	04
	08-14	63	04	12	0.06	0.19	13	41
	15-21	63	21	30	0.33	0.48	69	104
	22-28	63	18	30	0.29	0.48	61	104
Nov.-Dec.	29-05	63	22	51	0.35	0.81	74	175
	06-12	63	27	36	0.43	0.57	90	123
	13-19	58	23	30	0.39	0.52	82	112
	20-26	56	29	34	0.52	0.61	109	132
Dec.-Jan.	27-02	52	37	21	0.71	0.40	149	87
	03-09	34	23	08	0.68	0.24	143	52
	10-14	09	08	02	0.89	0.22	187	48
Total		741	219	261	4.76	4.62	1,000	1,000

[1]Number of bands recovered per day of hunting.

inclusive. The earliest goose hunting date within this period was October 11 and the latest was January 14. The total span was divided into 13 periods of seven days each except for the two in October, and the last one in January which was only five days. The second column gives the total number of hunting days that fell within a given period. For instance, in the eight years there were only 56 hunting days in the 10-day period, October 11-20, because the season started later than October 11 in several years. Likewise, the total number of huntings days per 7-day period was not constant after the December 13-19 period because the season closed on varying dates. The third and fourth columns show the total number of usable bands recovered in each time period. Only those returns showing place and date of recovery were used. The fifth and sixth columns give the kill index which was derived by dividing the total number of bands recovered in any period by the total number of hunting days in that period. In the last two columns the number of geese killed per period for each cohort of 1,000 was derived by the following proportion:

$$\frac{\text{Periodic Kill}}{\text{Total Kill}} = \frac{\text{Periodic Index}}{\text{Total Index}}$$

For example, substituting from the November 15-21 period for adults:

$$\frac{X}{1000} = \frac{0.33}{4.76} \quad X = 69.3$$

If the total seasonal kill was 5,000 geese, then each periodic kill would be multiplied by five to arrive at a total per period. Conversely, the number of geese killed per day could be derived by dividing the periodic kill by the number of days listed for that period in the first column, if the banding sample and number of recoveries were large enough to support such refinement.

Discounting 1960, the average number of Canada geese in the winter inventory in Oregon was about 10,000 between 1952 and 1962 with an average annual fall population of 15,000 before the harvest was taken. When the kill index for each age group is plotted against this population curve, it is apparent that the adult component becomes increasingly vulnerable as the season progresses beyond December 26 (Fig. 3). Most of the relatively more vulnerable juveniles have been removed from the population by then. Even though the total population has declined, the heavy rate of harvest remains constant. In order to maintain a constant kill from a shrunken population in which the juvenile component has been depleted the slack would have to be taken up by adult geese. An examination of the last two columns in Table 7

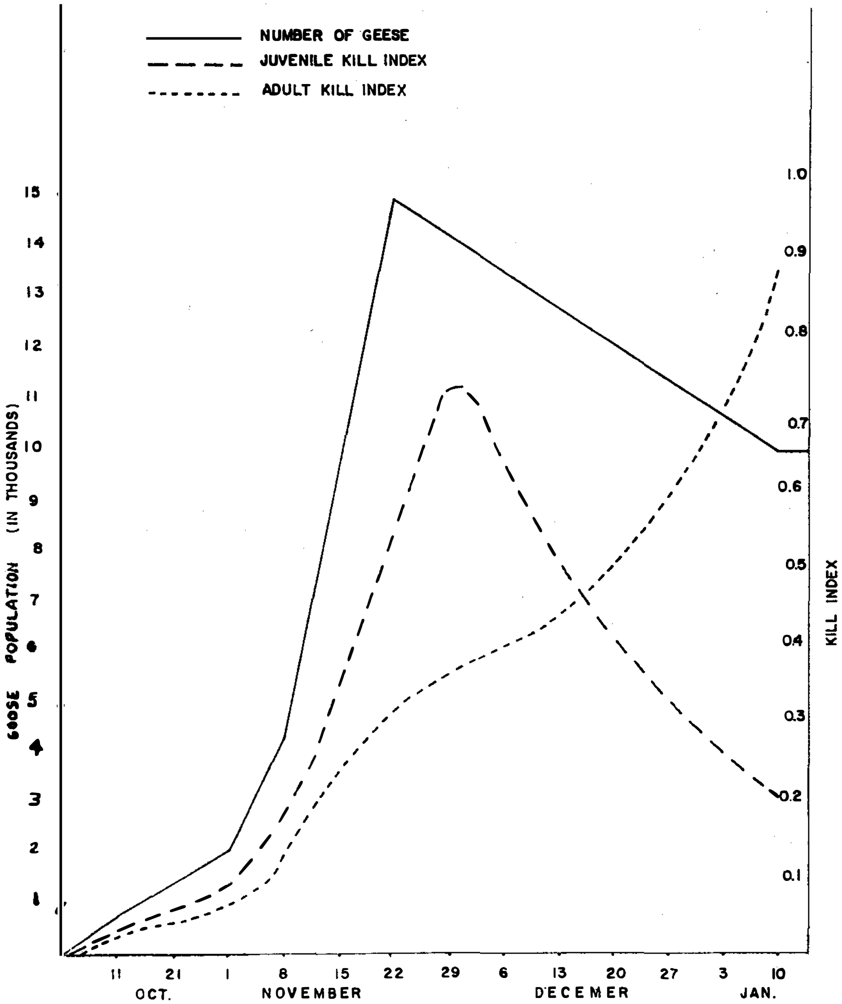

Figure 3

shows this to be so. About 91 per cent of the juvenile kill and only 52 per cent of the adult kill was made prior to December 27.

In this case, "adult" refers to yearlings and older, that component of the population which constitutes a breeding stock for the ensuing year.

In a hypothetical fall population of 15,000 geese the juvenile component would approximate 5,000 birds. Between 1952 and 1960 the "average" annual harvest in the Willamette Valley would have been composed of about 2,500 juveniles and 2,500 adults. The direct mortality rate for juveniles was twice that for adults (Tables 3 and 4). From the remaining 10,000 geese, about 5,100 young would be produced if 14 per cent of the flock were adult females with an 85 per cent nesting success averaging 4.3 young per brood.

What would happen to this same hypothetical population if the season were closed on December 26 and the kill index from Table 8 was applied to each age group? Only 2,275 young would be killed (91 per cent of the 2,500 from a long season) and 1,300 adults (52 per cent of 2,500), a total of 3,575 geese compared to 5,000 in the long season. From the remaining 11,425 geese, if the same success ratio were applied, 5,850 young would be produced for a total fall population of 17,275.

From this population with a December 26 closure, 3,035 young would be killed and 1,660 adults, a total of 4,695. By the following year the total harvest would have been restored to more than 5,000 geese through the simple device of protecting the adult component from late December on. Obviously this hypothetical growth rate could continue only to the extent that limiting factors other than harvest would let it assert itself. If these limiting factors can be identified, and, perhaps all except weather, controlled to some extent in conjunction with a curtailed season in the Willamette Valley, there is a possibility that the entire subspecies can be managed in a predictable manner.

There is no reason to believe that the breeding habitat could not support a much higher population than it has for the past several years. A shortage of wintering habitat is probably the greatest limiting factor at present. The geese are concentrated in a very restricted area. About 75 per cent of the Willamette Valley bands were recovered within a 20-mile radius of Corvallis, Benton County. In January and February of 1959 Trainer (unpub. manus.) counted an aggregation of 2,400 geese that occupied an area of 12 square miles about eight miles south of Corvallis. This was about one-third of the total wintering population in Oregon. Without identifying areas or assigning population figures to them, Kebbe (1959) describes the fall and winter conditions as follows: "The geese, when in Oregon, rest on six legal or natural refuges and fly to large fields to graze on winter wheat, clover, and newly seeded rye grass. Even though most of the feeding takes place on private land, complaints of damage are very few, with only 12 being reported in the last 10 years. Many ranchers, however, illegally harass the birds with shotguns and rifles without registering complaints of damage or obtaining herding permits.

"About 90 per cent of the geese shot in the Willamette Valley are taken over decoys placed near fence-row blinds. The other 10 per cent of the kill is made by pass shooting or jump shooting on gravel bars along rivers. In recent years, the best success has been enjoyed at artificial ponds where geese have been attracted to food crops planted specifically for waterfowl.''

The crux of the problem is explained in the final sentence quoted above. When hunting clubs can lure geese to gunfire with standing crops, surely they can be attracted to more secure areas by the same means. Properly dispersed and protected food patches would not only offer securiy to a much larger wintering population but it should reduce the present need for harassment from ranchers' fields. In the final analysis a larger post-hunting season population of geese with a normal component of adult females should result in a larger flock of juveniles returning for the following hunting season.

ACKNOWLEDGMENTS

All phases of the field work incorporated in this report have been conducted cooperatively by many employees of the Bureau of Sport Fisheries and Wildlife to whom I am grateful. My special appreciation to Fred Robards, U. S. Game Management Agent, who initiated the banding program on the Copper River Delta in 1951 and 1952 and conducted the Glacier Bay project after he was transferred to Juneau. Most of the information from the wintering grounds in the Willamette Valley was supplied by Chester E. Kebbe and Charles Trainer of the Oregon Game Commission. Dr. John Aldrich examined all specimens collected during this study to delineate the breeding ranges. Urban C. Nelson was most helpful in his critical review of the manuscript.

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DISCUSSION LEADER MANVILLE: Not so many years ago we knew practically nothing of the taxonomic relationships of the geese in Alaska. Today, largely through Mr. Hansen's efforts, the species composition of Alaskan geese is as well known as those on any similar area throughout the continent. These taxonomic details were not discussed in detail in this paper. Rather, Mr. Hansen has given us detail on the movements and management of these geese in Alaskan waters. I am certain there are many questions from the audience about this paper.

DR. CHARLES YOCOM: Do you have any information on the kill of the yearlings? I don't suppose you were able to segregate that data.

MR. HANSEN: Yes, we have that in considerable detail.

DR. YOCOM: Do you know what sub-species get down to our part of the country?

MR. HANSEN: Not definitely; it was my understanding that we were leaving it to you to get those birds and send them in to Dr. Aldrich.

DR. YOCOM: I can't hit them.

DR. ALEX DZUBIN [Canadian Wildlife Service]: What portion of the kill is made on Queen Charlotte Island, and is this *occidentalis?*

MR. HANSEN: It is entirely *occidentalis.* The type specimen for *occidentalis* was taken over a hundred years ago at Port Townsend, Washington, and in more than 600 returns from 3,000 birds banded, we have gotten none, and only four from Puget Sound. The type specimen for *fulva* was taken on the Queen Charlotte Island, from whence the vernacular came and we have not gotten one from Port Townsend *fulva* band back from any place on the Queen Charlotte or Vancouver Islands. How the type specimen came to be taken there, in 1927, I am at a loss to explain, and we have found none since. The other half of your question was, "How many are taken there?"; between ten and twelve per cent of the total bands have been recovered in Canada, on Queen Charlotte and Vancouver Islands. In contrast, over 65 per cent of the total bands have been recovered in Willamette Valley, in a twenty-mile radius of Corvallis.

DR. DZUBIN: I have one other question that interests me. Of those that are quite sedentary, does there seem to be a difference in age classification, or do you think it is a composite group of all age classes?

MR. HANSEN: According to our banding return information, there are all ages there. Those geese are just nonmigratory.

DISCUSSION LEADER MANVILLE: I am curious as to the possible effect of oil drilling in Alaska on the geese and their behavior.

MR. HANSEN: Dick, I presume you are referring to the new oil exploration on the Copper River Delta, the primary breeding grounds of this major sub-species. We have our eye on that and we have every confidence to believe that those breeding areas will be safeguarded. In Alaska, we have been getting excellent cooperation from those oil companies in the areas in which wildlife is of primary importance. We have no reason to believe that we can't work just as well with the people of this area. The forestry people, our people, and State Fish and Game are all working very closely with the oil people, and we are quite confident that these areas can and will be properly safeguarded. Incidentally, this area on the Copper River Delta where oil exploration is now taking place is also right in the center of the major trumpeter swan breeding population.

MR. GEORGE DAVIS [Vermont]: First, I would like to say that I think this is one of the finest papers I have heard in a long time. I wonder, though, Mr. Hansen, was the date 1927 correct for the collection of the type specimen? Wasn't it 1827?

MR. HANSEN: For *occidentalis* it was over a hundred years ago, 1850 something. The exact date escapes me at the moment, although I have it in the paper. The bird was taken during an expedition for pushing a railroad through. The type specimen for *fulva* was taken quite recently by, I believe, J. Monroe, and I believe that date was 1927. It could have been '17. However, it was quite recent —within this century.

MR. TERRY VAUGHAN [Colorado State University]: I wonder how you account for the gap between the breeding ranges of those two sub-species of geese.

MR. HANSEN: The geology and physiography of the coastline primarily. Until very recent years, there has been little good breeding area there. It has been glaciated right out to tide water and still is in many cases. We have one glacier that has a larger surface than the State of Rhode Island, for example. And some of the others have receded only within the past thirty to fifty years to where there is now a little habitat. That may be one of the primary reasons.

MR. RICHARD HUNT [Wisconsin]: Can you give a little information on your banding operations of these two species, and did you do any winter-ground banding?

MR. HANSEN: We have done no winter-ground banding. I believe they have banded a few in the Willamette Valley. We have done none in Alaska. In the Copper River Delta we have banded the majority of the young birds. In southeastern Alaska, the birds are practically all yearlings and older. Because they are very solitary, it is difficult to find enough youngsters there to repay the effort. We have found major molting areas in which there are several thousands, as we have in Glacier Bay, and we have worked on those populations. I don't know why, with the low hunting pressure on *fulva* and the low rate of band returns, that they don't increase in abundance. Certainly hunting is no limiting factor there. Obviously it must be the breeding habitat. They are very solitary in nature, and it is in very few bays and salt-chuck meadows that we will find fifty or more birds at any time in the summer. So I suspect that there is a limited amount of breeding habitat. They are not very tolerant of each other. On the Copper River Delta, on the other hand, where we have found as many as 112 nests per square mile, there is no reason to believe that they couldn't extend over a great deal more of that area more densely than they are at present.

MR. HARVEY NELSON [U. S. Fish and Wildlife Service, Minneapolis]: I would like to ask you, with the breeding behavior of these two sub-species, do you have any indication that the two-year-old birds are breeding?

MR. HANSEN: That is one of the major questions that has not yet been properly answered. In Glacier Bay, where we were banding yearlings and older, we have found the number of returns in the banding traps in years following banding rather high—a high percentage of all the birds banded. For instance, if they were yearlings only when they were banded, we tave taken a rather high percentage of those birds, three and four years later, and some of them even after those three or four subsequent summers, which would indicate then that they would be four to five years old or more and they were taken there in an idle status. What this represents, I am not sure. Whether they had lost a mate in a prior hunting season and had not yet remated, whether they had attempted to nest in the early summer and were unsuccessful and came to this area to molt, I am not sure. All I know is that it looks as though there are more idle adult birds in this southeast population than there really should be.

SALINE SOILS AND BRACKISH WATERS IN MANAGEMENT OF WILDLIFE, FISH, AND SHRIMP

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Land and water with a saline influence offer a particular challenge to wildlife and fisheries biologists. These extensive lands and waters usually have low potential for agricultural and economic return. They are often designated as better suited for wildlife. On the other hand, specific methods to manage them for wildlife have been outstanding problems.

Through extensive field trials, the Soil Conservation Service has developed sound techniques for wildlife management where saline conditions occur. Although this paper is based primarily on work in the Southeast, many of the same or closely related species of plants and animals of saline habitat occur on both the east and west coasts of North America. The ecology of salt marshes is probably more nearly alike continent-wide than that of any other kind of land and water.

A hindrance to technicians has been the lack of a uniform or standard method of expressing salinity. In the eastern United States, parts per million is the common unit of measure; while in the Western States, millimhos per centimeter is regularly used. In the Gulf States and Hawaii, grains per gallon is a common term. Many fishery workers use parts per thousand (0/00) in salinity measurement. Farmers in coastal sections often refer to "per cent of sea-strength." The nomograph in Figure 1 provides a quick and easy conversion of several methods of expressing salinity.

BRACKISH WATER IMPOUNDMENTS FOR FISH

Bass and bluegills, typical freshwater fish, have been found to be more salt-tolerant than is generally supposed. They will survive in salinities up to nearly 8,000 ppm. They thrive well and make good growth in salinities up to 5,000 ppm. However, reproduction ceases at about 2,500 to 3,000 ppm. This may be the answer to a fish culturist's dream—controlled populations. Field trials are being conducted in South Carolina to determine the suitability of waters of around 5,000 ppm salinity for bass-bluegill management or for bass or bluegills alone. Since the bluegills will not spawn, bass are unnecessary to control bluegill numbers. Bass can be fed well by the prolific "mud-minnows" (*Fundulus,* etc.). Fingerlings of either bass or bluegills can be added as necessary to replace the fish harvested or lost.

Several of the species used in freshwater food-fish farming such as

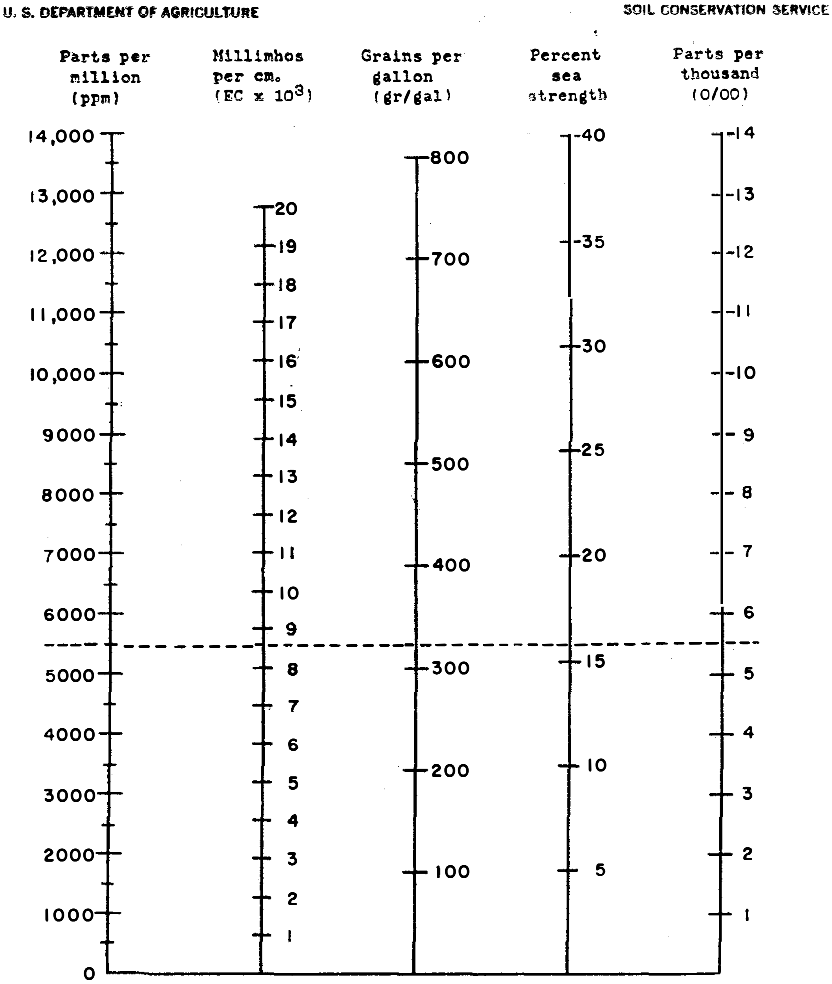

FIGURE 1

CONVERSION OF SEVERAL METHODS OF EXPRESSING SALINITY

With a straight-edge, read across the page. For example, 5,500 ppm is 8.6 millimhos per cm, 320 grains per gallon, 16 percent sea-strength or 5.5 o/oo

Israeli carp, common carp, and *Tilapia* are very tolerant of salinity. However, little effort has been made in the United States in the use of brackish water impoundments to grow these species.

From observations of the shrimp farming trials described below, brackish water ponds can produce commercial crops of saltwater fish or provide sport fishing. Impoundments are made by diking off areas of salt marsh in a manner almost identical with that required for widgeongrass duck ponds. For commercial scale operations, impoundments of at least 25 acres or more are desirable.

An open-top concrete sluice-box type of water control structure is best for the brackish-water fish pond. This should have several sets of vertical slots in each sidewall so that flashboards, screens, or plywood flapgates may be inserted. In trial ponds so far, only natural stocking has been attempted. This is done by letting tidewater gradually fill the pond through a flapgate. Fingerlings and small fish come in with the water. The flap prevents a return flow at low tide. Or a low-head turbine pump can also be used to fill and stock the pond as most fingerlings will pass through this kind of pump unharmed.

The time of year water is let into the pond plays an important role in determining which species of saltwater fish will be stocked. Much more investigation is needed. Growth of fish is rapid. Fingerlings that are let into the pond in the spring are ready for harvest in October or November. Some species may be left in the pond until the following year to grow to larger size, but it has not been determined which species will winter-kill in these shallow impoundments.

Trials thus far show that natural stocking can be used to grow crops of black drum, channel bass, fluke (flounder), gray sea trout, menhaden, mullet, spot, spotted sea trout, tarpon, and "ten-pounder" (*Elops saurus*). Good sport fishing can be provided in these impoundments by spot, "ten-pounders," and trout. At times, mullet can also be taken with hook and line. Blue crabs are abundant and provide additional recreation and food.

The fish produced so far in the large-size impoundments have been incidental or accidental to our field trials with shrimp production, and no measure of fish yield was made. However, in a one-acre saltwater research pond at Bears Bluff Laboratories, South Carolina, the production was determined to be from 250 to 300 pounds per acre per year, using natural stocking as described above (Lunz, 1951).

POND CULTIVATION OF SHRIMP

The use of brackish water ponds to grow crops of shrimp has been practiced in India, Thailand, and elsewhere for many years. In the United States, shrimp cultivation in ponds has been limited largely to research work at Bears Bluff Laboratories (Lunz, 1956; 1957). For the past three years, the Soil Conservation Service has been conducting field trials to extend the results of this research to determine if commercial crops of white shrimp (*Penaeus setiferus*) could be produced in large brackish impoundments. If feasible, this would provide a good land use for a part of the extensive areas of salt marsh in the United States.

The work by Lunz demonstrated that more than 100 pounds of shrimp per acre per year could be produced, and this would make a profitable operation. However, his small research ponds could be quickly filled or drained. Could impoundments of a size practical for a commercial operation (25 acres or larger) be properly stocked and the crop harvested? Such impoundments may take two weeks to drain, and even longer to fill. Several soil conservation district cooperators were willing to construct impoundments on their marshlands so that such field trials could be conducted.

Sites and diking specifications for shrimp ponds are similar to those for the widgeongrass duck ponds or the saltwater fish ponds described. Until more information is gained, only sites with high salinities (as might be evidenced by dominant stands of *Spartina alterniflora*) are being used. The sluice-box type of water control structure has been found well suited for shrimp ponds, although trials are also being conducted with two other types of structures.

Unfortunately, there is meager information on the life history of shrimp. They spawn off-shore under conditions possibly determined by temperature, salinity, pressure, or other factors. They are extremely prolific—a single female may produce a million eggs at one spawning and spawn several times during a season (Anderson, 1955). The larval shrimp, at the mercy of tides and currents, move to nursery grounds of inshore estuarine creeks and marshes. By then they have reached the post-larval stage but are still only a few millimeters in length.

It is at this stage they are stocked in the shrimp ponds. A screen of one-fourth inch mesh is placed in one end of the structure so that all water that enters the pond will filter through it. The post-larval shrimp pass through this small mesh easily but it prevents predatory fish of fingerling or larger size from entering the pond. Flashboards are inserted in the other end of the structure to a height that permits high tides to rise over the top of them to a depth of about 30 inches. Thus, twice a day, post-larval shrimp will be flushed into the pond by the inflow of water. This bold flow will only raise the water level (in a large-size impoundment) one or two inches on one high tide, so there is only a weak outflow during low tides, and relatively few of the post-larvae are lost. In present trials, this stocking process is permitted to continue from mid-May through June. At the end of this period, a flapgate is placed on top of the flashboards and the pond will automatically fill to maximum level. In a normal operation, it is not anticipated that any further attention will be required unil harvest in October or November.

The shrimp have been found to thrive and grow rapidly in these impoundments. Also they are not quite the delicate creatures as first supposed—they have survived salinities as low as 3,500 ppm caused from excessive rainfall and a pH as low as 5.5 caused from cat-clay formation. By October or November the shrimp have reached a length of 6 to 6½ inches in length and must be harvested. Otherwise, a winter kill is almost a certainty.

The shrimp are harvested by draining the pond through a long, inclined screen in the sluice-box. The water coming from the pond flows through the forepart of this screen, straining out the shrimp, which skid to the rear where they are raked into baskets. They are a firm-fleshed, premium grade of shrimp.

The field trials have demonstrated that it is possible to stock, grow, and harvest crops of shrimp in large brackish water impoundments. However, the trials have been beset by many troubles which could not be foreseen in a new operation such as this, and what could be called a fully successful crop has not been realized as yet. There have been structure failures because of lack of previous experience with the tremendous volumes of water which must be handled during stocking and harvest. Chief among the troubles has been fish getting into the impoundments and predation thus decimating the shrimp population. This has been caused by screen failures due to saltwater corrosion or blowouts caused by trash accumulations. (The problem is now considered solved by better screening material and adequate reinforcement.) Of concern, although it may turn out to be of no consequence, is cat-clay formation that might develop when the pond bottom dries during harvest, and again at the draw-down to remove wild fish before stocking begins each year.

MANAGEMENT FOR DUCKS

For brackish ponds with salinities of 10,000 ppm or over, widgeongrass (*Ruppia maritima*) is the best duck food to grow (Davison and Neely, 1959). It is a choice food of many species of ducks. They eat the seeds, leaves, stems, and even the roots of this plant. Management is simplified for widgeongrass ponds in that it grows in a salinity range above that tolerated by most waterweeds.

Sites for widgeongrass ponds are common in coastal salt marshes. These marshes naturally have a heavy growth of needlerush or cordgrass, both of which are almost worthless for ducks. The best locations are necks of salt marsh that extend inland with higher ground on either side. Less diking is required for these locations per acre of water impounded. However, it is still practical to extend a dike rectangularly out from higher ground to enclose an area of marsh for a widgeongrass pond. Choose a site where most of the water impounded will be at least two feet in depth. The pond may be filled with water from tidal fluctuation or with a low-head turbine pump of the type used for flood irrigation and drainage.

These impoundments will freshen gradually because of runoff from rainfall and hillside seepage, and will need to be recharged occasionally with salt water. In areas with sufficient tidal fluctuation, this can be done automatically by using a water-control structure set at a level which will permit the highest monthly tides to spill into the pond. Or a pump may be used to recharge the salinity.

A few bushels of widgeongrass scattered over the water of the pond will get it started. Any season of the year is suitable for planting, but spring is best because of the longer growing time. Growth and spread are rapid, so by fall the pond should have extensive beds of widgeongrass growing from the bottom to the surface of the water.

One waterweed of concern in a widgeongrass pond is a branching filamentous algae, *Cladophora*. Growth of this algae may become so intense as to smother the wigeongrass. It is also objectionable to ducks, as evidenced by their decreased use of ponds with *Cladophora*.

Field trials conducted in South Carolina demonstrated that *Cladophora* in widgeongrass ponds can be effectively controlled by mullet (Grizzell and Neely, 1962). These algae-eating fish can be stocked easily in ponds in tidewater areas by letting water into the pond in the spring of the year when fingerling mullet are in estuarine creeks.

In a salinity range of 3,000 to 10,000 ppm, a particular problem for duck field management exists. In coastal areas, a landowner or biologist is often confronted with this problem of developing a duck field in a location too fresh for widgeongrass ponds and too salty for freshwater duck-food plants. An additional complication is that the salinity of such areas usually varies over a period of years. These locations may often be recognized by sight, as characterized by a lack of any *dominant* type of natural vegetation. Most often the vegetation is a mixture of various species of cordgrasses, needlerush, and other salt-tolerant plants.

SCS field trials determined that a single duck-food plant — saltmarsh bulrush (*Scirpus robustus*) — would grow in a broad salinity range without the uncertainty of whether some years the field would be fresher or saltier than others (Neely, 1960). Although it probably grows best in the salinity range of 3,000 to 7,000 ppm, *Scirpus robustus* still thrives in a wider range, 1,000 to 10,000 ppm. It is tolerant of some of the acid conditions that may be associated with cat-clays, growing well at a pH as low as 4.3. The brown seed are of good size and have an extremely low rate of deterioration. Records show that bulrush seeds are eaten by many species of ducks. Measured seed yields on natural stands ranged from 400 to 950 pounds of clean salt-marsh bulrush seed per acre (unpublished SCS records). The species has the further advantage of being a perennial and of reproducing by tubers or seeds.

It was found that to generate and increase stands of *Scirpus robustus,* it is necessary to gradually flutuate the water from a low level (a saturated soil condition) upward to six or eight inches of flooding, and down again. The fluctuation is done during the spring, summer, and early fall, taking about 30 to 40 days for each complete cycle. There are no critical requirements. If an adverse condition causes deeper flooding for a few weeks, it is tolerated by the plants. The greatest caution is to prevent complete drying of the soil, which will likely cause cat-clay formation. In fields where stands of *Scirpus robustus* have been established by this method, no trouble has been experienced from competitive plants. This type of water fluctuation is either (1) unfavorable to other species or (2) the *Scirpus* becomes dominant to them under these conditions.

In coastal areas with tidal variation, a simple water control structure may be used which automatically permits fluctuation and which requires little attention (Neely, 1960). Or a pump may be used to provide the water fluctuation.

Dwarf spikerush (*Eleocharis parvula*) will also grow in this salinity range of 1,000 to 10,000 ppm. It is favored by water fluctuation but will grow on saturated soil or in shallow, clear brackish water. It is a fair food for ducks. They pull it up to eat the roots, then leave the tops to float on the surface of the water. Large masses of these floating tops are often found rafted on the down-wind edges of a flooded field.

A number of duck food plants will tolerate salinity up to 3,000-4,000 ppm. However, management practices for many of these are unknown. There are some salt-tolerant agricultural crops that might be useful in wildlife management. Figure 2 gives the approximate maximum salinity tolerance of selected agricultural crops (U. S. Salinity Laboratory, 1954), native duck food plants, and a few other native plants of saline habitat. Maximum salinity tolerance is influenced somewhat by soil type—usually greater on organic soils than on mineral soils. Some plants may grow at a certain degree of salinity but not produce seed.

SNIPE FIELDS

Methods for the management of snipe fields under freshwater con-

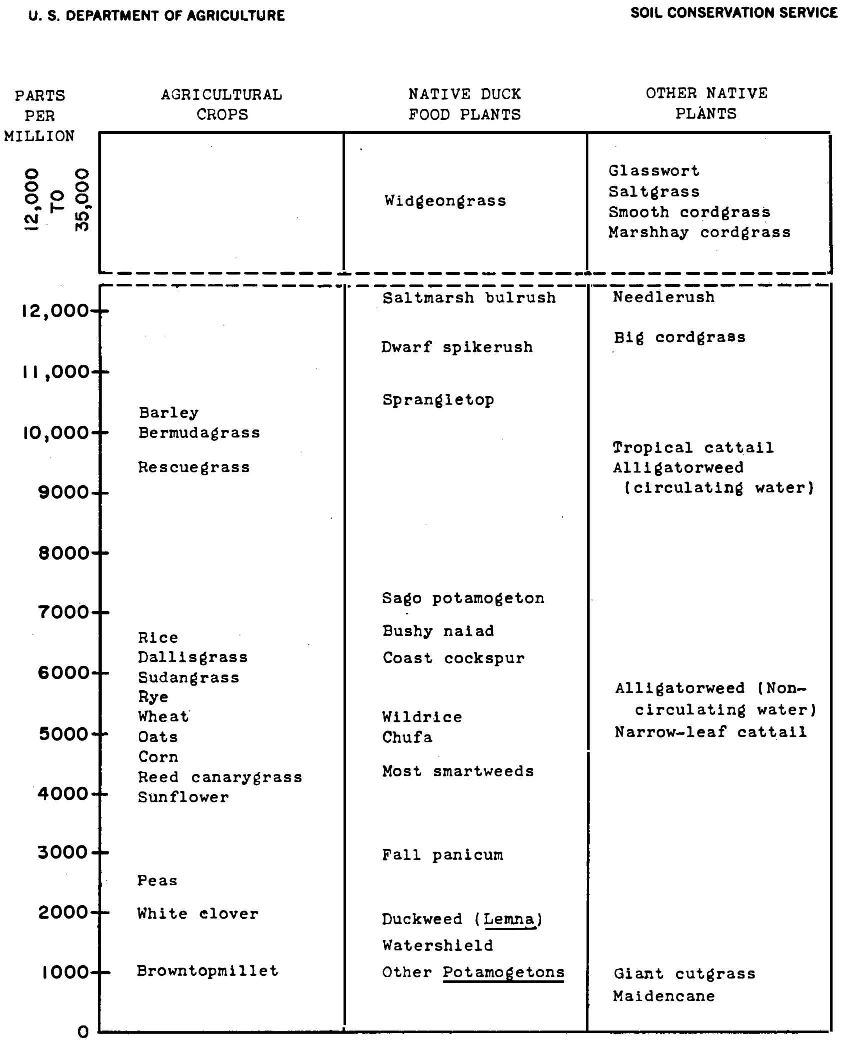

FIGURE 2

APPROXIMATE MAXIMUM SALINITY TOLERANCE OF SOME SELECTED PLANTS

ditions have been developed and have proven highly successful (Neely, 1959). These same methods were applied to two brackish marshes in the 5,000-6,000 ppm salinity range. As measured by snipe utilization, both of the fields were successful.

There are two principal methods of meeting requirements in snipe field management: (1) Chop or disk the native vegetative growth in the field in the early fall, so that a closely cropped meadow-like or disked field condition exists, and (2) shallow flood the field into puddles during the winter months. The organic material incorporated into the soil from the disking or chopping favors many of the soil-living animals that comprise the major foods in the snipe diet. Low dikes and a source of water are necessary for the very shallow, puddle-type flooding of the field.

It is possible that successful snipe fields could be managed even in the higher salinity ranges. In snipe food studies (Sperry, 1940), it was found that snipe readily eat insect larvae, univalves, clamworms, fiddler crabs, and other crustacea that occur at salinities of 15,000 ppm and above.

GOOSE PASTURES

Marshhay cordgrass (*Spartina patens*) grows in a very wide range of salinity where the water table is at, or slightly below, the soil surface. Dominant stands usually indicate salinities of 15,000 ppm or greater. Limited experience has shown that marshhay cordgrass can be managed to provide attractive wild goose pastures. Late summer burning is used to produce tender green shoots during the fall and winter months, besides removing the tall vegetation. Burn separate areas two to three weeks apart for the best feeding conditions. "Rotational burning" is necessary as the same area of marshhay cordgrass will not burn each year, since there will not be enough dead stems to "carry" the fire.

OTHER USES

In some instances where necks of brackish marsh extend inland in draws with higher ground on either side, it is possible to convert them into freshwater ponds by putting a dam across the lower end. The chief requirement is a watershed area above them large enough to provide a sufficient amount of freshwater from rainfall runoff. The salt leaches quickly, and usually within a year it can be classed as a freshwater pond. It can then be used for freshwater fish management, to grow freshwater aquatic duck foods, or as a source of drinking water for ducks. (Freshwater ponds even as small as one-quarter of an acre have proven highly attractive to ducks in saline areas where there was no other freshwater nearby.)

Where freshwater ponds become clogged with cattails or other waterweeds and a source of salt water is at hand, it is logical to assume that an easy way to eradicate the waterweeds is to let salt water into the pond. If the resulting salinity is high enough, it will kill the weeds.

However, when the pond is again filled with fresh water, frequently a very intense algal bloom of *Anacystis* (*Microcystis*) will occur and may persist as long as five years. The cause of this is unknown, but it is probably associated with the decomposition products of the previously destroyed freshwater habitat. This "pea-soup" water results in fish die-offs and prevents the growth of aquatic duck foods. There is enough residual salt to buffer an algicide, so that copper sulfate is ineffective for treatment.

CAT-CLAY PROBLEMS

The potential for cat-clay development probably exists in most coastal brackish marshes of North America. It also exists in some fresh-water marshes that have a recent geological history of sea-water inundation.

These cat-clays develop when sea water regularly or occasionally floods soils that have large amounts of organic material. Under anaerobic conditions, and in the presence of organic matter, the sulfates in the sea water are reduced to sulfides. In this form they combine with the iron in the clays to produce complex iron polysulfides. As long as the soil remains wet, the sulfides continue to exist in that form and there is no change in soil chemistry.

However, when such soils are drained and dried, the sulfides oxidize and produce sulfuric acid as a by-product of the reaction. In mild cases, the pH of the soil may drop from about 6.0 to around 4.0 within five years after being drained. In extreme cases, the drop in pH is to 2.5 or below. The soil is then barren for any known use. Enormous applications of lime—perhaps exceeding 50 tons per acre—would be required for even temporary relief. Every technician planning brackish marshes for wildlife, range grazing, or other use needs constantly to be aware of the cat-clay potential if there is to be a prolonged drying of the soil (Neely, 1958).

Unfortunately, some landowners have drained cat-clay soils to make cropland or improved pasture. This eventually presents the problem of how to reclaim these areas. The original purpose of the drainage for crops or pasture fails and the landowner wishes to convert the areas into fish ponds or duck fields. However, there has been the change in soil acidity due to the sulfide-oxidation process. When either fresh or brackish water is impounded on these areas, the pH of the water rapidly drops to 2.0-3.0. None of the higher forms of plant life will survive in this acid water. It is toxic also to fish.

The Soil Conservation Service began field trials in 1957 to determine if the above condition could be corrected by repeated impoundment and draining to exhaust the acid material in the soil. Four brackish ponds were used for the trials. These were made on cat-clay fields which had been drained and dried for five or more years in a failing attempt to develop pastures. The owners now wished to make them into widgeongrass duck-ponds but the water impounded became too acid. A plan was devised to flood the fields with brackish water, drain it off, and repeat. The size of the water control structures in Ponds #1 and #2 required a period of about a month for each change of water.

Pond #1, 120 acres, had an initial pH of 2.5. After four changes of water (4 months) it was only 3.0. After nine changes the pH was 4.0. On the tenth change of water, there was an abrupt rise to a satisfactory pH of 6.0.

Pond #2, 58 acres, had an initial pH of 2.5. After ten changes of water the pH was 3.5. After twelve changes, the pH was 5.5. Again note the abrupt rise to a satisfactory pH.

Pond #3, 100 acres, had an initial pH of 3.0. Because of a unique location in respect to tidal intake points, it was possible to route an almost continuous flow of brackish water through a 12-inch pipe, into and out of this pond. At the end of four months of this flow, the pH was 3.5. After twelve months, the pH was 4.0. After seventeen months of flow, the pH was 4.5.

Pond #4, 60 acres, had an initial pH of 3.5. This pond had a large, high-capacity water-control structure so the impoundment could be rapidly drained and refilled. This structure became defective and for a while the water fluctuated with the tide, so records of water changes are not available. After six months, the pH was 7.5 and there was a good stand of dwarf spikerush, but it was completely covered with a brownish deposit tentatively identified as ferric hydroxide.

From these trials, it was determined that the acid of such fields could be exhausted if there was enough water available for repeated changes. It appears that little can be gained by installing large water-control structures for rapid draining and filling. A shorter period will not give an opportunity for the commonly present acid-algae to decompose. Also the rapid transition to a more alkaline condition may produce an undesirable precipitation of ferric hydroxide.

A pH of 4.0 was found to be the critical point in correcting acidity in impoundments for growing duck foods. At a subtile change in pH slightly above this, dwarf spikerush begins to appear in the impoundment. Widgeongrass requires a higher pH, possibly more than 5.0, but this was not determined.

MEASURING SALINITY

A simple method, suitable for most field determinations in wildlife management, was developed in South Carolina for measuring the approximate salinity of water. The instrument used is an inexpensive Vogel Urinometer—originally designed for use in urine analysis. The complete outfit is pocket-size and consists of two small hydrometers and a small glass cylinder. One of the hydrometers is used for salinities of 0 to 25,000 ppm and the other for 25,000 to 50,000 ppm. Vogel Urinometers are available from most laboratory or medical supply firms.

To use the Vogel Urinometer to measure salinity, fill the glass cylinder with the water sample. Now float the hydrometer in the cylinder (use the hydrometer graduated 1.000 to 1.025). Read the scale where it protrudes through the surface of the water. Each scale division, reading down from the top, is equivalent to 1,000 ppm salts in the water. Each fifth division of the scale is numbered 1.005, 1.010, 1.015, etc. Disregard the 1 and just read the figures to the right of the decimal point. For example, if the hydrometer floats at 1.008, the salinity is 8,000 ppm. Readings between the divisions have to be interpolated (about one-quarter of a division—250 ppm—is as close as you will be able to read). If the scale of the first hydrometer floats clear of the surface of the water sample, the water is above 25,000 ppm salts so switch to the other hydrometer in the kit for the high salinity readings.

The Vogel Urinometer is calibrated to read correctly only at 60° Fahrenheit. Above that temperature the hydrometer will float deeper than the proper scale reading. Below 60° it will float higher. However, it is easy to make the proper correction. Measure the temperature of the water sample with a small glass thermometer (the type photographers use in the darkroom is excellent). For each degree the temperature is above 60°, *add* 100 ppm to the salinity reading on the hydrometer. For example, if the water temperature is 68°, add 800 ppm to whatever the hydrometer scale indicates. If the water temperature is below 60°, *subtract* 100 ppm for each degree below 60°. (Note: the correction is slightly greater than 100 ppm/degree but that much accuracy is not necessary as it would exceed the basic accuracy of the hydrometer.)

Another method of measuring salinity is by the electrical conductivity of water or an extract from water-saturated soil. The greater the amount of dissolved salt, the better the sample will conduct an electrical current. Being the reciprocal of resistance, which is measured in ohms, conductivity is expressed in mhos (ohms spelled backwards). The standard unit is the conductivity through a one-centimeter cell of the sample and is meaured as millimhos per centimeter ($EC \times 10^3$).

Several types of instruments are manufactured for measuring electrical conductivity in millimhos per centimeter. The disadvantages of these instruments for field biologists are that they are expensive, some have a limited range of salinity measurement, and they are more of a laboratory type of instrument and not well suited for field use. On the advantage side, they are very accurate and provide the best method of measuring salinity of the soil.

Titration with silver nitrate has probably been the most universally used method of measuring salinity. It is extremely accurate and is perhaps the best method of determining very small amounts of salt. The salinity can be measured in either parts per million, parts per thousand, or grains per gallon, depending upon the standardization of the silver nitrate solution.

One procedure is to use a 50-milliliter sample of the water to be tested. Add five or six drops of a five per cent potassium chromate solution for an indicator. Titrate with a silver nitrate solution (Standardized for 1 ml = 5 mg NaCl) to a color change of yellow to orange. The number of milliliters of silver nitrate used, multiplied by 100, gives the salinity of the sample in ppm. Many field biologists find it more practical to purchase standardized solutions from a commercial laboratory than to prepare their own.

SUMMARY

Methods have been developed for the management of brackish water impoundments for commercial shrimp production, for producing crops of fish for commercial harvest or sport fishing, and to grow duck foods. Methods have also been developed for making duck fields, snipe fields, and wild goose pastures on saline soils. Management methods are described for various ranges of salinity.

Cat-clays are a potential hazard for wildlife management in coastal marshes. By means of repeated changes of water, it is possible to reclaim some areas where cat-clays have developed.

An inexpensive and convenient field method of measuring salinity is with a Vogel Urinometer. Other methods are by electrical conductivity and titration. A nomograph is presented for easy conversion of the various ways of expressing salinity. A listing by salinity tolerance is made of selected agricultural crops, native duck food plants, and other native plants.

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DISCUSSION

DISCUSSION LEADER MANVILLE: Thank you, Mr. Neely. You have heard many suggestions for utilizing these lands occasionally referred to as sub-marginal, or of low fertility. Although Mr. Neely did not pin it down to one resource, he did at the possibility of managing these lands for many types of resources. I hinted curious myself as to just what the range of the tides is in the areas on which he reported.

MR. NEELY: Well, in the particular area where our field trials for salt water fish ponds and shrimp ponds are concerned, we have a mean tide of about five feet. We believe that we could carry on the same operation, however, with pumps where there is very little tidal variation.

MR. ROBERT CHABRECK [Louisiana Wild Life and Fisheries Commission]: I would like to ask Mr. Neely if he has had any experience with moving shrimp into ponds supplied by a pump. We have tried this on a small scale but haven't had very much success with it.

MR. NEELY: The disadvantage we would run into in stocking a shrimp pond with a pump is to know when the post-larval shrimp are in the creek or area from which you want to pump the water. We are using more or less of a shotgun method where the water is let in from mid May to July, and somewhere in that period we would expect the most heavy concentration of post-larval shrimp. The post larval shrimp, incidentally, could likely come through a low-head pump unharmed because of their small size.

MR. JOHN R. CLARK: I wonder what experience you have had with fish. You mentioned it in passing. Could you say just a few words about any experience you might have had with fish in such enclosures?

MR. NEELY: The full paper covers such things as bass and bluegill management in brackish water, which seems almost heresy, up to the salt water species. In our impoundments we have been able to produce black drum, channel bass, great spotted sea trout, ten pounders, and quite a variety of others. As far as salt-water fish goes, this type gives very good fishing, and you have the additional possibility of growing a commercial crop. We now have some trials underway for managing bass and bluegill separately in ponds with a salinity of about 4-5000 ppm. Therefore, we have a possibility of controlled populations since they won't spawn at this salinity. You stock a certain number of fish per acre, and that is how many fish you have. As you know, an over population of bluegill is usually one of the things that leads to trouble in these ponds.

MR. CLARK: Since the location of the impoundments must be critical when you are using natural stocking, that is deriving your recruitment from the open sea with salt water fishes, I wonder if you have assembled data of a survey nature on the location of areas that would be suitable for such impoundments?

MR. NEELY: Not as such. The type of locations we like to use have a tidal variation and we get recruitment from the tidal variations. As far as you can go inland with brackish water and still have the tidal variations, you can still get such fish as mullet stocked.

MR. BOB DEHARMON: Do you have any growth data on these shrimp after they stay inside this impounded area for three or four months?

MR. NEELY: The post-larval stage when they are stocked is only a few millimeters long, and when we drain in November, the shrimp are 6 to 6½ inches long. We have to harvest shrimp then because winterkill would be almost a certainty.

VALUATION OF A FISHERY[1]

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Of all the problems involved in the wise management of fish and wildlife, none is more pressing than the development of a sound method of measuring their contribution to our economy. The time has passed—if indeed it ever existed—when the fisheries could exercise an automatic claim on water and other resources. The costs of preserving the environment of the fisheries and of the necessary protective and propagation measures are mounting. At a time when rising population and per capita incomes are expected to produce rapid and continuing increases in the demand for both commercial and recreational fishing, natural limitations and the encroachment of civilization are trenching steadily upon supplies. The urgency of adequate valuation of these resources is, of course, heightened by the fact that the decisions made now are largely irreversible. We may discover, some decades hence, that an accurate accounting of the value of our fisheries would have justified their preservation or extension in many areas, but once they have been sacrificed to alternative uses they can seldom be restored except at prohibitive cost.

This does not imply that fishery resources have an absolute value derived from some mystic quality not capable of measurement in dollars. There may well be occasions when social welfare requires the sacrifice of all or part of a fishery resource in the face of more compelling demands. The central theme of this paper is that fisheries, in the last analysis, must stand the same test as other users of natural and human resources: the enhancement of human welfare. Moreover,

[1] This paper is based on an article in *Land Economics* May, 1962. Support and assistance of the Department of Fish and Game, State of California, is gratefully acknowledged.

it will be argued that this is best accomplished within the framework of a market price system in which our most essential choices are made. Where the market mechanism does not register these choices adequately—certainly the case in the fisheries—it is essential to simulate its operation to develop estimates that will permit comparison of the net contribution of the fisheries with that of competing users of common resources. The growing public demand for outdoor recreation facilities is as much a part of the process of economic choice as the decisions to buy food, clothing, shelter, and other necessities. As a lifelong fisherman and an economist I see no conflict in these attitudes. If the fisheries are worth as much as they seem to me and my fellow sportsmen, accurate valuation will support conservation and propagation measures. If not, they must make way for more important resource uses.

For the vast majority of resources, valuation is carried out perfectly adequately by the market mechanism. No public policy is required other than to provide the information necessary to permit owners of resources to use them efficiently. As long as income-producing assets and their products are bought and sold in a free market, the opinion of many informed investors is brought to bear on the flow of net income which these assets will yield and the rate at which it is to be discounted back to the present. Private and public interest are both served by using resources in a way that maximizes their present value. Difficulties arise, however, when resources are not freely marketable, when ownership in the usual sense cannot be established (that is, when resources are held to be common property), and when it is not possible to identify accurately either those who receive the benefits from the use of the resource or those on whom costs are inflicted in the process. The benefit-cost approach to valuation, now widely used in situations of these types, was developed initially to deal with conflicting water use patterns, and thus has found its principal application in the handling of river basin development programs. It is of broader applicability, however, and offers the most promising approach to the valuation of fisheries, where the common-property status of the resource and the fact that sport fishing services are not marketed in the usual sense rule out the normal pricing process.

VALUATION OF COMMERCIAL FISHERIES

The valuation of commercial fisheries presents no special problems with respect to the calculation of benefits. The end products are sold in conventional manner, and can be valued by reference to market prices. Calculation of costs (and therefore of net benefits), however, presents serious conceptual difficulties. Most fisheries are regarded as common property; anyone is free to enter the fishery, subject only to any general licensing and conservation measures imposed by the State. Under this concept of "no ownership," it is painfully obvious that no net economic yield will be realized. If there is any margin at all between benefits and costs (the latter including a reasonable return to capital and management), new vessels and men will enter the fishery until costs and prices are again brought into equality.

This is the essence of the conservation problem in fisheries. Each individual fisherman may realize that he would be better off if fish were allowed to propagate and to reach more marketable size, but any attempt by the individual to increase yields by reducing his fishing effort simply results in a larger catch for other individuals. It is literally true that "everyone's resource is no one's resource." The common property status of a commercial fishery also makes it impossible to use conventional benefit-cost techniques in determining its maximum net economic yield. Under present concepts of rights to fish and present regulatory methods there will be no net yield from a commercial fishery once full economic adjustment has been attained. Even if the fishery were destroyed the labor and capital engaged in it under these conditions would produce as much or more when shifted to other occupations.[1]

But surely this involves a comparison of the yield from fisheries with that of other resource users under vastly different conditions. The net yield from power, irrigation, and other water uses is calculated on the assumption of sensible management to maximize income from a valuable property right. Yet fisheries are valued on the basis of a legal concept of free entry that prevents anyone from establishing property rights and virtually guarantees that costs will rise to meet income at any level of production. A more valid basis of comparison would require that the potential net yield from the fishery be estimated on the basis of the lowest attainable costs available with present technology. This would imply a situation in which either a franchised producer or perhaps the government itself is assumed to manage a fishery resource to produce the largest sustained net economic yield of which it is capable. The technology of commercial fishing is such that calculations of minimum attainable costs should be no more difficult and no less accurate than those undertaken in estimating benefits and yields from other water uses.

In an unpublished study, Mr. D. H. Fry of the California State Department of Game and Fisheries has estimated net economic yields from the Sacramento and San Joaquin River salmon fishery using this

[1]For a detailed discussion of the economic effects of the common property concept, see Gordon (1954) and Crutchfield (1956).

technique. Average landings over the last ten years of record are approximately eight million pounds, worth about $3,300,000 to fishermen. Fishermen exploiting this population at present are receiving incomes barely sufficient to cover operating expenses and it may be assumed that total costs are equal to total receipts. Fry's calculations indicate that a modern small-boat gill net fishery, operating on a fully rational basis, could take the same catch at an annual cost of approximately $330,000. In short, a net economic yield of approximately $3,000,000 per year would be realized, using known techniques, but with the fishery restricted to an optimum number of boats. As a by-product, control of escapement would be more precise and far easier to administer.

This may well be an exceptional case. It is believed, however, that the difference between present economic returns and the maximum attainable would be very substantial for virtually every intensively exploited commercial fishery. If, for example, potential net yields from anadromous salmon fisheries might range from 50 per cent to 90 per cent of market values, the scope, timing and form of power development programs on western rivers might have been altered significantly. This does not mean that fish should always win out over power. But it would be comforting to feel that the decisions reached reflected an accurate appraisal of benefit and cost from all potential users of the same river flows. Application of this approach might have prevented the step-by-step destruction of a major part of the great Columbia River salmon fishery, to cite the most obvious case.

It is also worth noting that river development projects frequently involve partial or total destruction of commercial fisheries in order to permit the development of power, flood control, irrigation and transportation projects. The latter uses represent new economic activity for which new capital equipment must be put in place, presumably in the right spot at the right time. The destruction of all or part of the fishery, however, will render much existing capital devoted to processing and marketing virtually useless: While the loss of these investments may be offset in the long run by increased economic yield from other uses of water, the gains do not accrue to the same people, and frequently are not offsetting within the same region. Equity considerations suggest that consideration of the negative effect of any kind of development project on an existing commercial fishery must be extended beyond fishing activity to measure the losses inflicted on processers and marketers whose capital equipment is not adaptable to other uses.

We conclude that the common property status of our commercial fisheries, which has been carried forward even where conservation programs have been instituted to curtail overfishing, has resulted in serious undervaluation of the contribution of the fisheries to the economy. In view of the long-run nature of decisions to maintain or reduce a fishery, it would seem far more appropriate to calculate potential net economic yield on the basis of rational management in making comparisons of fisheries with other competing resource users.

VALUATION OF SPORT FISHERIES: SOME FALSE ISSUES

The valuation of sport fishing presents much greater difficulties, even of definition. For example, there is much confusion in current literature: over (1) the nature of the "product" in sport fishing; (2) the distinction between gross and net economic yields; and (3) the question of whether sport fishing should be valued in money terms even in principle. We shall argue that sport fishing, as a service, represents an economic product which is identifiable both as to form and usage. The primary difficulties in placing a value on this service arise because sport fishing, like most other outdoor recreation, is not marketed commercially. Moreover, general acceptance of the principle that all citizens shall have access to sport fishing under public ownership or control, free or at nominal cost, makes it even more difficult to determine the number of users and the value which they place on the right to fish. Potentially, then, sport fishing can be valued like any other productive service. This is indicated clearly by the experience in Eastern Canadian and European waters, for example, where fishing rights are leased or sold on a commercial basis, and where regular market prices are established as a result. The fundamental problem arises out of a social decision—in many respects a wise one—to give away valuable water use rights to anglers.

Before turning to the valuation problems presented in this kind of setting it seems desirable to dispose of some false issues which have clouded analysis of the economics of sport fishing.

1. It has been argued that sport fishing is incapable of economic measurement because its contribution is "intangible." If the term "intangible" refers to the fact that no physical product is involved, the point is entirely irrelevant. The services of professional athletes, lawyers, doctors, motion picture actors, and a variety of other economic producers are also intangible; yet their services are clearly defined, the users can be identified, and their price is determined in conventional fashion by supply and demand considerations. In a more basic sense, many of the physical commodities can be more accurately described as generators of useful services; we use the transportation services provided by an automobile, not the automobile itself, in our capacity as consumers.

The word "intangible" is also used to indicate that certain economic services are not measurable in money terms. It is, however, quite possible to put a price on sport fishing and to ration its use by allowing fishing rights to go to the highest bidder. The fact that we have chosen to make these rights freely available, and to ration the available supply of fish by imposing catch limits or other restrictions, is a social decision only. It is at least conceptually possible to develop estimates of what sport fishing is worth to its users.

2. A substantial body of opinion in the United States and Canada holds that sport fishing should not be valued in money terms, even in principle. Stripped of its emotional content, this position rests on the assumption that the values placed on fishing (and some other types of outdoor recreation) are infinite. No other competing use, however important, should be permitted to cut into available supplies of sport fishing resources. Alternatively, the unwillingness to subject sport fishing to economic evaluation may imply that the values involved are in some way loftier and more desirable than those involved in man's everyday choices relating to the business of living.

I feel strongly that this view must be rejected. The principle of free choice on which our market economy rests is not limited in application to phyiscal necessities alone. The market mechanism registers with a satisfactory degree of accuracy not only our desire for food, clothing and shelter, but also the relative value that we place on symphony concerts, education, travel, and a host of other alternative uses of income. We must, after all, make decisions as between physical consumer goods, and those products which satisfy the intellectual needs of society. To argue that economic values cannot be placed on resource uses that contribute to education or esthetic satisfactions is to deny the very rationale of a private enterprise economy and the free society of which it is an essential part.

3. A closely related position holds that fisheries, both sport and commercial, cannot be analyzed with conventional valuation procedures because they involve the production of food. It is argued that rising world population, coupled with physical limitations on the food supply, will eventually result in values for food products greater than those indicated by the market mechanism. Again, this indicates a fundamental misunderstanding of the economic process in an enterprise economy. Most of the developed western economies like that of the United States are faced not with a problem of producing enough food but of making the necessary economic and social changes to take advantage of our ability to produce more and more food with less and less effort. Quite apart from this empirical evidence, if protein foods should become increasingly scarce, their prices will rise to reflect that

scarcity. To argue that the market mechanism will not recognize fully the need for more fish implies that it has broken down in the performance of its basic task: the translation of need and willingness to pay into price changes which induce the needed adjustment of production.

4. A final invalid objection to current valuation of both commercial and sport fisheries involves a time dimension. Since a fishery, properly managed, will yield its benefits in perpetuity, it is argued that valuation based on current output and cost will significantly understate its real importance to the economy. It should be noted, first, that the perpetual flow of output from a properly managed fishery does not make it unique. Forests are capable of a sustained yield of wood, rivers of a sustained flow of water, and capital equipment (properly maintained and replaced when necessary) of a continuous flow of electric power. Valuation of a sport or a commercial fishery is simply a special case in a general valuation procedure: the establishment at a moment of time of the present value of the stream of net income to be realized in the future.

CURRENT VALUATION TECHNIQUES

Most of the applied work in valuation of sport fisheries represents some variant of the gross expenditure approach. Since the service itself is rarely sold, there exists no record of the market value of sport fishing. We may, however, take advantage of the fact that the amounts spent on fishing represent a reasoned estimate of the individual fisherman's appraisal of the product. The value of what he must give up in order to enjoy his sport can be taken as its gross market value to each fisherman, and these figures may be aggregated to give a total value for the sport fishery in question. It should be noted that the expenditures of fishermen represent only part of the cost of providing the fishery. The cost of local, state, and federal services which contribute directly to sport fishing should also be included. This approach thus provides an estimate of the cost required to get the angler to the fishing area, properly equipped, and with a prospect of catching something.

Unfortunately, this concept of gross market value or gross expenditude on sport fishing is not particularly useful. Most of the crucial policy issues turn on estimates of the actual loss to the economy if the fishery were to be curtailed or eliminated completely. Clearly, expenditures on gasoline, fishing tackle, lodging and other expenses incurred in sport fishing do not fall in this category. If the sport fishery were to disappear, these expenditures would be directed at other recreational activity or at other goods and services. We would certainly be somewhat worse off, since we would be forced to second choices, but it is apparent that the full measure of the loss will be far less than the total spent on sport fishing. The results of the endless surveys of sport fishing expenditures are of real importance to manufacturers of tackle and other industries directly concerned with servicing fishermen, but they contribute nothing material to the vital question of the relative importance of fisheries as compared to competing users of resources.

What is really needed is a measure of what fishermen would be willing to pay for the right to fish. The great majority of sport fish must be rationed, by catch limits, possession limits, or other techniques, to prevent overfishing. It is obvious, therefore, that the "price" of sport fishing is below it equilibrium value; that is, we are giving away valuable rights rather than charging the full amount fishermen would be willing to pay rather than turn to other uses of funds. It is this amount which would be lost if the sport fishery were to be shifted to other products, the money value of the right to fish would disappear with no offsetting increase elsewhere in the economy. This is a measure of net economic yield, precisely comparable to that employed in benefit-cost analysis generally. It is the only figure that will permit valid comparisons of the contribution of sport fishing to that of other competing products, and valid appraisals of the soundness of various types of investments in conservation and propagation programs.

There is no easy way in which the value of rights to fish can be estimated. It is important, however, that we recognize the significance of this application to sport fishing of the concept of net economic yield. The cause of conservation and expansion of sport fishing opportunities has been seriously damaged, in my opinion, by the attempt to represent gross expenditures as a true measure of the net economic contribution of sport fishing to the economy. We will do far better to work with numbers that are smaller but that can stand the test of economic validity—to which they will inevitably be subjected.

It is one thing to state a principle of valuation and quite another to make it operational. A number of writers have attempted to develop techniques by which a demand function for fishing rights could be simulated. Clawson (1959), Trice and Wood (1958) and Hotelling (1949) have all proposed methods in which differential travel costs are used to estimate the price that could have been charged for use of recreational facilities to those living close by. From this we could derive schedules showing the amount of usage at varying charges, and thus calculate the maximum net revenue under optimal management. There are technical differences in these proposals which need not concern us at this time. All are potentially capable of providing estimates of the type needed.

In actual operation, however, there are serious difficulties in obtaining useful results from any of them, although the techniques proposed by Clawson are probably closer to being operational than the others. The assumption that people near the resource have exactly the same attitude toward its use as those located at greater distances is likely to involve difficulties. The "price" paid by people far removed from a recreational resource would probably understate its worth to those nearby who know far more about its attractions. It also seems likely that a considerable number of people would have settled in the area because such facilities were readily available, For obvious reasons, these techniques tend to break down where all or a major part of the users are concentrated in the immediate vicinity of the resource. Finally, these techniques lump together the benefits from all types of outdoor recreation available at a given location. They do not permit segregation and separate evaluation of benefits from sport fishing, boating, camping, and other joint benefits flowing from the recreational opportunity. Moreover, they do not permit separate evaluation of other factors that might have induced more distant users to make the trip to the site in question. This would not be serious if it could be assumed either that all recreational benefits are additive or complementary, or that they are available only in fixed proportions at any one location. Neither assumption seems warranted. Fishing is frequently competitive with boating, water skiing, and similar sports, and it is almost always possible to vary the extent of the development of each of these various uses. Unless all recreational uses of resources in the area are of exactly equal value, the "mix" of different types of recreation will have a significant effect on total value derived from its use.

A more direct approach to the problem would be to survey fishermen in the areas in question to determine the effect of varying charges for the right to fish on their planned fishing time (Ciriacy-Wantrup, 1952). A sufficiently broad and proper stratified sample could be aggregated to provide a demand function for fishing rights at various charges that would permit determination of the maximum net yield from a fishery. Again, however, practical considerations make this approach extraordinarily difficult to use. Experience demonstrates that surveys of "intention to buy" are subject to biases which frequently lead to overestimates of demand. It is one thing to say that one's fishing would not be affected by a $10 license fee, and quite another if it becomes necessary to pay the $10. In addition, direct surveys of the willingness to pay fees for fishing rights must specify a variety of other considerations. For example, the answers obtained would vary significantly if the additional license fees were coupled with increased catch limits or the complete abolition of catch limits. Similarly, the amount which would be paid for a particular type of sport fishing license would depend critically on whether other sport fishing available to the angler were to remain free or to be taxed at the same rate.

It may well be that these problems could be overcome in a properly designed survey, carried out by highly competent enumerators. It might be well worthwhile to attempt such surveys under conditions where the complicating factors mentioned above are at a minimum. At the very least, they might bring us more useful information than the large sums now being spent on surveys of gross expenditures by fishermen.

Two other approaches to the valuation of sport fisheries which attempt to bypass the knotty problem of measuring net economic yield (or willingness to pay for fishing rights) deserve some attention. The first argues that a minimum value for sport fishing could be established from the market value of the fish taken by anglers. In cases where sport and commercial fisheries exploit the same species this is clearly possible. In cases where species are reserved entirely to sport fishing it would be considerably more difficult to simulate a market price. In any event, the procedure could be justified not on the ground that the fishermen's actions are governed by the market value of his potential catch, but rather on the ground that the sport catch of any fishery being exploited at or near maximum sustained yield represents a net subtraction from the potential commercial catch. While this is analytically correct, it begs the really crucial question. Where sport and commercial fisheries are based on the same species, the *relative* value of the two uses is frequently a matter of vital concern, and if they are equated by definition we can derive no useful answer as to the proper allocation of available fish.

It has also been suggested that the value of a sport fishery could be estimated by assuming that the value of a man-day of sport fishing is equal to a man-day spent in productive activity. In a crude sense it might be assumed that the total national output can be produced only if sufficient time is taken for recreation and recuperation. A more refined version would value fishing days at the income level actually earned by each fisherman, presumably determined on a sample basis.

Even if the crucial assumption that recreational hours make possible production hours be accepted, this method of analysis would be of little use. It results in the nonsense conclusion that all recreational activity (or, for that matter, all time other than that devoted to working) is of exactly the same value. It is perfectly obvious that this is not true of the many recreational activities which are priced in the market. Again, the primary problem of evaluating fisheries by comparison with other recreational uses of resources would remain, since all would be equal by definition.

CONCLUSIONS

In brief, the prospects for finding *the* universal method for the valuation of sport fishing are dim. We should hardly expect to find it otherwise. There is no more reason to expect uniform values per day or per fish for sport fishing than for acres of farm land or bushels of potatoes. What we need are uniform principles, which can be applied to a variety of unique situations. We are really handcuffed because the enormous assistance of the market price mechanism, reflecting the collective informed decisions of users of the service, is not available to us.

All is not black, however. The Clawson approach does hold real promise in some special cases, and much can be accomplished in terms of orders of magnitude even where absolute measures of value are not obtainable. Sampling can provide reasonable estimates of angler days and numbers of individual fishermen. Faced with any of several types of policy decisions (the construction of a dam, for example), we can estimate the total dollar value and amount per angler which would be required to move the project out of the feasibility range. Common sense may then suffice to judge the reasonableness of this minimum significant value for the sport fishery affected. Similar reasoning may be usefully applied where the issue involves competing sport and commerical fisheries. We need not, after all, argue for perfection or no economic analysis as the only alternatives.

Finally, I should like to offer, in the face of certain disapproval by a majority of professionals in the field, a plea for more realistic pricing of sport fishing. There is no obvious reason why we should not levy charges for sport fishing licenses which cover at least part of the real economic value of the privilege conferred. At present income levels this will not work any real hardship on the great mass of fishermen, and it will give us an indispensable statistical toehold on the basic problem. Paradoxical as it may seem, the insistence on virtually free access to sport fishing may have the effect of closing off the information which would do most to guarantee its preservation and growth.

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DISCUSSION

DISCUSSION LEADER MANVILLE: We have heard some very stimulating ideas on an extremely complex topic in a field which means bread and butter to many of us. It has been good to hear reference to some of the intangible values of fisheries to which the dollar sign may not be conveniently attached. I am sure Dr. Crutchfield will be glad to answer questions which any of you may have.

MR. DON MERRICK: You have made reference to how not to evaluate the fisheries. I am wondering if you have given thought to your proposed new method as to whether it would give fisheries greater value in the light of other types of development—hydroelectricity, for example—and what the relationship would be between the two in your new method.

DR. CRUTCHFIELD: I can give you two illustrations. One, I already suggested, were calculations which Dr. Fry made in the Columbia River. About 9 per cent of the gross market value of that salmon catch, purely commercial value, gives an annual yield of about $3 million a year, capitalized at 4 per cent. This would mean that the resource is worth probably $75 million, and that is quite an additional cost to add to a hydro project. I have also run some rough calculations, which have been taken only as very crude estimates because the work is not yet complete, on two other cases, one involving the Columbia River. These are rough and should only be taken as such, but I would estimate that of the 20 to 25 million dollars, which represents roughly the gross market value of the Columbia River salmon catch, something in the vicinity of 15 to 18 million dollars represents net economic yield if we really harvested this fish. As you know, all of the upstream run could be siphoned off at the upriver dam.

A third case represents the sport and commercial values of the silver and chinook fishery on Puget Sound. Here we could not evaluate accurately the sport catch, but what we are doing is sort of doing it in a negative sense. We know roughly the number of salt-water fishermen who fish salmon on the Puget Sound River. We know the gross value of the commercial catch and know pretty well the net value. This would give us an estimate of what we would have to charge each salt water fisherman if we established that the sport fishing is more valuable than the commercial fishing. It takes a very, very low figure indeed for salt-water anglers to come up with the conclusion that the sport utilization is probably the most economic. What I think we can do is not to get absolute measures which are very accurate but better than or worse than decisions which for policy purposes may be very very important to us.

MR. GEORGE EIKER [Wyoming]: We have been wrestling with figures for a good many years, on the valuation of sport fisheries. You mentioned the fact that people can go out and have some other kind of recreation with their money. I wonder if you would explain just why that would be any different than the value of commercial fishing. That person might just as well go out and buy beef.

DR. CRUTCHFIELD: Yes, it would. What we are trying to measure is the gross market value of a sport fishery which can be measured roughly by what people are willing to spend to get to the fish and with equipment to catch the fish. But if the fishery is to be cut back by 50 per cent, we'll say, because of a hydro project, the question is: "What is the net loss?" This is not the total amount that people will be spending on that sport fishery because, while we are being forced to second choices, we are not as well off as we were before. We wouldn't have gone fishing in the first place, but we will be able to use the money for other things.

But there is a difference with regard to the right to fish. It costs about a hundred dollars a year for the average Puget Sound steelhead fisherman. Suppose we were asked to pay an additional fifteen dollars a year, which most of the steelhead fishermen would pay rather than go without. The total market value then is about $115 a year to the average steelhead fisherman. If the fishery were to disappear, the $100 that he spends on tackle and gas and so forth would be spent on something else. The $15 would be lost entirely. That is the total net loss, and that is what you have to compare—the loss in value to the sport fishery as against the benefits that you get from power or irrigation or whatever usage is involved, because they are also calculated in net terms; that is, the market value of what you get, minus the cost of producing. This is the one that I think is hardest for people to swallow; yet you can't sensibly argue that if the sport fishery would disappear, this would be four or five billion dollars' loss to the economy. There would be some loss, but we wouldn't lose that much, and we wouldn't do the sport fishery any good by arguing that it would.

SALT-WATER ANGLING AND THE RESOURCES PROBLEM

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There has been much comment in recent years about the rapid expansion of salt water sport fishing. Remarkable growth has been shown by such indicators as skiff rentals and tackle sales. Clearly the sport is expanding at a dramatic rate.

The role of salt-water angling in the national economy has been defined in reports of many surveys. The most comprehensive of these is the U. S. Fish and Wildlife Service's National Survey of Hunting and Fishing for 1960, which shows an increase in all components of salt-water angling of 35 per cent in only five years. There were 6.2 million salt-water fishermen in 1960 who fished a total of 81 million days.

Growing apace with the sport itself has been a general concern about the impact of so much fishing on our seafish resources. In response to this concern, Congress in 1959 directed the Secretary of the Interior to begin a special investigation of salt-water angling. The first major project under this directive was an inventory of catches of marine anglers, conducted for us by the Bureau of Census as an adjunct to the 1960 National Survey of Fishing and Hunting. The survey consisted of a house-to-house canvass of 45,000 persons in 18,000 households which were selected by area-probability sampling techniques. A full technical report will be published by the Bureau of Sport Fisheries and Wildlife in the near future.

From the survey material we can draw a general description of the fishery and its role in the national recreation picture. There were 6,198,000 salt-water anglers who took 632,872,000 fishes in 1960—an average of 102 per fisherman. Table 1 shows that the fishing is distrib-

TABLE 1. SUMMARY OF SALT-WATER ANGLING IN THE UNITED STATES (EXCEPT HAWAII) DURING 1960

Area	Number of anglers	Number of fish Total	Per angler	Pounds of fish
I. Maine to New York	1,160,000	97,383.000	84	183,840,000
II. New Jersey to Cape Hatteras North Carolina	1,344,000	114,502,000	85	178,000,000
III. Cape Hatteras to Florida Keys	1,024,000	156,942,000	153	370,112,000
IV. Gulf of Mexico	1,412,000	184,582,000	131	411,110,000
V. South California (Point Conception, South)	687,000	50,064,000	73	154,120,000
VI. Alaska to Point Conception	714,000	29,399,000	41	113,770,000
All Areas	6,198,000	632,872,000	102	1,410,952,000

uted rather evenly among the coastal regions, if shoreline length and population density are considered.

The total catch of 633 million fish indicates a heavier drain on marine fish resources than had been expected. A better idea of impact on the resource is to be gained by catch volume, which we have estimated to be 1.4 billion pounds for 1960. This figure is based upon estimates of average weight for individual species categories as reported to us by state conservation departments, marine laboratories, and experienced fishermen.

The catches are presented in more detail in Table 2 for the 20 species groups taken in greatest number. These 20 groups comprise nearly 80 per cent of the total number of fish caught. Together they account for about 63 per cent of the catch volume.

The survey yields no data precise enough to provide for a determination of the effects of fishing on the resources. The only available basis for even a general comparison appears to be with commercial finfish landings for human consumption, which amounted to about 1.7 billion pounds in 1960. This indicates only that the 1.4 billion pounds taken by sportsmen represents a substantial proportion of the total catch of seafishes.

From such subjective appraisal of catch volumes, one is led to the conclusion that there is even now a heavy rate of exploitation on our fish stocks by the present 6.2 million anglers. Present predictions call for a near five-fold increase in salt-water anglers by the end of the century. We must then ask ourselves this question: What can be done to meet the needs of the 30 million anglers of the year 2000? The answer will certainly involve not only skillful management, but also basic resource improvement.

The great recreational value of angling cannot be challenged. Fishing is a versatile and varied activity. It provides an opportunity for exercise, fresh air, and an escape from the fast pace of modern life.

TABLE 2. CATCHES BY SALT-WATER ANGLERS OF THE 20 MOST IMPORTANT (NUMERICALLY) CATEGORIES OF SPECIES REPORTED IN THE 1960 NATIONAL SURVEY OF SALT-WATER ANGLING. AREAS ARE DEFINED IN THE SIDE HEADS OF TABLE 1. FIGURES ARE GIVEN IN 1000'S.

Species category	Area I		Area II		Area III		Area IV		Area V		Area VI		All Areas	
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Bluefish	4,831	11,110	11,748	25,850	7,181	13,640	54	80	......	......	......	......	23,814	50,680
Bonitos	179	720	398	1,030	26	180	47	210	12,079	42,280	......	......	12,729	44,420
Catfishes	......	......	781	600	8,934	13,400	22,290	22,290	......	......	690	690	32,695	36,980
Croakers	......	......	8,214	7,390	3,741	3,000	31,611	18,970	1,901	1,900	110	80	45,577	31,340
Drum (Red)	......	......	456	11,400	4,527	27,160	10,294	32,940	......	......	......	......	15,277	71,500
Flatfishes	28,794	40,310	12,382	12,380	202	300	3,517	6,330	2,633	6,580	3,118	7,800	50,646	73,700
Groupers	......	......	......	......	2,286	34,290	9,346	74,770	......	......	......	......	11,632	109,060
Grunts	......	......	......	......	19,032	20,940	1,877	1,310	......	......	......	......	20,909	22,250
Jacks	......	......	10	10	8,241	41,200	4,324	24,200	......	......	......	......	12,575	65,410
Kingfishes (*Menticirrhus*)	1,139	800	3,143	1,570	18,098	16,300	7,241	6,520	......	......	......	......	29,621	25,190
Mackerel, Atlantic	10,097	10,100	750	830	......	......	......	......	......	......	......	......	10,847	10,930
Mackerel, Spanish (*Scomberomorus*)	......	......	......	......	7,380	24,830	5,149	11,330	......	......	......	......	12,529	36,160
Mullets	......	......	68	20	17,128	15,420	2,044	......	......	......	......	......	19,240	17,480
Porgies	14,909	13,420	3,177	3,180	10,553	20,050	8,550	12,770	......	......	......	......	37,189	49,420
Puffers	6,437	3,220	4,256	1,700	18	10	......	......	......	......	......	......	10,711	4,930
Seatrouts (*Cynoscion*)	295	530	3,308	3,310	15,352	23,030	64,881	103,810	......	......	......	......	83,836	130,680
Snappers	......	......	......	......	9,433	26,410	3,414	9,560	......	......	......	......	12,847	35,970
Spot	......	......	23,703	7,110	6,526	3,260	......	......	......	......	......	......	30,229	10,370
Striped bass	2,742	12,340	6,530	24,810	67	360	......	......	61	240	3,002	19,510	12,402	57,260
White perch	1,413	850	13,162	6,580	948	280	191	100	......	......	......	......	15,714	7,810
Others	26,547	90,440	22,416	70,230	17,269	86,052	9,752	83,880	33,390	103,120	22,479	85,690	131,853	519,412
Total	97,383	183,840	114,502	178,000	156,942	370,112	184,582	411,110	50,064	154,120	29,399	113,770	632,872	1,410,952

Every man can enjoy fishing—whether young, old, rich, or poor. There are white perch and puffers to be taken with simple gear, or bonito and striped bass for more expensive tackle.

Then too, the catch of the sportsman is becoming a more important part of the family diet. On-the-spot facilities for handling his catch are increasing. The trip home is shorter. Freezers which can hold his excess catch are now common in U. S. households. This means that no foodfish taken for fun need be wasted.

Thorough analysis of the status of our seafish resources cannot be made until extensive current statistics on angling are available. This requires a widespread cooperative statistical collection program along the whole U. S. coastline. The Bureau of Sport Fisheries and Wildlife will do its utmost to expedite the establishment of this program.

DISCUSSION

DISCUSSION LEADER MANVILLE: Thank you, Mr. Clark. This 1960 survey of salt-water angling brings for the first time information on an international detail. Some of the figures are truly eye opening. This paper presents a little different complexion from the one previously presented. We will now throw Mr. Clark's paper open for discussion.

MR. BOBBY HARMON [Louisiana Wildlife and Fisheries]: Since you are a skin diver, have you had any experience with tagging large Jewfish?

MR. CLARK: I have not. The possibility of tagging fish underwater, has been the subject of a lot of discussion among biologists and skin divers, and we hope there will be some technique which will make this possible in the future.

MR. HERBY ALLEY [Florida]: I noticed that the tonnage of fish caught by sport fishermen is fairly close to that of the commercial fishermen. I am wondering, in making this survey, if you have some way of differentiating between the sale of commercial fish to markets as compared with the sport fishermen to the markets? In other words, how many fish are being sold by the so-called sports anglers in the markets?

MR. CLARK: We realize there must be some duplication. I think it is not a significant part of the whole picture. One reason I think so is because it is an accepted practice by people who collect statistics not to record units of less than a hundred pounds, and most of the sportsmen selling their catches deal with fish of less than that. I can't really give you an answer because we don't have the information to analyze. But I hope by working closely with the Bureau of Fisheries that we will be able to work some basis for excluding that sort of information.

FISHERY OCEANOGRAPHY IN THE TROPICAL ATLANTIC

ROBERT C. WILSON

Bureau of Commercial Fisheries, Biological Laboratory, Washington, D. C.

The announced title of my talk is somewhat misleading. While there has been some oceanographic research in the tropical Atlantic, I do not propose to give a history of it. My intention is, within the time allotted to this presentation, to discuss the background of a research program planned for the tropical Atlantic, together with its reasons for being, and its direction and character.

As many of you know, there is a growing tuna fishery in the tropical Atlantic, pursued by Japanese longline vessels, by French and Spanish live bait vessels, and by a few American tuna clippers. The most significant development is by the Japanese. In Fig. 1 may be seen the growth of the fishery in terms of vessels participating. In Fig. 2 the main Japanese longline fishing grounds during 1960 are depicted. In Fig. 3 is shown the Japanese catch of yellowfin tuna, with the principal species plotted against the fishing effort in boat months. It would ap-

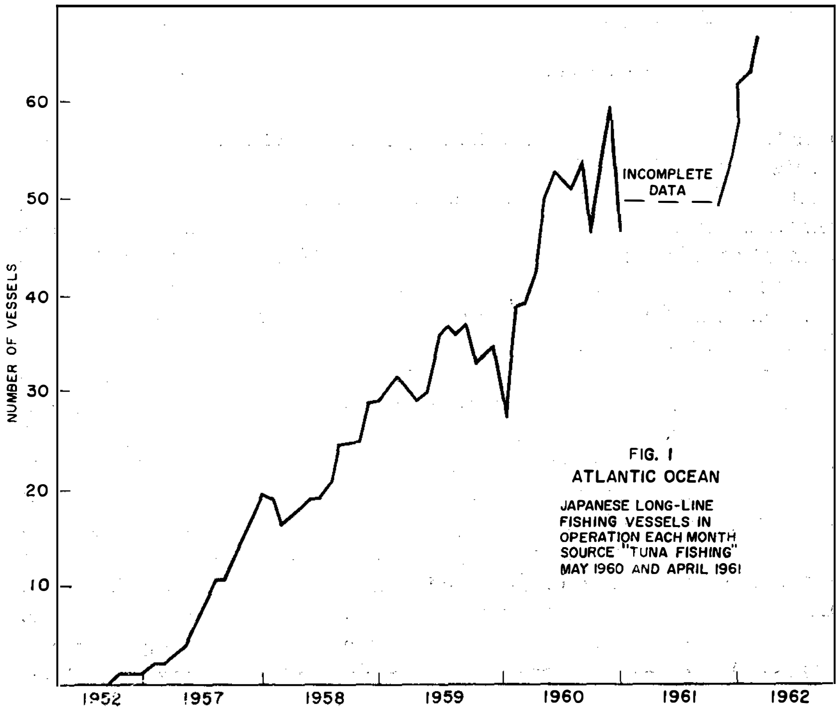


FIG. 1
ATLANTIC OCEAN
JAPANESE LONG-LINE FISHING VESSELS IN OPERATION EACH MONTH
SOURCE "TUNA FISHING" MAY 1960 AND APRIL 1961

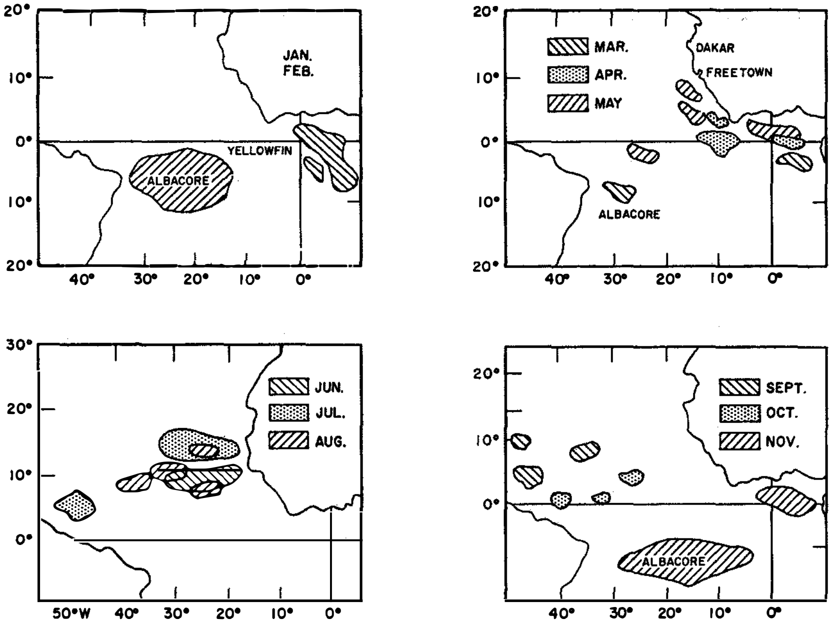


FIG. 2
MAIN JAPANESE LONG-LINE FISHING GROUNDS IN 1960

pear that further increases in fishing effort could result in a commensurate increase in catch.

In addition, there are a number of trawlers of many nations taking demersal and midwater fishes; the Russian fleet is the most impressive segment of this fishery. The interest of both African and non-African nations in the fisheries of this region is an expanding one, with announcements of plans and new developments being frequent items in the flow of news concerning fisheries.

There are two important reasons for this interest, first because the eastern tropical Atlantic appears to possess valuable fishery resources, and secondly, because the 80 million people in the humid tropical area about the Gulf of Guinea lack, to a crippling degree, protein in their diet. It is, unfortunately, a characteristic of the humid tropics that while carbohydrate foods can be produced there in abundance, protein foods cannot. There are a variety of reasons for this, among which the prevalence of diseases in domestic animals is an important one in Africa. While the application of modern agricultural science could do much to solve this problem, it would be a time consuming approach because of the research necessary to develop required answers and be-

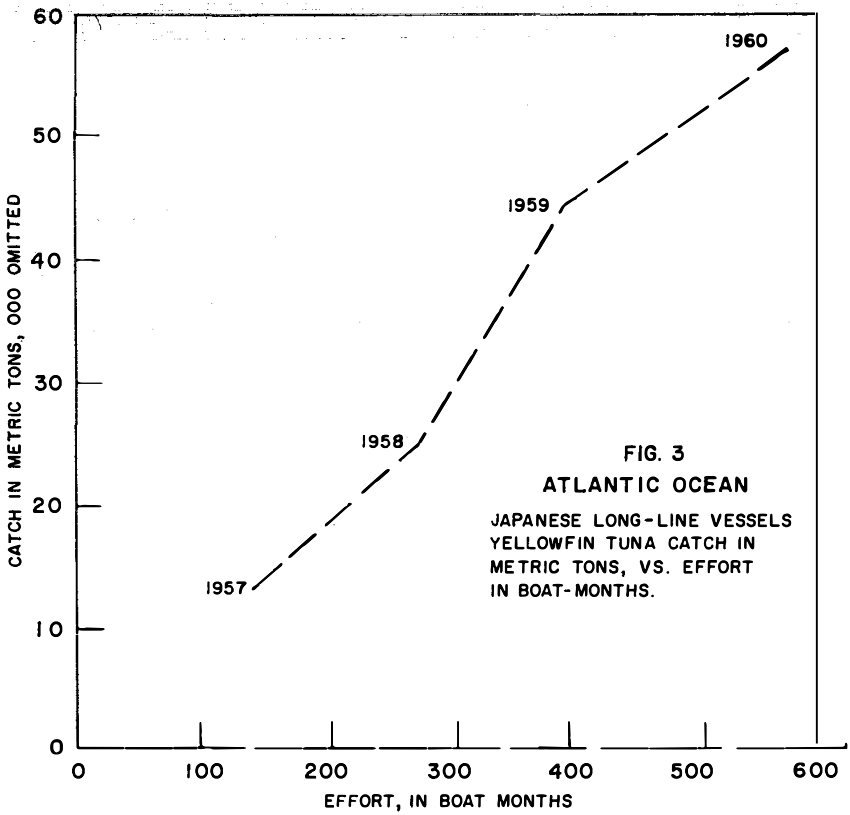


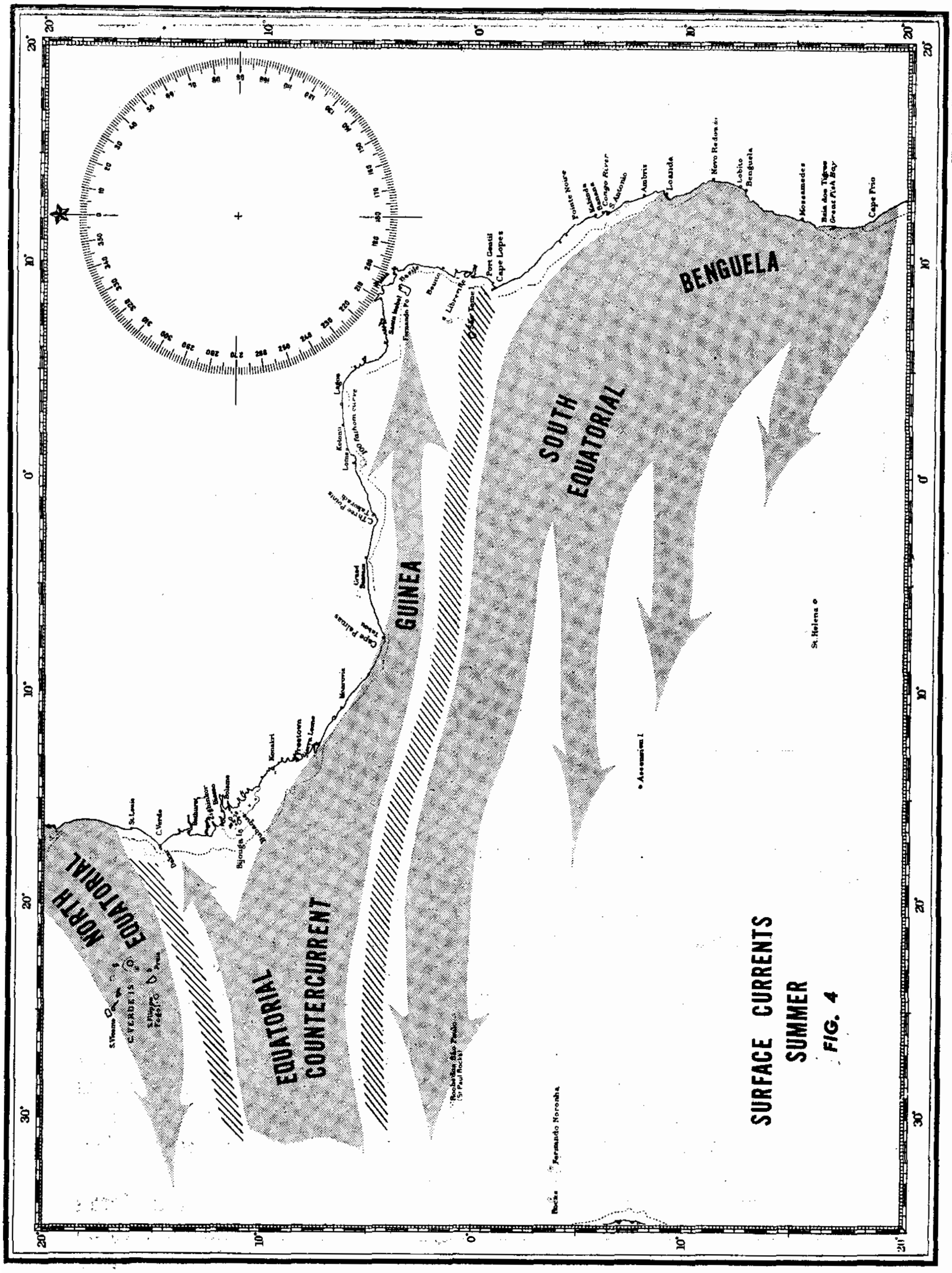
FIG. 3
ATLANTIC OCEAN
JAPANESE LONG-LINE VESSELS YELLOWFIN TUNA CATCH IN METRIC TONS, VS. EFFORT IN BOAT-MONTHS.

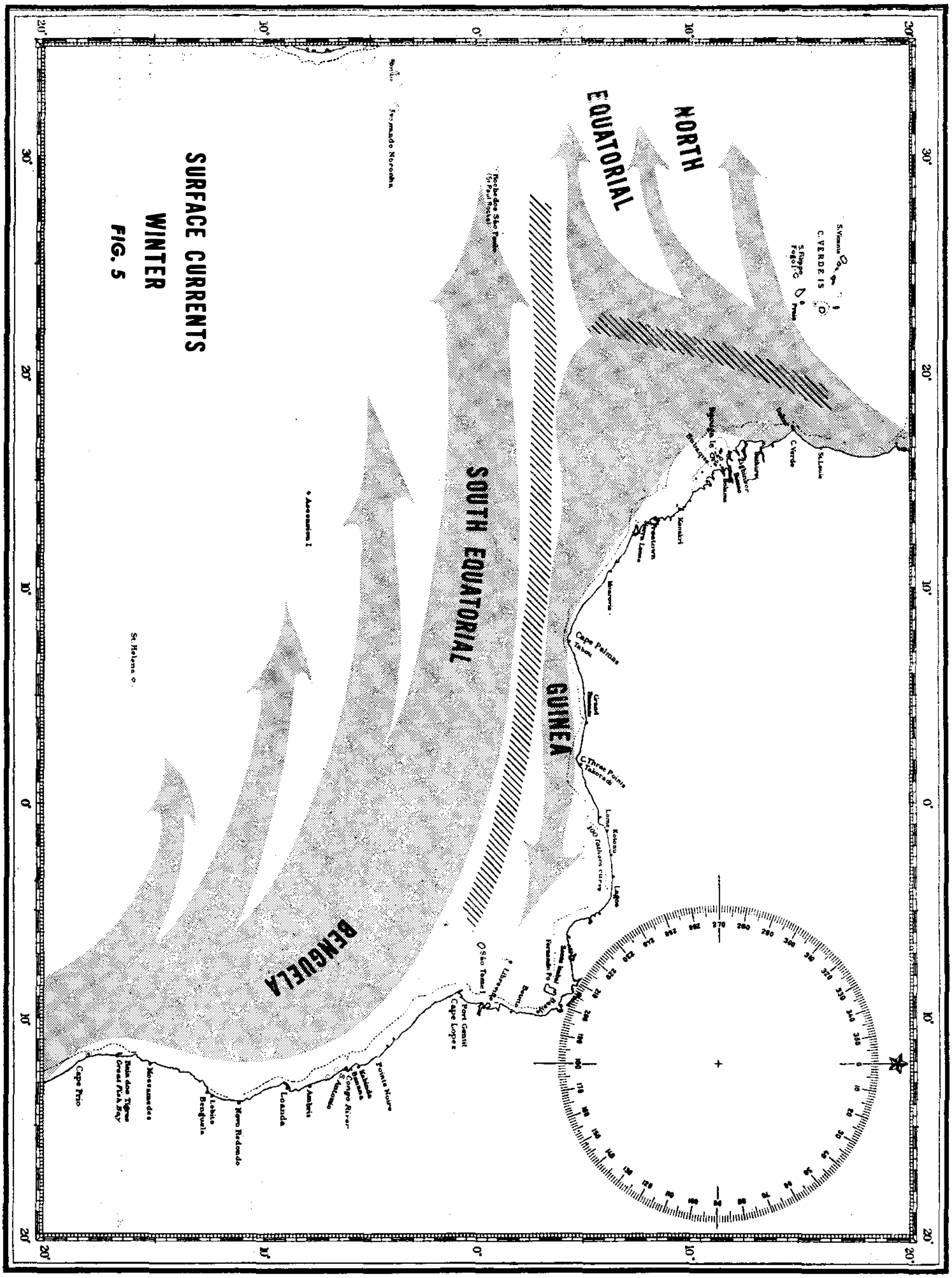
cause the application of these answers could require a difficult reeducation of the African farmers.

A direct solution to this problem would be to utilize the available fishery resources. The implementation of such a plan would require the successful solution of a series of problems, beginning with the production of fish and continuing through processing, distribution, and sale.

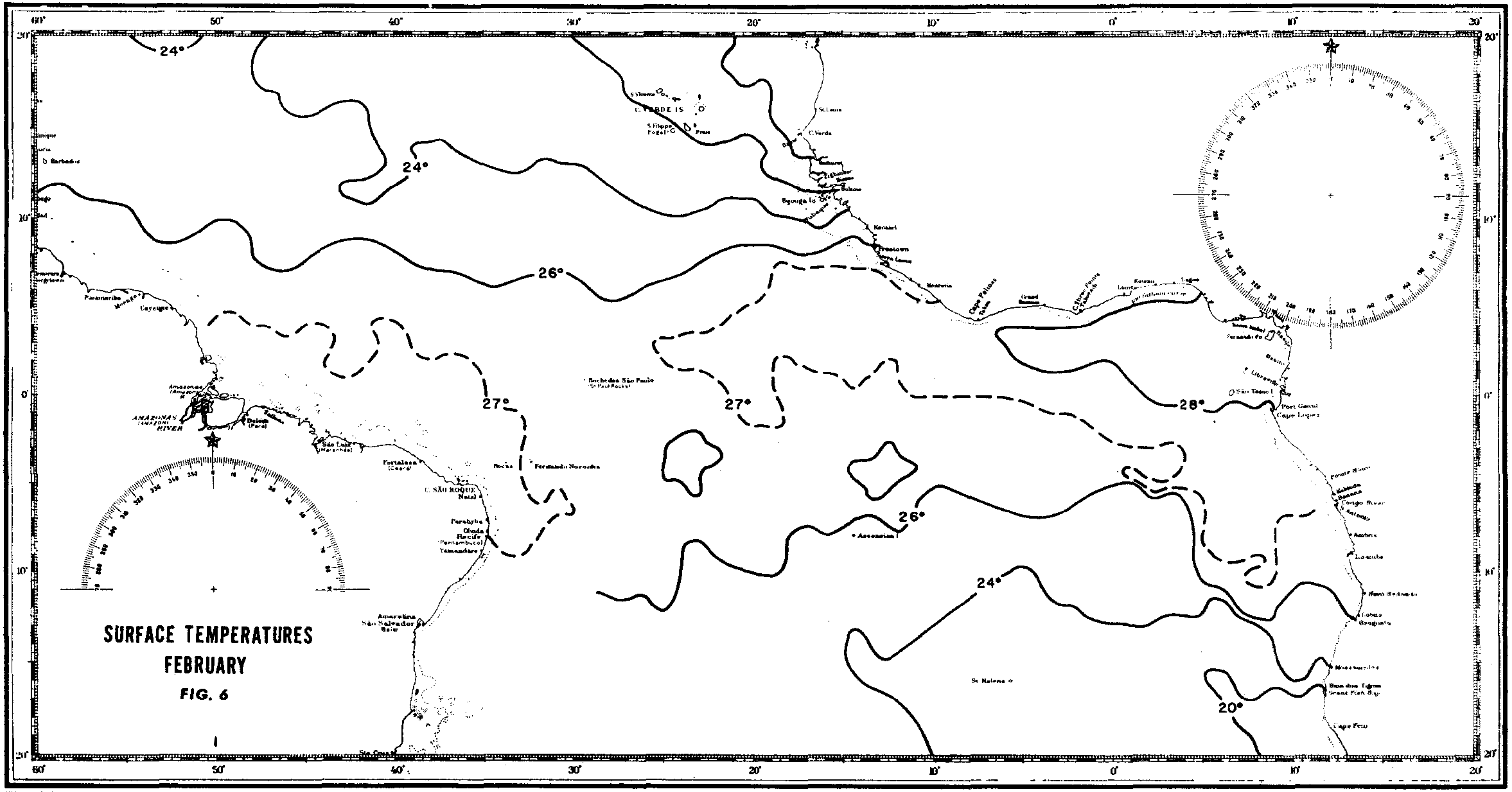
For both political and humanitarian reasons we are interested in a solution to the problem of protein dietary deficiencies in Africa, as well as other parts of the world. The stability of the new nations of Africa may depend upon it, and the ability of their peoples to effectively progress will be determined by it.

The fishery resources of West Africa are of a number of kinds. Some of these appear to be of susbtantial magnitude but of a character to be of modest unit worth; these resources are obviously of greatest value

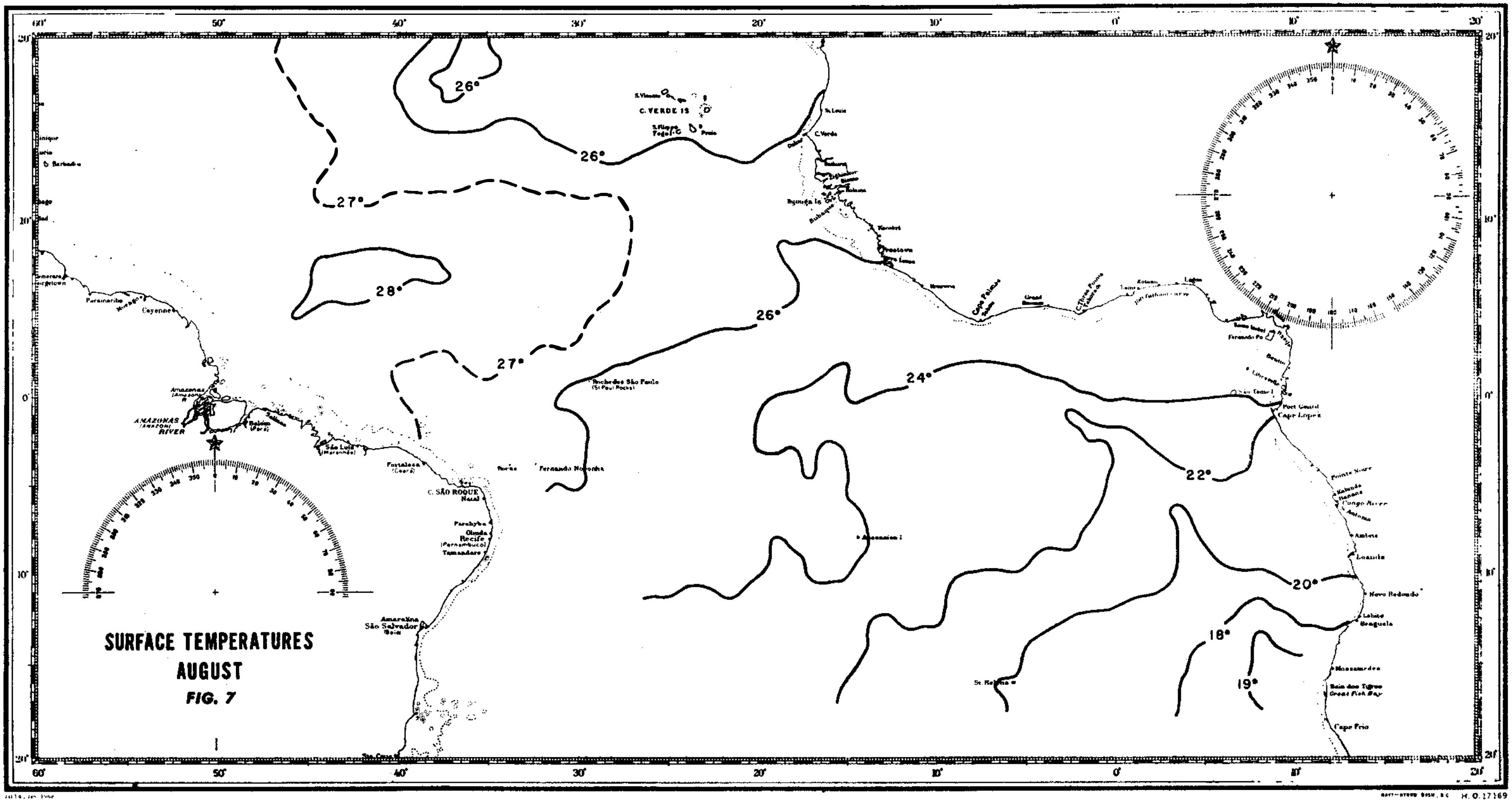

NORTH EQUATORIAL
EQUATORIAL COUNTERCURRENT
GUINEA
SOUTH EQUATORIAL
BENGUELA
SURFACE CURRENTS
SUMMER
FIG. 4



SURFACE CURRENTS
WINTER
FIG. 5



SURFACE TEMPERATURES
FEBRUARY
FIG. 6



SURFACE TEMPERATURES
AUGUST
FIG. 7

as a source of protein in the local diet. Food products based on their use should be most reasonable in cost, other factors being equal. The tropical sardines certainly and possibly some of the demersal fishes are of this kind. Others such as the tunas, being predatory fishes feeding on fish such as the sardines, are likely to be less abundant. In view of the world demand for tunas, the possibility of basing a low cost product for local consumption on their use is poor; however, their exploitation in the waters of the eastern tropical Atlantic would, by reason of the establshment of fishing bases, freezers and canneries, provide considerable income to the people of West Africa.

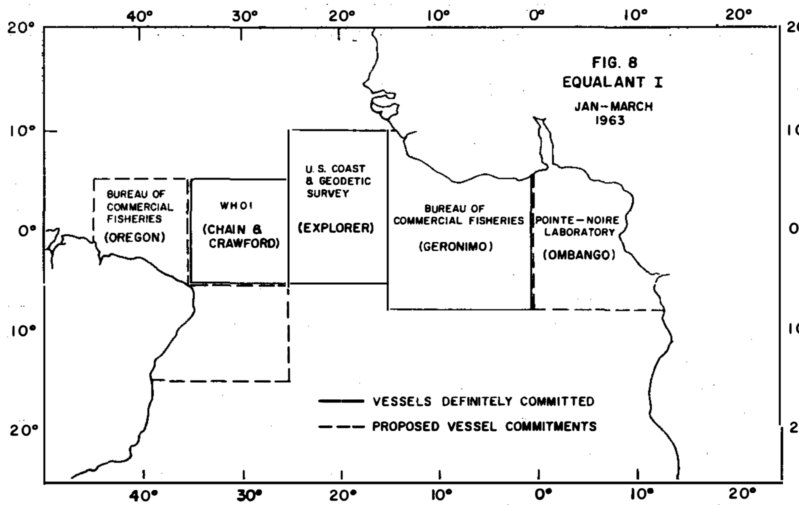
Two research programs, in which we have considerable interest, are now being developed in the fisheries and oceanography of the eastern tropical Atlantic and the waters of the Gulf of Guinea. In addition, there are a number of programs involving both fisheries and oceanographic research now in being which are the individual responsibility of some of the nations of West Africa. These national programs are less in scope than the two mentioned above.

One of these is a survey of the demersal fishes of the African continental shelf. This program is to be conducted by C.C.T.A. which is a regional scientific and technical organization of certain of the African nations south of the Sahara. This organization has applied to the United States for funds to conduct the program and AID (Agency for International Development) has definitely agreed to support it.

The plans involve the use of two trawlers of about 200 to 250 tons to define the limits of trawlable areas between Cape Blanc (Mauritania) and Angola and to determine the nature and abundance of the trawlable fishes. Some oceanographic and bottom data will be taken at each trawling station to relate to the catch. The work will be done in 1963 in two periods of four months duration, the first from January 1 to April 30, and the second from July 1 to October 30. This will permit the survey to cover the two principal climate and fishing seasons in these waters, and the entire area will thus be covered twice.

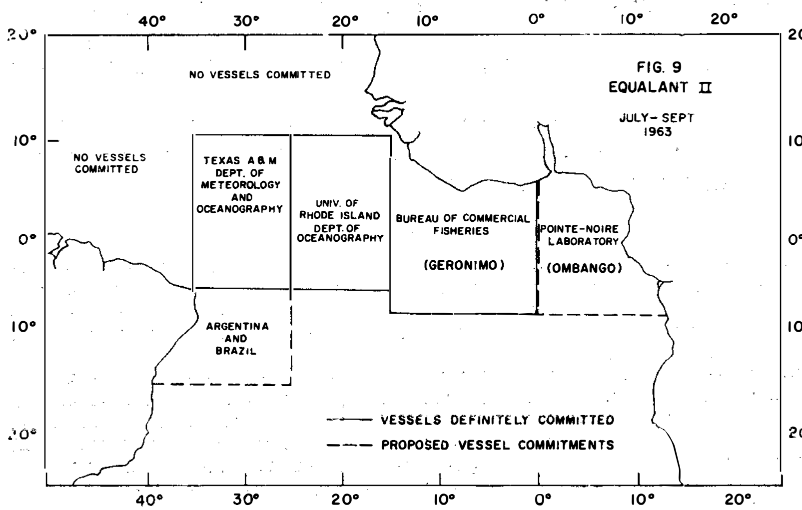
Research vessels of some of the African nations, such as those at Abidjan on the Ivory Coast, Lagos in Nigeria, and Pointe-Noire in French Congo will investigate selected areas during the period of seasonal change—that is during May and June.

The Bureau of Commercial Fisheries is planning a major fisheries and oceanographic research effort in the eastern tropical Atlantic beginning about this same time and coordinated with the program of C.C.T.A. The Bureau's will be concerned with the pelagic fishery resources and the oceanography of the Gulf of Guinea and the eastern tropical Atlantic from about Latitude 20°N to Lat. 15°S and from the African coast to Longitude 30°W. This program was proposed to the



Interagency Committee on oceanography (ICO), and was approved by that group. Currently, the program is under active consideration by ICO for submission to the Intergovernmental Oceanographic Commission as a U. S. sponsored International program.

A suitable vessel will be converted for the program to be ready by January 1963, which will be followed by a second vessel conversion to be ready a year later.



As part of our planning for this program, we have begun a review of what is known concerning the oceanography of the eastern tropical Atlantic.

As may be seen from Fig. 4, the surface currents are complex. During the northern hemisphere summer, the Equatorial Countercurrent is strongly developed, and is the source water for the Guinea current. During the northern hemisphere winter (Fig. 5), on the other hand, the Equatorial Countercurrent is missing, and the North Equatorial Current system is the source water for the Guinea current. The Equatorial Countercurrent water is warm, very saline, and nutrient poor, while the North Equatorial is cooler, more nutrient rich water. Thus we may expect dramatic changes in the distribution of the biota, as well as the weather, in the Gulf of Guinea area. The role of the Equatorial Undercurrent in this area is not clearly understood.

In Fig. 6, showing surface temperatures for February, warm water extends all across the equatorial area, with a pocket of the warmest water in the Gulf of Guinea. During August (Fig. 7), the whole area is affected by cold upwelled water from the south, and by cold water from the north. It is already evident from our review that general knowledge of changes in the biota associated with the physical environmental factors of the area is lacking.

We have, therefore, planned the first year's work (1963) to be oceanography of a general descriptive nature. As a consequence, we invited persons doing oceanographic research, and with a known interest in this area, to a meeting on February 26, 1962, in Washington, D. C., to discuss cooperative research in the tropical Atlantic. Interest was shown by all participants, and plans for synoptic oceanographic surveys of the entire equatorial Atlantic circulation during two periods of calendar 1963 are being developed, called *Equalant I* and *Equalant II*.

It is planned that pelagic fisheries survey work will be carried out during calendar 1964, and 1965, using results from the 1963 work for experimental design of later work.

DISCUSSION

DISCUSSION LEADER MANVILLE: Thank you very much, Mr. Wilson. We have been taken further afield and in a different direction than heretofore this morning. This whole program is a fascinating one, and one quite new to me. Any of you from South Africa or Japan, or for that matter closer to home, are invited to pose your questions to the speaker.

MR. CLARK: I was very interested in seeing what was presented here by Dr. Wilson in terms of big-scale cooperative oceanographic work because we are involved also in the sponsorship of large-scale oceanographic survey programs to extend all along the Atlantic Coast and perhaps into the Gulf of Mexico. The period during which this work will get under way coincides rather well with some of the work proposed in this paper, and I know that there are other large-scale oceanographic survey programs being launched or proposed. So it appears to me that by 1964 or 1965 there will be a very extensive network of oceanographic survey work being carried out in the Atlantic. Fortunately a lot of it will be directed toward the environment of the sea rather than environment of animals, which is very encouraging to all of us people who are interested in the ecology of the sea and not just the physical properties of the ocean.

CHAIRMAN CROKER: I would like to express, on behalf of all the sponsoring organizations, our thanks for the speaker participation in this really far-flung and widespread program this morning. I am only sorry that our other speaker, Dr. Chapman, was called overseas and could not give his paper, which would, in a sense, tie in the topics that the other speakers touched upon. It is a really big development in the interim to provide food for a hungry world. The oceanographic programs are going forward in all the seas of the world and a tremendous awakening in resources and latent research certainly points for an exciting future in the salt and fresh water world.

TECHNICAL SESSIONS

Wednesday Morning—March 14

Chairman: THOMAS H. RIPLEY
In Charge, Range, Habitat and Recreation Research, Southeastern Forest Experiment Station, Asheville, North Carolina

Discussion Leader: DANIEL LAY
Wildlife Biologist, Texas Game and Fish Commission, Buna, Texas

FOREST AND RANGE RESOURCES

PROBLEMS IN FOREST HABITAT MEASUREMENT

THOMAS C. EVANS
U. S. Forest Service, Washington, D. C.

When your chairman suggested this topic, it was with the tacit understanding that he would accept something less than a profound analysis of forest wildlife habitat problems. He knows me to be a forester and a statistician with a high interest in and sympathy toward the problems of forestry and wildlife habitat in the research program of the Forest Service. But I cannot pose as a wildlife specialist. I am sure, therefore, that he will not be surprised if I exercise Olympian disregard for his suggestion, and offer you some discussion within my experience of how the statistician and the wildlife specialist may best pool their talents toward improving the quality of forest habitat surveys and experiments.

I begin with the premise that habitat evaluation and experimentation are sampling problems, and therefore have statistical implications. Only rarely, if ever, can we conduct surveys or experiments with a complete population. More often, we work with but a mere fraction, a sample of the population, and from these samples make inferences concerning the population. This experience is not unusual, nor unique.

Most human decisions are made with partial information. A physician may diagnose disease from a single drop of blood or a microscopic section of tissue. A housewife judges the palatability of a watermelon by a "plug," or by the sound it makes when sharply rapped by her knuckles. And amid a bewildering array of claims and choices we select toothpaste, insurance, even mates and careers with but a fragment of the total information. All this, we do with the ardent hope that the drop of blood, the melon plug, and the advertising claim truly describe the population they represent.

In manufacture, in agriculture, in science, and no less in wildlife, partial knowledge is the normal state. The census is rare; the sample is commonplace. Indeed, however attractive a complete census may appear, there are several good reasons why the sample is often, if not always preferred. In the first place, a complete census may be impossible. For example, we could not test the germination capacity of all the seed to be sown in a forest nursery, or measure the bending strength of all the timber to be used in a bridge, or the tearing strength of all the paper to be used in a book, or the firing of all primer caps in sports ammunition. If we admitted such destructive tests, quite clearly no seedlings would be grown, no bridges built, no books printed, and no sports arms fired. Some sampling procedure seems to be in order.

A census is sometimes simply impracticable. Consider the staggering task and prohibitive cost of testing the quality of all the water in a reservoir, weighing all the fish in a lake, or all the deer browse on a 10,000 acre game management area.

Further, sampling estimates are faster and cheaper than a census. This property alone is attractive to administrators. And finally sampling estimates provide more information on a greater number of attributes, and often information of greater accuracy, than the census.

If sampling, then, is a prominent part of your discipline, it would seem desirable if not even necessary to seek a union of the biological perspective which all of you exercise in wildlife management and research with a statistical perspective your surveys and experiments deserve. There are several ways to bring this about. One is education in statistics. Another is consultation with a professional statistician. Both are useful. But as a general observation I believe it is unlikely that wildlife specialists will be, or for that matter can be expertly trained in both a biological science and a mathematical discipline. It is more likely that your own specialty will command so much of your attention and time that answers to your statistical problems will have to come from the trained statistician.

I propose, therefore, not to discuss statistics, nor sampling methods, nor experimental design, but rather to consider the working relationship between the wildlife specialist or manager as a client, and the statistician as a consultant, and to point out what each can and should bring to the consultation table if the coalition of talents is to be fruitful.

The first requirement in consultation is that you and the statistician obtain a clear statement of the problem. This may be, and often is the most difficult part of the operation. Generally, the statistician will know little, perhaps nothing about your specialty or about the substantive field of your study. But this imperfection need not be a deterrent to successful consultation. Statisticians commonly range over a wide area of subject matter, and, upon invitation to participate, are usually eager to understand your problem. It will take time; less time if the consultant is familiar with your field, more time if he is not.

The statistician may, of course, know quite a lot, and if he does some of the usual difficulty of the language barrier is overcome, but it is also likely that his contribution will be as much or more substantive than it is statistical. It is always well to recognize that the moment a statistician steps out of his role as an expert on variability, he exceeds his authority and speaks as an ordinary citizen or another scientist. Pressed upon the point, I believe any statistician would admit that responsibility for statistical design is job enough for one man, and that his primary contribution to your problem is statistical, not substantive.

Whatever his experience may be, a general description of the background of the study, its economic or social implications, as well as some of the relevant history will help. All the while you are describing it, he will be trying to recast the study in statistical terms to decide whether or not statistical data and inference will help you, and how it can help.

He may ask some impertinent questions, not to display his or your erudition or the lack of it, but rather to refine the objective of the study and ultimately to state that objective in clear and unambiguous language.

Consider, for example, that you are interested in the composition of deer browse in mixed hardwood forests. Assuming the statistician is totally ignorant of the subject, it will be your responsibility to inform him of just what you mean by browse. All browse, or some preferred species? What species? What portion of the plant? What aerial zone? How high up? How close to the ground?

Once the definition is clear, the statistician will probably ask what you wish to know about it. Its weight? Nutritional value? Proportion by species? And upon getting an answer, say "proportion of weight of preferred browse to total browse," he will begin to imagine a population of plots, as yet of undetermined size and shape, each of which can provide an observation of that proportion. He conceives that if resources in time, manpower, and money were unlimited it would be possible to observe the proportion on all plots and thereby obtain an exact proportion for the entire population. This is his model, completely and unambiguously described.

But we know that wildlife managers and research workers do not have unlimited resources. The immediate concern then is how to obtain a sample.

Once the problem is described, the statistician can lead discussion through quite an array of techniques. He will have a general idea of what kind of a survey (or surveys) or experiment (or experiments) will be required to obtain a solution, and it is his responsibility to explain the procedures and utility of each. He may have some idea of the kind of observation to make. If he does not, he will ply you with questions on the experience you and your colleagues have had in taking similar data, or he may suggest an exploratory sample or test of the size and shape of the observation unit. He will need, and may have some idea of the natural variation among the observation units; if not, he may insist on a test or at least a search of relevant literature. He will certainly elicit from you a statement of the precision that you expect from the study. And he will demand to know the physical boundaries of the population which the observation units comprise; i.e., the frame from which the sample will ultimately be drawn.

These specifications of the observation, the frame, expected precision, and estimated variance are second in importance only to a clear-cut objective. You, and you alone can specify the precision you are willing to accept. You and you alone are responsible for the frame. The statistician has the responsibility to examine and to search out the most efficient size and shape of observation, and its characteristic variance.

Sooner or later you will have to consider cost of the survey and make an administrative judgment whether or not the information is worth the expenditure. A good preliminary estimate of size of the test will be possible once the statistician is given expected precision and an estimate of natural variation. From this, and your knowledge of the cost of an observation, the total cost may be quickly assessed. Even at this early stage you have the responsibility of making a decision to continue or to abandon the study. If the cost is unduly high for the precision you stipulated, you and you alone must decide if you can live with a smaller sample, less precision, and lower cost. If the cost is less than you had anticipated, you and you alone must decide if the higher precision possible under your budget is a real advantage or a myth.

In the remainder of the planning, the work of the statistician looms larger. He will be responsible for designing the sampling or experimental method, for definitions, and for field and office procedures. He will describe the selection of the sample, and possibly even draw it for you. He will prescribe the calculation of sample estimates and the errors, and when it is decided mutually that no further editing of procedures is required, he will be responsible for a complete plan of the survey or experiment. During these labors, you, as a scientist may or may not assist, but I am sure the statistician would welcome your questions and suggestions.

When the plan is complete, the statistician should review it with you in every detail, explaining how any variation from the recommended procedure will affect the results. It will be the full responsibility of the scientist or manager to carry out the instructions without departure. Occasionally, the statistician may help with or even supervise the field work, and he will often ask for field checks or may conduct them himself.

When the data is finally collected, the statistician should be responsible for the computations if the statistical arithmetic exceeds the experience of your clerical staff. This is particularly true if the computations are executed by an electronic computer.

Finally, the statistician should be responsible for interpreting the results to you, and explaining the statistical implications and inferences that appear. You, and you alone must be responsible for whatever action the survey or test prompts.

As a final admonition, I strongly recommend that the scientist or manager should never lose contact with his data. If complexity of the statistical manipulations are bewildering, he may have to learn some statistics in spite of our earlier implication that he need not be even an amateur statistician. If the intricacy of electronic data processing is a paralyzing mystery, he may have to learn a little programming or at least be able to read an output tabulation. It has been my experience that most statisticians are quite willing to explain their techniques over and over again if necessary; most of them are the very essence of patience, and sometimes, they need it.

What is offered here is a somewhat idealized outline of the postures and motions which, in my experience, lead to a skilled union of the special talents of the statistician and the scientist or manager. In real life, not all statisticians work this way. Some of them telescope or rearrange the steps of the outline according to their personal preference. Others add and delete steps depending on their familiarity with the subject matter under study. All of them strive to help you, the scientist, you the manager, toward a better understanding of the environment you hope to control, and to bring the art of resource husbandry closer to the science of resource control.

DISCUSSION

DISCUSSION LEADER LAY: Thank you, Tom, for a very interesting discussion of a universal problem that cuts across all of our disciplines, and I think this paper is a sign of the maturity of our profession, the approach to a leveling off of our attitude and our approach to the technical difficulties of combining statistics with our other responsibilities and disciplines.

I like this approach he uses of consultant-client relationship. He inspires confidence just as you want your doctor to inspire confidence, and I think we have all gotten a lot of fresh ideas on this problem of handling statistics.

Now the floor is open for discussion. There is one point about which I think you might ask Tom, and that is for any comments he might have on standards for guidelines as to costs for statistical consulting.

MR. EVANS: The costs of consulting, I think you will find, are very nominal if they exist at all. The large reservoir of potential consultants exists largely in the universities. On the staffs of universities, and I'm sure in all the land-grant colleges, at least, there are certain affiliations with the agricultural experiment stations where there is at least one statistician on the staff. I do not think that outside metropolitan areas like New York and Chicago, statistical consultants are common, and what statistical consultants do exist in the country are working largely in the field of industrial applications. I would recommend, if you feel you want the advice of a statistician, that you try your local university or the agricultural experiment station or the research group or the Forest Service or the Department of Interior. If you can't find one, let me know. I have a couple who are handy.

I am not so sure, Dan, but what you might be touching on the cost of computing as one of the integral portions of this cost. Here I am quite enthusiastic on computing. We have done quite a bit of it in the Forest Service. While it is impossible to generalize on the statements that are possible, whether this will change with equipment, with ability or with talents, I think, if I may generalize at all, that electronic computers, over and above what you might do with ordinary accounting machines, will reduce the costs of your surveys and experiments to at least one-half of their present cost or what they might cost if the work were executed by a group of statistical clerks.

To give you some idea of the savings that are possible in our nationwide forest survey, the work which was at one time executed over a period of twelve weeks with ten clerks is now being done on a sophisticated computer in something over two hours at a cost of approximately one-eighth of the cost of doing it by hand. There are tremendous savings. This is a most favorable aspect of the cost of computing.

The great benefit of computers exists when either there is a tremendous volume of data to be analyzed or when the arithmetic is extremely complex. For small problems not exceeding, say, 1,000 observations and which would require just an analysis of variance or a statement of means and errors, there might be some question whether you should approach a computer at all. But if the work you have to do is either repetitive or extremely complex, then I would certainly recommend that you consult a professional data processing expert. I'm sure you will find it to your advantage both in cost as well as in time-saving.

MR. LOWELL ADAMS [University of California Medical Center]: I want to compliment Tom on a very beautiful concise delineation of the nature of consulting in the statistical field. The possible criticism that I might have is that the difference between the responsibilities of the statistician, on the one hand, and the person who is consulting, on the other is perhaps oversimplified. Tom, of course, recognizes this and he can't introduce all of the nice shades of relationships that he knows exist. But I would like to emphasize that sometimes a person who is taking advantage of the consultation of the statistician has to know enough statistics so that he can say to the statistician, "No. This suggested method that you are proposing will not accomplish what I had in mind." Conversely, the statistician sometimes has to step out of his role as a statistician and say to the experimenter, "Well, have you described or defined your frame correctly? Might it be possible that this definition might be better?" In doing so, he certainly is stepping out of his role, as Tom has indicated, as a statistician, but frequently very necessarily so.

As I say, my criticism is only with regard to emphasis in that this clear-cut division between the statistician, on the one hand, and the consultant, on the other, is a gradation not a clear-cut distinction.

MR. EVANS: I appreciate what you have said and I certainly agree with it. However, this is a discussion that would require another paper, I suspect.

RECENT FOREST MANAGEMENT TRENDS—POSSIBLE EFFECTS ON WILDLIFE MANAGEMENT

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The purpose of this paper is to examine some of the more recent trends in forest management and attempt to speculate in regard to their possible effects on forest wildlife management. Forest management policies and techniques will vary, of course, in their effect on species of wildlife. A practice that benefits deer for example, may or may not be beneficial to other species. Each practice would have to be evaluated on a strictly local basis. Obviously, such a complex subject can be dealt with only in general terms with perhaps a few specific examples.

THE PREDICTED FUTURE OF FORESTRY

In attempting to predict the future of forestry, the capacity of the forest to grow wood and the needs of consumers for wood products have been the two factors most thoroughly investigated. Perhaps too little attention has been given to a very essential element—the forest products industries that convert wood into its various consumer forms. The character of the forest industries will have a great deal of influence on how much wood will be grown, how much will be used, and the form in which it will be used (Craig, 1960). Forest economists are generally agreed that the pattern for the next decade includes an increase in total demand for wood products but a decline in per capita consumption.

In a summary of the Forest Service report, *Timber Resources for*

America's Future, E. C. Crafts (U. S. Forest Service, 1958a) states: "The outlook for forestry in a national setting as just described could hardly be other than favorable. There have been relatively high prices, strong demand, and no general depression in recent years. Forestry is being practiced on both private and public lands at an accelerated rate. It is increasingly recognized that growing timber is economically profitable under certain conditions, particularly where forest industries have substantial timber and financial resources."

The last statement is particularly interesting in the light of a rather unusual trend that has been taking place in the forest industries in the past few years. A large number of company mergers have taken place, far more than have occurred in any like period in the past (Dealey, 1958). In order to assess the importance of this trend, a few basic questions must be asked. What is the motivation for the present marked tendency to merge? What are the likely effects of such mergers on forest and wildlife management? Assuredly, many of the advantages of merging are directly related to either increasing or stabilizing profits. The advantages may be in several forms: operating economy, tax advantage or—more important from our point of view—a means of acquiring needed resources such as capital or timberlands. Companies that acquire additional timberland provide the industrial forester with a better source from which to acquire the resource. Moreover, the acquiring firms stand to gain additional finances, facilities, and personnel. The expansion of forest operations, in particular the well integrated companies, might well result in cost economies as well as provide for larger, contiguous forest holdings. Larger, more integrated industries increase the proportion of the forest resource which may be economically utilized. Therefore, it appears likely that forest management possibilities, as a whole, may be more flexible because a wider range of timber size and quality classes could be economically operable. In addition, a greater percentage of the primary unit (the tree) may be converted to useful products, thus spreading the costs of timber production over a greater quantity of products.

The present trend in the forest industries toward larger integrated operations supported by large timber holdings affords greater possibilities for more flexible and intensive forest management practices.

ACCELERATION OF FORESTRY PROGRAMS

There appears to be considerable evidence that progress is occurring more rapidly in public and private forestry programs than was anticipated by the authors of *Timber Resources for America's Future* (Craig, 1960). The long-range and short-term objectives in the 1961 program for the development of the National Forests certainly bears this out (U. S. Forest Service, 1961).

State forestry programs are expanding. Between 1945 and 1957, forest fire protection under state programs was increased by 32 per cent and expenditures for this purpose were quadrupled. Additional area in need of protection has been reduced to less than 10 per cent of the total (Swager and others, 1958).

Private forestry endeavors have also shown a great growth. The planting program alone is a striking example. A Forest Service report shows that planting has already increased to a rate of more than 1½ million acres per year of which 88 per cent is privately owned (U. S. Forest Service, 1958b). Also encouraging is the little noticed Forest Service report that natural seeding is making a net annual reduction of 312,000 acres in the area needing planting (U. S. Forest Service, 1958a). The forest as a wood production plant is growing in capacity. Will its capacity in providing wildlife habitat keep pace?

PATTERNS OF LAND OWNERSHIP—A NEED FOR STABILITY

Despite economic policies and technological advances that intensify forest management, there exists the key problem of obtaining increased stability in forest land use in the more heavily settled areas. The pattern of farms yielding to suburbia, forests to recreational areas and industry demanding more land is a familiar one. Continuously, new developments are pressing on the land and obscuring the outlook for the land use stability so necessary for forest and wildlife use.

The burgeoning rural residence, and various organized civic groups are all acquiring lands and have learned to apply political pressures in achieving their goals. While these uses of forest land are legitimate and desirable, the fact remains that this type of land use is often impermanent from the long-range viewpoint. Devotion of such areas to single rather than multiple use and the prevention of unduly diversified objectives that preclude economic forest and wildlife management is a key task. It would seem that many of the objectives of the diversified land owners, although not all, could be attained under a properly integrated plan of multiple land use. Perhaps zoning and the legislative determination of land use are possible but controversial solutions to this problem. At any rate, the important trend is the apparent one of increasing fragmentation of holdings in the more heavily settled areas which seems to be proceeding at a more rapid rate than is consolidation in building up economic-sized ownerships (Shirley, 1957). This is, indeed, in marked contrast to the trend already observed in industrial ownership in the more remote regions.

UNIT AREA CONTROL

The definition of unit area control may differ as it is discussed in the literature by Hallin (1954), LeBarron (1958) and Davis (1959). Basically, it involves identifying small forest stand condition classes and treating them according to their silvicultural needs using any means that are appropriate. The general idea is not new, but is becoming more popularly applied and is desirable from the philosophical point of view. Since the essence of the unit area control approach is flexibility, and allows the use of any appropriate silvicultural system, it may be difficult to identify areas as small as five acres from a management control standpoint. Nevertheless, unit area control, despite the many complications and difficulties, appears to be a growing trend and gaining in popularity. With such intensive and yet extremely flexible silviculture in the offering on National Forests, some interesting possibilities are open for wildlife management. For example, Adams (1958) presents the possibilities of having a rotation system of deer-forest management. Under the unit area control type of management, it is proposed that certain small areas scattered throughout the forest be clear cut. Ordinarily, prompt regeneration is induced in these openings. On some restricted portions of critical winter deer range, it is hoped to develop the practice of delaying regeneration for one cutting cycle. During this "fallow" period, (fallow from the forest production point of view) the aim will be to produce deer forage. Later, when forest regeneration is started on the clearing, other clearings will be created nearby by logging other unit areas.

With such an intriguing, intensive yet extremely flexible system, it is not difficult to envision myriads of possibilities of practices benefiting wildlife. Undoubtedly unit area control will, however, promote many a case of premature grey hair for the forest manager by reason of its complexity from the control standpoint!

SHORTER CUTTING CYCLES

One of the most obvious effects of more intensive silviculture and, of course, management is the shortening of cutting cycles. By definition, a cutting cycle is the period elapsing between the initiation of successive logging operations on the same unit of land. Since the length of a cutting cycle is one of the more important forces in determining the speed with which a forest is placed on a sustained yield basis, it is of utmost concern to the forester. This may be more easily seen, perhaps, by visualizing the proportion of forest area that is covered by logging. Actually, the proportion covered by logging is the reciprocal of the length of the cutting cycle in years. A short cutting cycle of ten years will cover one-tenth of the forest area each year; a longer cycle of forty years (not uncommon at present) covers one-fortieth of the area annually.

Besides the speedier initiation of a sustained yield basis, short cutting cycles have several advantages of the utmost importance to foresters and wildlife managers. The main crop is removed by a series of cuttings instead of fewer or even a single cutting. If such is the case, accessability is an important factor. To the forester, it is a necessity for harvesting, protection and timber stand improvement purposes. To the wildlife manager, accessibility is important from the viewpoint of controlling harvest of game. The salvage of risk trees is facilitated. This is highly important, for example, in the case of northern hardwoods where decadence may follow logging. From the wildlife point of view, this may well point the way toward a serious reduction of birds and mammals that require den trees. Gysel (1961) observed that a managed, northern hardwood stand contained approximately one-half of the tree cavities, burrows and nests that an unmanaged stand contained. In this case, management consisted of only two improvement cuttings spaced ten years apart. Since stumpage may be either too valuable to leave for den trees, or cull trees must be killed for timber stand improvement purposes, it may be more economical to utilize artificial dens much as has been done for the wood duck.

In softwood stands another dilemma is evident. The typical northeastern spruce-fir stand may have a relatively high percentage of fir. Fir is a fast-growing species but much of this advantage may be lost unless it is managed under short cutting cycles (to salvage mortality). Moreover, short cutting cycles are necessary to eliminate large fir and poor-vigor spruce and fir trees so as to reduce the vulnerability of the stand to damage by spruce budworm attack. There are indications that even twenty-year cutting cycles may be too long for a stand that has a high percentage of balsam fir (Hart, 1956). One cannot help but wonder what the effect of such short cutting cycles might be on the winter concentration areas of deer! Will crown closure be sufficient for adequate protection from the elements? Will partial cuttings under short cycles affect other factors of shelter such as minimum size and efficient shape in relation to food-area proportions? These questions are problems in timing as well as spatial. It may be assumed that in terms of deer yard management, long cutting cycles produce a constantly changing variety of conditions for deer while short cycles involve fewer changes and therefore, more stable conditions. Switching from softwood to hardwood management, the concern changes from that of shelter to food production. Would the advent of short cutting cycles in hardwood tend to *stabilize* the supply of browse; for example —leading to a more stable deer herd, assuming that all other factors such as shelter are stabilized? Few of these answers are known and, as can be imagined, a project designed to get the answers would be long term and complex.

INCREASING EMPHASIS ON HARDWOOD MANAGEMENT

The concept of low-grade hardwood stands being relatively worthless has in recent years been giving way to a different point of view. McQuilkin (1957) believes there is an opportunity to develop and practice silvicultural and management methods that can efficiently utilize hardwood sites.

One of the chief factors favoring such utilization is the improved technology and expanding market for hardwood pulpwood. About one-third of the wood now going into pulp is hardwood. With this market, it becomes profitable to remove low-grade hardwoods from stands and thereby improve wood quality and habitat quality. The job of putting run-down hardwood forests under management thus becomes economically feasible from the time of the first conditioning cuts. Surely this is good news for wildlife managers, since this is one important way in which the economic barrier to diversifying pole hardwood timber may be broken. In Maine, Gill (1956) is of the opinion that increasing cuts of hardwood promise to do more for deer populations than any other current land-use practice. Farmland abandonment has held this distinction in the past. However, much old farmland has reverted beyond the brush stage favorable to deer. Hardwood pulping promises to set back much of this maturing growth and provide abundant, perhaps even super-abundant deer food. Deer yard management integrated with hardwood operations should increase or at least maintain deer populations in areas favorably situated in regard to hardwood pulpwood markets.

The favorable situation in the pulpwood field is further abetted by other technological advances—for example, better knowledge on how to dry and use beech lumber—and by the sustained high level of industrial and economic activity in the country. All this means markets for low-grade hardwood material without which no substantial progress in hardwood stand improvement is possible. And, without which, diversification of hardwood types, particularly the less favorable ones of old-growth and monotonous pole-timber, is economically unfeasible.

Delving further into hardwood management, future procedures may be based on two primary objectives: management for high value products and management for bulk products. It is almost impossible to generalize on procedures so let us pick on our own northern hardwoods as an example. Under high-value product management, the largest yields in uneven-aged forests are associated with relatively large volumes per acre. This is true because a large proportion of the growing stock is in large trees. This in turn means fewer trees per acre. To manage for these products, a stocking of about eighty square feet of basal area after cutting is recommended (Gilbert and Jensen, 1958). About two-thirds of the stand would be composed of pole-sized timber.

The other alternative of managing for bulk products would aim for a basal area of sixty square feet after cutting. With this stand structure and level of stocking, much of the growth would be pole timber and most of the products cut would be small. Cutting cycles would probably average twenty years longer than those of high-value product management.

Essentially then, the main differences between the two types of management are:

1. 25% more trees per acre under bulk product management.
2. 25% less basal area under bulk product management.
3. 30% of the bulk products stands would be in pole-sized timber or smaller.
4. 60% of the high value product stands would be in pole timber and smaller.

From the wildlife point of view, it might appear that the high-value product stands would be of superior food and cover value because of the greater range of diameter classes and higher percentage of younger age classes. This might further be substantiated by the fact that cutting cycles would probably be half as long in the high value product stands as the control of mortality, cull and growth rate is much more pressing in these stands than in bulk product stands. Therefore, as mentioned before, the shorter cutting cycles in high value product stands would tend to stabilize the periods and the amount of reproduction present. That is, reproduction would not be super-abundant for one period of the rotation and almost totally absent at all other times. Since there would be well distributed reproduction in both time and space, it would seem that environmental conditions for wildlife would be stabilized. Conditions would not be optimal nor minimal but might be somewhere in the vicinity of compatibility with the growing of commercial timber and other land uses.

To confound the issue even more, the choice of silvicultural system such as clearcutting in small patches or strips would affect the distribution of reproduction radically from that of say single tree selection. Yet the over-all pattern would be the same.

RECENT TECHNOLOGICAL ADVANCES

Increasing general mechanization of forest operations is a well known trend and probably need not be discussed here.

The ever-expanding use of chemicals will exert a profound influence on the forest in its role as wildlife habitat. It is impossible to generally evaluate such influences as they could conceivably result in either beneficial or adverse effects on wildlife populations. Each problem, therefore, must be appraised in the light of its own peculiar situation. Herbicides, for example, may have adverse effects if applied extensively in monoculture situations. On the other hand, herbicides may be valuable in promoting greater habitat diversification and greater quantities of desirable plants on a given site.

In addition to the use of chemicals for positive wildlife management purposes, repellents and deterrents are becoming increasingly important. Spencer (1962) emphasizes the approach to chemical control of wildlife by population and behavioral management rather than by destructive means.

The development of successful direct-seeding techniques, largely by utilizing repellents, has led to fairly extensive seeding, particularly in the South and West. In Louisiana, for instance, over 100,000 acres have been successfully reforested by this method (Mann and Derr, 1961). Moreover, dramatic developments in systemic chemicals give promise of opportunities for self-contained plant protection. There are indications of possible future animal control on a selective basis (Spencer, 1962). It is hoped that this may permit control of destructive animal species while, at the same time, provide a measure of protection to desirable wildlife species.

In view of the increasing concern with wildlife damages, effective chemical controls may well assume an important role under intensified forest management conditions.

SUMMARY

Forest management and silviculture, in general, are becoming intensified and more flexible. Trends of economic importance, land ownership patterns and an advancing technology have contributed greatly to this movement. Wildlife management may either benefit or suffer losses in the way of habitat improvement. Evaluation of the impact of these trends on wildlife habitat must be done on a local level.

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A METHOD OF EVALUATING HABITAT FOR FOREST WILDLIFE

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With the increased emphasis on managing forests for multiple use it is necessary to determine the relative emphasis to be given each proposed use. The emphasis will depend on the capacity of the forest to support the use in question. Thus to determine how much wildlife the forest can support it is necessary to know the kinds, amount, and distribution of wildlife foods—and the relation of this resource to other environmental and land-use factors. This study was designed to provide such information for the Missouri Ozarks where forest lands cover more than 12 million acres.

This paper presents the sampling techniques used. Presentation of findings is limited to showing how forage production varies between forest types and between stand-size stocking classes within a forest type.

Forests provide habitat for many of our important game species. The production of wildlife is greatly influenced by the nature of this habitat. Composition and production of understory forest vegetation varies between forests. Understory vegetation is influenced by forest type, structure, site, and by past land use (Halls and Crawford, 1960). Composition of browse plants in certain forest types has been reported for Oklahoma by Lindzey (1955), for Florida by Harlow (1955), and more recently for Georgia by Moore, *et al.* (1960). Several investigators have reported that understory vegetation varies greatly, depending on density of timber stands (Read, 1961; Gaines, *et al.*, 1964; Ehrenreich and Crosby, 1960). Dalke (1941) reported the yields of some important wildlife foods in three forest types in Missouri. However, he did not relate production to site factors, stand density, or effects of past land use.

The effect of timber harvest and timber stand improvement on understory vegetation has been reported by Martin, *et al.* (1955), Baskett, *et al.* (1958), and Swift (1953). Grazing and burning have also been reported to significantly influence understory vegetation (Halls, *et al.*, 1952; Lay, 1957; and Stoddard, 1957).

All of these reports yield valuable information. However, more comprehensive information is needed to evaluate habitat capacity for game food and to prescribe management needs. Knowledge of yields of wildlife foods over more extensive areas and a better understanding of ecological relations would be especially useful. Burke (1956) and Moore, *et al.* (1960) pointed out that a method of making extensive, rapid, yet precise inventories of habitat was needed in order to furnish administrators with accurate, ecologically sound information. Moore, *et al.* (1960) devised such an inventory method in trial sampling of three forest types in Laurin County, Georgia. They measured browse frequence and tied the measurements to the Georgia Forest Survey. They reported that these measurements served as an index to amount and quality of browse material available in the three types.

The present study involved inventory of a more extensive area, and provided information on yields, as well as on the frequency of herbaceous and woody vegetation in the forest understory. The frequency of important fruit-producing trees was also determined. Forage was related to forest structure, site factors, timber management, livestock use, and fire history. This inventory was also tied in with a forest survey, in this case the recently completed second Missouri Forest Survey.

The study was a cooperative project between the Missouri Conserva-

tion Commission and the U. S. Forest Service. The authors wish to acknowledge the work of Roger Kirkman, U. S. Forest Service, in supervising the field crews and the advice and criticism received from many other members of both the U. S. Forest Service and the Missouri Conservation Commission.

METHODS

Design: This study was designed to yield information applicable to the more than 12 million acres of forest lands in the Missouri Ozarks. However, some of the information should also apply to similar upland forests in the remainder of the state and possibly in adjoining states. The recent second Missouri Forest Survey, to which the study is tied, is part of a continuing and comprehensive national survey to provide up-to-date, accurate information for management of the nation's timber supply. Most of the systems, procedures, and definitions used in the Missouri Survey follow most national standards (U. S. Forest Service, 1959).

The second Missouri Forest Survey was a triple sampling. The first part consisted of determining forest-nonforest proportions from aerial photos by taking a dot sample. Next, photo measurements were made to determine forest type and density. Finally, actual measurements were made on the ground. Statistical accuracy of commercial forest measurement was within ± 2 per cent per million acres. Basic work units were counties, and most individual counties were sampled to within ± 5 per cent.

National Forest lands cover about 1.36 million acres in Missouri. The present evaluation of wildlife habitat was confined to National Forest land, for several reasons. The 13 National Forest Ranger Districts are well dispersed throughout the Missouri Ozarks and include all important forest types common to the Ozark region. Maps and aerial photographs are available for all districts along with more thorough forest survey information. Field crews had easy access to all areas; and equipment, additional personnel, and facilities were available in the districts.

Preliminary sampling of the major forest types indicated that from 150 to 180 one-fifth-acre plots for each type class would measure total understory vegetation to within 10 percent of the true mean at the 95 per cent confidence level. Insofar as possible, each of the eight major forest types was sampled proportionately to its acreage in a district. For instance, the bulk of the redcedar forest type acreage occurs on two National Forest Ranger Districts in the southwest portion of the Ozarks. Thus, most of the redcedar plots were located in these two Districts. Knowing the distribution of forest types and the approximate number of plots needed in each type, we could calculate the number of plots desired in each Ranger District. However, in random sampling we did not always obtain the exact number of plots of each type needed for a district and usually had to take additional plots. Therefore, the sample for some forest types was slightly larger than necessary.

National Forest Ranger Districts are broken down into compartments (work units). These compartments were used as the basic units in this survey. Ranger Districts average about 125 compartments with about 800 acres in each compartment. On each Ranger District a given number of compartments (approximately 9 per cent) were randomly selected. A starting point was picked on the compartment map and a traverse line was then drawn in a selected cardinal direction. These procedures were all completed before the crews left Ranger headquarters.

The crews then went to a selected compartment, located the starting point of the traverse line, and proceeded by compass along the line. Most plots sampled were located at 5-chain intervals along the line. In forest types of limited occurrence plot intervals were reduced to two chains.

Collection of Data: A total of 1,351 one-fifth-acre circular plots were taken by 3 two-man crews. Before starting the actual sampling, which ran from June 19 to September 1, 1961, the crews were given a week's training.

The following data were taken on each one-fifth-acre plot:

Factor	Categories
Forest types	8
Stand size and stocking	10
Site class	4
Aspect	2
Position on slope	7
Per cent slope	5
Livestock use	8
Livestock species	2
Fire history	4
Logging or TSI	8
Erosion hazard	5
Current erosion	5
Soil stability	5

Additional measurements made on each one-fifth-acre plot included total basal area of timber stand, basal area of merchantable timber (poletimber or sawtimber size), and total crown cover. Basal area measurements were obtained from four readings of a 10-factor prism. Per cent crown cover was taken from four readings of a spherical densiometer.

Production of herbaceous browse vegetation was measured on eight randomly located quadrats 3.1 feet square and 5 feet high, using the double sampling method (Wilm, *et al.,* 1944) at a 1:7 ratio. Fruit-producing trees were counted on four randomly located 100th-acre circular quadrats within each one-fifth-acre plot. Number of fruit-bearing trees was recorded by species. Both mature fruiting stems and mature stems not fruiting were counted.

All data were coded to facilitate automatic data processing. A list of plants that the crews might find in the understory vegetation of Ozark forests was prepared. For coding, three letter symbols were devised to represent each species, species group, or genera. Unknown plant species were collected, mounted, and shipped by field crews to Dr. David Dunn, professor of taxonomy, University of Missouri, for identification. Once identified, specimens were returned to the field crews.

Forest types were pine, oak-pine, black oak-scarlet oak, white oak, post oak-blackjack oak, redcedar, hardwood-redcedar, and mixed hardwoods. Stand-size stocking classes were nonstocked, restocking, seedlings and saplings, poles, and sawtimber. Each stand was classed as poor, medium, or well stocked. Site capability classes were based on site capacity for production of 16-foot sawlogs of pine, hardwoods, or cedar. Dates of fire, logging, and timber improvement measures recorded in the District Ranger headquarters enabled field crews to determine the exact time since such occurrences.

Average total basal area and average basal area of merchantable size timber (pole and sawtimber) were obtained from four readings of a 10-factor prism on the one-fifth acre plot. Percent crown cover was calculated from four readings of a spherical densiometer on the one-fifth acre plot.

Herbage and browse were measured in quadrats located at a random point on each of eight equally spaced lines radiating from the one-fifth-acre plot center to the plot edge. The first line was a random bearing and subsequent lines were spaced 45 degrees apart. For each species in a quadrat the current year's growth of herbage or browse was estimated. On one of the eight quadrats (randomly selected) the herbage was clipped and weighed following estimations. Occurrence of plants by species in each quadrat was also recorded.

Field Procedures: Samples of green vegetation were collected and weighed by the field crews. After these samples were oven-dried, dry weight was determined and recorded on the field data sheets. This enabled later correction of green weights to oven-dry weights.

Growth of key plants was recorded at various places throughout the Ozarks to determine the per cent of total growth made by certain dates. These measurements indicated that most of the total annual growth had been completed by the early part of the survey. So corrections for growth taking place during the months of the survey were not necessary.

Collections of twigs and leaves of woody species commonly utilized by deer were also made. Twigs and leaves were weighed separately and regressions calculated to determine the weight of woody twigs available to deer during the winter.

From the one quadrat on each plot that was both estimated and clipped, regressions on clipped and estimated weights were calculated by groups of weights (0-30 grams, 31-70 grams, 71-150 grams, 150+ grams) and by field crews. This correction factor was then applied to all species before totaling.

Checked data from all field data sheets were then punched on cards for analysis by automatic data processing machines.

RESULTS AND DISCUSSION

Only preliminary analyses of the data had been completed at the time this paper was written. These first analyses show that total production of herbage and browse varied considerably between forest types and between various stand size stocking classes within types (Table 1). The redcedar type had the greatest total yield, 565 pounds

TABLE 1. HERBAGE AND BROWSE PRODUCTION (POUNDS/ACRE, OVEN-DRY) BY STAND-SIZE CLASSES IN SEVERAL FOREST TYPES IN THE MISSOURI OZARKS

	Forest type							
Stand size	Cedar	Hard-wood cedar	Pine	Oak-pine	Mixed hard-woods	Post oak-black-jack oak	Black oak-scarlet oak	White oak
Seedlings and Saplings	615	440	335	305	580	280	200	180
Poles	360	235	210	165	370	220	140	145
Sawtimber	......	......	230	180	365	205	160	200

of herbage and browse per acre. The redcedar-hardwood and mixed hardwood types had the next highest yields, and productions in the other forest types were much less. Poorest production was found under the black oak-scarlet oak forest type.

Total herbage and browse production was greatest under seedling and sapling stands of all forest types and least under pole stands for all types except post oak-blackjack oak and mixed hardwood stands (Table 1). Production also varied with degree of stocking within each stand size class. Seedling and sapling and pole size stands usually had greater production in poorly stocked stands than in well stocked stands. However, in sawtimber stands production increased as the stand matured. The black oak-scarlet oak type, which is the most common forest type in the Ozarks, is a good illustration of the varia-

TABLE 2. GRASS, FORB, AND BROWSE PRODUCTION (POUNDS/ACRE, OVEN DRY) IN STAND-SIZE STOCKING CLASSES IN THE BLACK OAK-SCARLET OAK FOREST IN THE OZARKS

	Seedlings and saplings		Pole timber			Saw timber		
	Medium stocked	Well stocked	Poorly stocked	Medium stocked	Well stocked	Poorly stocked	Medium stocked	Well stocked
Grasses	35	20	10	15	5	10	15	10
Forbs	65	45	30	30	20	35	40	45
Browse	185	115	115	110	105	105	115	130
Total	285	180	155	155	130	150	170	185

tion in herbage and browse production with differences in stand size and stocking classes (Table 2).

Browse plants made up about two-thirds of the total production except under hardwood-cedar, cedar, and mixed hardwood types, where browse made up about one-half or less of the total yield (Table 3). Browse production was by far the greatest on the cedar type. However, this was due to the presence of a large amount of redcedar included in the browse production figure.

Forb production in the mixed hardwoods was 160 pounds per acre, compared to only 30 to 55 pounds per acre in the other forest types. Grass production was highest in the cedar and hardwood-cedar types, 200 and 105 pounds per acre, respectively, compared to only 15 to 50 pounds per acre in the other forest types.

Many more analyses of the data collected in this study will be made. However, the purpose of this paper is not to present all of the data, but to explain the sampling techniques used. All preliminary examinations indicate that this inventory method will provide sensitive information on production and frequency of forage for various forest types and stand-size stocking classes. To aid these further analyses of yields or occurrence of species groups with various forest stand, environmental, or past land use factors, each automatic data processing card records only one individual species or species group.

CONCLUSION

This survey will relate basic quantitative information on forage in the Missouri Ozarks to forest stand and environment. It will guide

TABLE 3. GRASS, FORB, AND BROWSE PRODUCTION (POUNDS/ACRE, OVEN-DRY) IN SEVERAL FOREST TYPES IN THE OZARKS

	Cedar	Hard-wood cedar	Pine	Oak-pine	Mixed hard-woods	Post oak-blackjack oak	Black oak-scarlet oak	White oak
Grass	200	105	35	20	50	35	15	15
Forbs	50	55	55	40	160	40	30	45
Browse	315	180	155	125	160	155	110	115
Total	565	340	245	185	370	230	155	175

future management and research. The survey will tell us what is available for various animals and will suggest what conditions are most favorable for food production. By relating our figures of wildlife food production per acre with acreages of forest types and stand-size stocking classes given by the Missouri Forest Survey, we can estimate within known limits of error total forage production in a given unit of area.

This survey alone will not determine the carrying capacity of the Ozark range for important wildlife species, but must be related to other studies of food habits, preferences, utilization, and nutritive quality. The method presented here should be applicable in other areas, especially those having hardwood or mixed hardwood stands.

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DISCUSSION

DISCUSSION LEADER LAY: Thank you, John, for a very interesting example of the kind of work that is going on in one part of the South in forest surveys. This

is a field that has hardly been scratched. We are on the threshold of the time when we are going to have quantitative data to work with that will surpass anything we have had in the past in judging conditions and capacity and planning our game management programs on forest lands.

I might say that our Chairman, Tom Ripley, has conducted a similar survey of browse and forage in northern Georgia which has been reported at another meeting, and I notice that John has taken advantage of some of the trends he found in his earlier survey.

AERIAL AND MIST-BLOWER APPLICATION OF HERBICIDES IN SOUTHERN FORESTS AS RELATED TO WILDLIFE MANAGEMENT

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The present paper is based largely upon the activities and reports of the Herbicide Sub-Committee, Forest Game Committee, Southeastern Section of The Wildlife Society. Sub-Committee members are:

John Kirch, Research Dept., Amchem Products, Inc.
John Newsom, Chief of Game Mgt., Louisiana Wild Life and Fisheries Commission
Howard Miller, Chief, Wildlife Mgt. Branch, U. S. Forest Service, Southern Region
Walter Beers, Research Forester, Buckeye Cellulose Corp.
E. B. Chamberlain, Jr., Asst. Federal Aid Supervisor, U. S. Fish and Wildlife Svc., Atlanta, Georgia—Chairman

We gratefully acknowledge the assistance of these gentlemen, as well as those many others who so materially aided in this work.

The Sub-Committee actually had its origin in an informal discussion at the 1961 Southern Weed Conference. At its appointment in May 1961, it was charged with three questions:

1. Is the use of widespread herbicide treatments, such as by airplane or mist-blower, sufficiently general in southeastern forest management to be important in wildlife management?
2. If such herbicide treatments are important to wildlife management operations, what is the nature and extent of their effect on wildlife habitat and populations?
3. Should such effects appear to be detrimental, might possible modifications of the treatment techniques be suggested to minimize damages?

Even a partial review of the literature shows the tremendous amount of work which has been done and the interest which exists in herbicide treatments by airplane or mist-blower in the field of forest management.

The Proceedings of the 1960 Southern Weed Conference contain 14 papers, and the 1961 Proceedings contain 8 papers dealing with mist-blower, or aerial application of herbicides, to forest lands. The 1959 Proceedings contain 5 such papers; the 1958 Proceedings, 2 papers; and the 1956 Proceedings, 5 papers. The 1962 Conference Program included 3 presentations on this subject. The Ninth Annual Forestry Symposium (1960) of Louisiana State University was devoted to "The Use of Chemicals in Southern Forests," and included one discussion on aerial application of herbicides.

At the 1961 Southern Weed Conference, Drs. Burns and Box of the LSU School of Forestry reported upon a 1960 questionnaire survey of industrial foresters throughout the South. Replies indicated that approximately one-fourth of the total area treated chemically for hardwood control was by aerial and mist-blower application. This amounted to about 150,000 acres treated by aircraft and mist-blower during the one year, based on a sample which showed 30,100 acres aerial-sprayed and 18,800 acres mist-blown. These figures were somewhat larger in 1961. However, considering the overall acreage in southern hardwoods, the figures in themselves may seem unimportant.

This practice developed over a five-year period, for prior to 1955, only a few small experimental plots had been treated with selective herbicides by aerial application. In 1955, Hiwassee Land Company conducted the first, large-scale aerial application of 2,4,5-T in the Southeast. In July of that year it sprayed 2,000 acres of low value, inferior quality hardwood stands on the Cumberland Plateau in East Tennessee. In the years following, additional work has been conducted by Hiwassee Land Company and a number of other industrial and private timberland owners in the Southeast. A helicopter is more commonly used for this purpose than are fixed-wing aircraft, due to its higher degree of maneuverability. The helicopter passes back and forth over the area being treated, in adjacent flight lines 45 feet wide, and at a height of 25 to 50 feet above the timber. Rates of application vary from 1 lb. to 2 lb. of 2,4,5-T acid per acre in a total volume of 3 to 5 gallons of solution per acre. A typical formulation would consist of one-half gallon of ester (containing 2 lbs. of 2,4,5-T), one-half gallon of diesel oil, and four gallons of water. The work is normally conducted from the latter part of May through early July.

Mist-blower application of selective herbicides to weed forest stands was first used in the South in 1957 by S. F. Potts of Crawford, Mississippi, who developed a lightweight compact blower for mounting on the back of a small crawler tractor. In 1958, additional trials were conducted with the Weyerhaeuser Company in Mississippi and Alabama. About this time, Forestry Suppliers, Inc., of Jackson, Mississippi, brought out a similar type mist-blower labeled the "Hurricane." These two types of blowers, along with a few larger blowers for mounting on the back of a larger crawler, have been used by approximately 25 forestry organizations in the past three years in the South.

The technique involved with the mist-blower is to move across the area to be weeded in adjacent lanes 20 to 40 feet in width. The herbicide rate of application and formulation is the same as in aerial spraying.

Aerial-spraying may be used to remove either an overstory or an understory, while the mist-blower is designed to weed out the smaller, understory vegetation. In either case the purpose of the weeding treatment is to remove a sufficient number of hardwood stems to allow establishment and release of the pine seedlings that will form the new stand. No effort is made to remove all hardwood stems, for it is neither necessary silviculturally nor desirable for wildlife.

Aerial-spraying and mist-blowing to remove undesirable hardwood competition from pine sites are recognized as silviculturally sound practices now in general use throughout the Southeast by many woodland organizations. Consequently, such herbicide treatments may definitely be considered as of regional concern in wildlife management.

Evaluation of the effects of these herbicide treatments on wildlife habitat and populations is difficult. The Sub-Committee in its approach to this inspected various large-scale and experimental programs. Without such inspections this report would have been impossible. At the same time, many difficulties and dangers are involved in attempting to draw conclusions as to effects. In this connection, the following observations seem valid:

1. Aerial application of herbicide is widely used to control oak sprouting in mechanically-cleared site preparation areas. In such cases, oak control may be 85-90% effective and control of other vegetation 75% effective.

2. Aerial application of herbicide is frequently used to convert a commercially worthless type, such as swamp titi, to pine. With titi, approximately 95% of the plants may be killed back to the ground, so that subsequent seeding of pine can be done successfully. However, it appears that 50-60% of the plants may resprout at the base. In cases where the brush was very dense or browse was above the reach of deer, this type of treatment may be at least temporarily beneficial to deer.

3. On general pine-hardwood sites, aerial and mist blower applica-

tions are widely used to achieve silvicultural weeding. Helicopter or fixed-wing aircraft application can be expected to kill 70% of the overstory (exclusive of pines), and mist-blower applications 65% to 70% of the understory vegetation. Where a good burn is accomplished, in conjunction with the herbicide treatment, understory reduction will be much more complete. This kill will occur over a period of two to three years. Total kill is not obtained because of skips in application, apparent inherent resistance of some species and individuals within a species, and occasional unfavorable soil moisture conditions.

4. Understory vegetation can be expected to increase considerably after the second year, so that it may become much more dense than originally. Grass and herbaceous growth may likewise increase.

5. Many sites will normally be managed for hardwoods and not converted to pine. Such sites, on which foliage spraying for conversion would not be economically or silviculturally desirable, include: river bottoms, canyons, very steep slopes, and most north slopes. As a wildlife management measure, one-chain strips may be left on each side of larger streams. In addition, much consideration should be given to the possibilities of mixed-stand management on those pine-hardwood sites where herbicides are less efficient. Probable future increased demand for hardwoods and the dangers inherent in pure pine management are factors here.

6. Hardwood understory may never be eliminated on some sites because of its tenacity and the costs involved. Experience has shown that the species commonly treated with herbicides in the South may be divided into three groups depending on ease of control.

Easy to control: hackberry, grape, post oak, sweet gum, yellow poplar, black cherry, sassafras, willow, sycamore, sumac, white oak.

Fair to control: blackgum, tupelo-gum, swamp chestnut oak, southern red oak, black locust, northern red oak, yaupon, redbud, blackjack oak, waxmyrtle, persimmon, sandjack oak, magnolia, American elm, turkey oak, sweetbay, silver maple, beech, blue beech, dogwood, hickory, huckleberry, sourwood.

Hard to control: winged elm, ash, honeysuckle, water oak, hawthorn, holly, gallberry, red maple, kudzu, live oak, palmetto, mountain laurel, rhododendron.

7. At this time, it appears that widespread application of herbicides on upland, pine-hardwood sites may benefit deer and rabbit, harm squirrel, turkey, and coon, and temporarily benefit grouse. As the age of the pine stand increases, conditions for deer and rabbit will also probably worsen. In an approximate 30-year rotation, ecological effects can be considered in three segments.

The first ten-year period begins with the initial cutting, girdling, or herbicide treatment. This prepares a seed bed and increases light and moisture to the understory. Herbicide treatment provides pine release, with the new pine crop and new understory plants growing more or less together. The pines gradually become dominant and suppress the understory. It appears that the initial abundance of food will benefit deer, grouse, and rabbits. Squirrel and turkey are virtually eliminated.

In the second ten-year period, the pine will become more dominant. Mast production of the overstory will continue sparse, so that habitat value for deer, rabbits, and grouse will decline. If pine thinning is carried out, wildlife values will be enhanced.

The final period prior to harvest will likely be that of lowest wildlife values provided no thinning has been done.

8. In no case was there found to be any direct animal mortality from the chemicals used.

9. Pine conversion on some sites is beneficial to soil and water management, since the longer lasting pine litter holds water better.

The last of the original three questions is perhaps the most difficult of all. This is largely due to the fact that wildlife managers are not able to quantitatively state the effect on wildlife populations of any given change in any unit of habitat. Consequently, we deal in generalities which are only partly satisfactory. Thus, while we may have reasonable assurance as to the relative value of various plant species for wildlife food or cover, we cannot with much accuracy define just how much of what plants is necessary to support the various wildlife species at any particular level. The individual, company, or agency that wishes to maintain forest game wildlife values on lands treated with herbicides by airplane or mist-blower can, however, do the following things:

1. Conduct the original and follow-up treatments in such a way as to leave skips and buffers between spray blocks. This is, in fact, the result of most management spraying at this time in the Southeast. In general, the greater the diversity of plant species and the greater the interspersion of types, the better will be the wildlife habitat. Fortunately, a checkerboard effect is being achieved on many ownerships through the spraying of scattered blocks ranging from 50 to 200 acres in size.

2. Evaluate the area in question in terms of the wildlife species for which it is suited, and favor the plant species most valuable to the wildlife concerned. Perhaps more is now known concerning the food preferences and requirements of the white-tailed deer than of the other forest game species important in the South. The work of Pearson (1943), Korschgen (1954), Lay (1956, 1961a, 1961b, 1962), Collins

(1961), Harlow (1961), Harlow and Tyson (1959), Goodrum and Reid (1958), Goodrum (1959), and Strode and Chamberlain (1959) among others, shows the great importance of acorns and fruit, as well as a proper supply of quality browse, in maintaining this species. Food habits studies of the wild turkey are not so extensive, but the work of Wheeler (1948), Schemnitz (1956), Mosby and Handley (1943), Garrison and Strode (1959), Powell (1961), and Dalke, Leopold, and Spencer (1946) again emphasizes the heavy use made of acorns and fruit, along with herbaceous material and insects. So far as the gray squirrel is concerned, the studies of Allen (1952), Colin (1957), and Uhlig (1956) demonstrate this animal's need for acorns and other nuts, fruit, seeds, buds, and flowers from a variety of tree and shrub species.

All of these investigations show the need for a good variety of food plants.

3. Treat in blocks of 600 acres and less, so that greater variety of habitat types will be available. This size treatment unit is compatible with most forest management, and small blocks are definitely indicated by the average home range size of the species concerned. For deer in the Southeast, this amounts to from 500 to 2,000 acres (Hahn and Taylor, 1950, Tyson 1952, and Progulske and Baskett 1958). Turkey ranges are considerably larger, but squirrel ranges are quite small, two to seven acres per animal (Flyger 1960, Colin 1957, and Uhlig 1956).

Food requirements of a 100-pound deer are about 2.5 pounds of air-dry forage per day. By green weights, this averages 7.3 pounds in spring, 6.3 in summer, 5.8 in fall and 5 in winter (Lay 1956). Gray squirrels require about 1.5 pounds (air dry) of food per week. Available deer forage in unburned loblolly habitat ranges seasonally from 150 to 220 pounds (air dry) per acre, but the amount available to deer is estimated to vary from 52 to 68 pounds (Lay, 1956). Browse production on most of the vegetation types supporting deer in Florida has also been determined (Harlow, 1959).

Acorn production varies widely (Collins, 1961), individual trees producing as much as 45 pounds in some years though averaging 3 to 18 pounds (air dry). Fruit production of other species is extremely important. For example, dogwood will produce 38 pounds/foot of basal area, fringetree 65 pounds/foot of basal area, French mulberry 20 to 50 pounds/acre, blueberry hawthorn 46 pounds/foot of basal area, and flatwoods plum 22.6 pounds/foot of basal area. These figures are for green weights (Lay, 1961b, 1962).

4. Treat the obvious pine sites first, reserving the marginal hardwood sites for subsequent years, as some managers are now doing. More

hardwoods are increasingly being used for pulp, and even marginal hardwood sites will produce some revenue from hardwoods until such time as they are needed for softwood production. In this connection, J. E. McCaffrey, Vice-President of International Paper Company, recently stated (McCaffrey, 1962) that during 1960 hardwood pulp comprised 20% of the total wood requirements in the Southeast, and that a slight increase occurred in 1961. The Bowaters Southern Paper Corporation has a mill now using 60,000 cords of hardwood pulp per year (Edgar, 1962).

Consideration of the complexities of herbicide-wildlife relationships indicates three prime research needs:

(1) *More selective sprays and techniques.* It seems that there is much opportunity for development of herbicides and treatments, which will give the results necessary to silvicultural weeding and pine release and at the same time do minimum damage to the more valuable understory species. For example, a "perfect" hardwood control job may result in much heavier pine regeneration than necessary for either pulp or sawlog stands. A much more desirable level of control would give the necessary release, while leaving the valuable hardwood species in moderate quantity.

(2) *Good quantitative studies of the changes in vegetative composition following herbicide operations and of the effects of these changes on populations of the various game species.*

(3) *Determination of the effect of checkerboard patterns of ten to twenty different successional stages within perhaps 5,000-acre blocks.*

These problems are all basic and their solutions essential to sound wildlife management. Equally important, and far more encouraging, is the spirit of mutual concern and cooperation now evident between wildlife and forest products interests in the Southeast.

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DISCUSSION

DISCUSSION LEADER LAY: Thank you, Ed. I would like to explain that this paper is the result of a lot of hard work by a committee which included foresters and chemical company representatives, and the surveying was conducted from the standpoint of a cooperative effort, and it was not made as a survey of wildlife interests by wildlife people alone. That background should be kept in mind.

I know among the audience we must have some who had divergent reactions to those pictures. The foresters who like to plant pine trees doubtless found some vigorous growing stands portrayed that looked very attractive, and those of us who are spending a lot of time studying hardwoods and fruit production could hardly imagine a more devastating scene than we witnessed on one or two occasions. So it depends on your viewpoint as to how you reacted to some of those pictures. But this is an example of monoculture, an example of the kind of intensive and intensified land use that is affecting wildlife all over the country. In the South, the pine trees are worth more than any other land product on my sites, and intensive pine production, such as these pictures demonstrated, is to be expected. The question is: How can we salvage part of the habitat and make the most of the facts of economic life on our range? The floor is open for any comers.

MR. DALE H. JONES [Denver]: Some of those pictures look esthetically like they might be hard to sell to some people. I was wondering what type of I and E approach you used.

MR. CHAMBERLAIN: Are you referring to an I and E approach from the point of view of the timber company, the state game agency, or in what respect?

MR. JONES: Mainly just from the point of view of the general public. In other words, you see a large area along the highway. One of the slides showed just a vast area that was sprayed and dying. Then also there was the picture you had of many snags sticking up. At least, in some of this country, particularly in the West, esthetically that is hard to sell to people.

MR. CHAMBERLAIN: That is equally true in the Southeast, and I think that the impact of that problem on the operating companies is perhaps one of the principal reasons why the wildlife interests are enjoying more consideration in treatment, in planning the procedures and techniques. Some consideration is being given by the operating companies to measures which will maintain some wildlife values.

The general I and E approach, to get back to your first question, on the part of the companies that do express concern seems to be one of trying to modify their techniques in order to be able to say they are maintaining some degree of wildlife habitat population.

DISCUSSION LEADER LAY: Of course, the difficulty with those snags is that they are temporary and after two, three or four years it is difficult for the layman to see any sign of the hardwood stand that had been there. All they see is a pure stand of pine. It looks very attractive from many standpoints.

MR. EDWARD DOLEMAN [California]: I am interested in your experience with the heavier applications of herbicides and the effects of these applications on the young pine trees.

MR. CHAMBERLAIN: Do you mean heavier than what we mentioned in the paper?

MR. DOLEMAN: Well, you mentioned that these herbicides were applied at different rates. I was wondering if you had any experience with applications that were heavy enough to kill some of the pine trees.

MR. CHAMBERLAIN: There have been such occurrences. I think, in general, they have been confined to relatively small places. In some cases, it seems to have been due to the diesel oil carrier that was used rather than the herbicide itself. But there have been some cases of pine damage, although not any large acreages that I know of.

DISCUSSION LEADER LAY: Ed, it is my understanding that that potential damage to the pine trees is limiting the amount of herbicide that can be applied, and that accounts for the fact that we have water oak and a few species to be thankful for that are very difficult to kill.

MR. CHAMBERLAIN: That is certainly one of the factors involved.

MR. SAMUEL H. LAMB [New Mexico]: The chairman mentioned the fact that the wildlife people might not like some of that and that the foresters might like some of it. It seems to me that the same principle should be held in mind that we consider in the West concerning brush control for range improvement. If the people who are interested in brush control confine their efforts to the areas that will produce the best grass after the brush has been controlled and leave us the areas that will not produce grass so well for the game, we can get an integrated land use that perhaps is beneficial to both; and it seems the same principle would apply in the Southeast. The very fact you showed that the trees along the wash there didn't kill as easily as the ones elsewhere indicates that maybe they could be left for the wildlife.

MR. FRANK BARICK [North Carolina]: First, I would like to commend Ed for the very objective and fair way in which he treated this in our study. Then the other thing I would like to say is that, as Ed pointed out, this has been going on since 1953, which I think is one of the earliest dates indicated, and then he indicated also that more intensive efforts have been expended since 1955—and this is 1962—and that within a space of seven years there have occurred tremendous developments in the improvement, if we can call it that, of this technique. When I think also of the number of pulp companies that are concerned with pulpwood production, especially pine, throughout the Southeast and the number of acres which they control and the tremendous economic urge under which they operate, I just shudder to think of the implications of this type of work as far as wildlife management is concerned.

I think it is incumbent upon this group of people here assembled who are concerned with wildlife management to take every opportunity to let their concern be known, and in a very forceful way, in their own localities so as to keep this monster—if we can call it that—under control and keep it from doing as much damage to wildlife resources as it is potentially capable of doing.

DISCUSSION LEADER LAY: Thank you, Frank. That is certainly true. It is certainly a point we should all keep in mind. Obviously, we can do more through negotiation, through research, and through cooperative efforts with foresters who do want to try to continue to have some game capacity in their forests than we can ever do with compensating habitat improvements. It's just like trying to bail the ocean out with a teacup to plant game food and hope to compensate for such large-scale changes as are taking place through the economic forces of forestry.

MR. DRISCOLL [Oregon]: In the South, in the forest type conservations and in the brush types of hardwood species types, have they experienced any adverse effects as a result of this practice from the standpoint of wildlife damage either by deer or other kinds of wildlife browsing or grazing on the trees?

MR. CHAMBERLAIN: Yes, there has been some primarily from deer and, in some cases, from rabbits. But there have been extensive cases in some localities of deer browse damage on pine plantations which would seem logically to result from the elimination of other foods.

MR. DRISCOLL: I do believe we have to be very careful with this type of practice. We have had some very bad experiences in the Pacific Northwest along this line. We have many brush fields up there covered with manzanita and other species which are very dense, but there is somewhat of a residential stand of coniferous timber in the understory. The objective is to remove the shrubby overstory: in effect, to release them for growth and enhance reproduction in these areas. In many cases, literally thousands of dollars have been thrown down the drain trying to reforest these brush fields. That has been eliminated because it has created a habitat for deer or elk, in our case, and they have moved into these areas and literally wiped out any kind of an attempt to reforest these areas. So I think we have got to be very careful with any kinds of these practices.

DISCUSSION LEADER LAY: That is certainly true in the South as well, although it is probably not as serious as it is in your part of the country. We have witnessed occasions in eastern Texas when mass tree removal on the range brought about deer browsing of pine seedlings to a serious extent as a result of forcing the deer to eat something they didn't want to eat. It is poor deer management when you are forcing your deer to eat pine trees, but this can happen, of course.

THE PLACE OF BROWSE SEEDING IN GAME RANGE MANAGEMENT[1]

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"Seeding or planting may be used to restore needed plant cover, or to improve range composition. Experimental work is so lacking that little can be recommended as to species and methods." These two sentences are quoted from "The Deer of North America," edited by Walter P. Taylor and published in 1956. Since 1956 results from research in several western states permit us to make some recommendations as to what to plant and how to plant it. This paper summarizes the findings from a 10-year cooperative study between the Pacific Southwest Forest and Range Experiment Station of the Forest Service, U. S. Department of Agriculture and the California Department of Fish and Game and discusses how these results can be applied in a deer management program.

Many browse species have been considered for reseeding. But nearly every state studying browse seeding has settled on bitterbrush (*Purshia tridentata*) as the species warranting the most attention. This is true in California. Bitterbush grows naturally on all of the important winter deer ranges east of the Sierra Nevada-Cascades. It is a good herbage producer, withstands grazing well, and is highly palatable and nutritious. As knowledge increases, other species will probably become important for seeding under specific conditions. But bitterbrush will undoubtedly remain one of the most important species for browse seeding.

PLANTING METHODS

The mechanics of browse seeding do not differ appreciably from those used for grass range seeding. Any type of range seeding is essentially a farming job. The first step is to select a site suitable for seeding. The best guide to bitterbrush site adaptability is whether it has grown there in the past. If this isn't known, soil surveys and site evaluation will be necessary. Bitterbrush should not be planted where the soil pH is above 7.3 in the top five feet or where drainage is poor. The drier the site, the less chance for success. We have had excellent success from nearly every attempt with annual precipitation

[1]Contribution from cooperative investigations between the Pacific Southwest Forest and Range Experiment Station and the California Department of Fish and Game. Work was done under Federal Aid in Wildlife Restoration Act, Pittman-Robertson Research Project W51R entitled "Game Range Restoration."
[2]The Experiment Station is maintained at Berkeley in cooperation with the University of California.

averaging above 12 inches and soils heavy enough to retain moisture well. We have had success on drier sites, but not as consistently.

Good seedbed preparation is the next step and a very important one. Seedbed preparation has two main purposes. One is to prepare a smooth firm seedbed so that the seeding operation can be done accurately. The other is to rid the area of other vegetation which would otherwise compete directly with the young seedlings of the seeded species for moisture and nutrients. Most of the seedings in California have been made with machines. The brushland plow, developed especially for rough rangelands, has proved best for seedbed preparation. It does a good job nearly anywhere that a crawler-type tractor can be operated. Heavy brush should be either burned or removed mechanically before plowing. The brushland plow can root out a fair amount of brush and still do a good job of plowing. But if the brush is heavy, the plowing will be trashy and difficult to seed. Also, turning under large quantities of brush forms air pockets, and the soil dries rapidly. After plowing, the soil is loose and somewhat uneven. It does not fulfill the requirement of a smooth, firm seedbed. Harrowing with three 10-foot sections of railroad iron, hooked one behind the other and about two feet apart, smooths the soil and usually firms it satisfactorily. A roller can be used if further firming is necessary for accurate control of planting depth.

Scalping is another site preparation method which has been used in a number of western states (Holmgren and Basile, 1959; Brown and Martinsen, 1959). This method is particularly suitable on loose, rock-free soils where the main competitors are cheatgrass (*Bromus tectorum*) or other annual weeds. In extremely steep terrain, hand scalping followed by hand planting is the only feasible planting method. Machines have been developed for scalping and seeding on less steep terrain. One such machine is the Idaho adaptation of the Flexiplanter. It consists of a middle-buster plow which scalps a 30-inch strip and is followed by a seeder which plants a row in the middle of the strip.

A variety of methods and machines can be used for planting the seed. Regardless of method or machine, the objectives are all the same: to distribute the seed evenly, to place it at the proper depth, to cover it with soil, and to firm the soil over the seed.

Planting tools range from hand tools to fairly complicated machines. The rangeland drill, a machine developed expressly for seeding rough rangelands, has done the best job in California. This drill is patterned after the fluted-feed type of farm drill, but the disk openers on individual arms are capable of riding over obstructions 12 to 18 inches high. The large wheels make the drill easy to pull in rough, rocky country, and the frame is strong enough to minimize breakage. The rangeland drill will seed anywhere that the brushland plow can plow.

One drawback to the rangeland drill, and all other fluted-feed drills, is that it cannot be adjusted to seed bitterbrush alone at the low rates normally used without damaging the seed. Therefore, the seed should be mixed with some bulky material. Rice hulls do a good job when mixed in a ratio of eight pounds to three pounds of seed. A setting of 48 notches on the rangeland-drill feed will sow about six pounds of bitterbrush seed per acre.

Seeding depth is controlled on the rangeland drill by depth bands and by adding weight to each disk opener. We recommend planting the seed one inch deep on soils that retain moisture well. On lighter soils which lose moisture rapidly, we recommend planting the seed about 1½ inches deep.

The drill is equipped with drag chains attached behind each disk to cover the seed. These chains are usually satisfactory, but on trash-free seedbeds a log chain dragged in a U shape behind the drill will do better. Press wheels, now being designed for the rangeland drill, may improve seed coverage and soil firming over the seed.

Firming the soil after planting is particularly important in spring planting. Loss of moisture from loose soil on dry sites can mean the difference between success and failure. Since press wheels have not been available, rollers and cultipackers have been used. Some rollers are designed for attachment to the rangeland drill. With these drilling and packing can be done in one operation—if the tractor has enough power to pull both.

Whether to plant in the spring or in the fall depends on the planting site. In northern California, spring planting has produced three to four times as many seedlings per acre as fall planting. In Idaho and Washington, fall planting has given by far the best results.

Successful planting depends upon the soil remaining moist during the critical germination and emergence periods. Seedlings generally emerge earlier from fall plantings than from spring plantings because fall-planted seed is in the ground and ready to sprout as soon as the soil warms up in the spring. Consequently the critical period is later for spring planting than for fall planting, and the soil must remain moist longer for spring planting to be successful. Either adequate, well-distributed precipitation or high soil-moisture retention (loam soils retain moisture well while coarse sands retain moisture for only a short while) can provide this longer moist period. Where either, or both, of these conditions are met, spring plantings are usually successful.

SEED TREATMENT

Seed intended for spring planting must first be treated to break its natural dormancy. With fall planting seed dormancy is broken naturally by over-wintering in the soil. Simulating the natural over-wintering process is one method of breaking the dormancy of spring planted seed. This requires that the seed be kept moist, aerated, and cold—between 32° and 41° F (Hormay, 1943). Its main draw-back is that the seed must be kept moist until planted. Moist bitterbrush seed is often and easily damaged so that machine planting is impossible. A better method consists of soaking the seed in a 3 per cent solution of the chemical thiourea for three to five minutes (Pearson, 1957). The seed can then be dried and will germinate as soon as it is again moistened.

We also recommend treating bitterbrush seed with Endrin-Arasan as described by the Denver Wildlife Research Laboratory, U. S. Fish and Wildlife Service (Spencer, 1959). This is the best method presently available to reduce rodent depredations of the planted seed. Rodent damage has not been a serious problem on drill plantings in northern California but has on spot plantings in California and other States.

FURTHER INFORMATION NEEDED

Some questions still remain unanswered. We know how to get the seedlings above ground on many sites in California and in other States. But we need to extend this knowledge to other sites not yet studied and find how to protect and manage the seedlings once they emerge. Frost heaving, damping off, rodents, insects, deer, and livestock all damage young seedlings. Damage from some of these sources can be eliminated or reduced. From others, perhaps not.

WHERE SHOULD WE USE THIS NEW TOOL?

Bitterbrush reseeding is, we feel, ready for field application. We need field application to answer some of the yet unresolved questions. Reseeding is just another tool in deer management, not a cure-all. Its main application is in curing past mistakes such as overgrazing, ill-advised plowing and fire.

When large acreages of important deer range burn, it may take years, even hundreds of years, for desirable browse to come back. Bitterbrush sprouts in some areas, but over most of its range it reproduces from seed. In nature a burned area is seeded by rodents that carry the seed in and bury it for reserve food. If this seed is to produce plants, either rodents must be reduced in number before they get a chance to dig up the caches or they must bury more seed than needed for food. Even then, rodents have very restricted ranges and seldom carry seed more than about 500 feet into a burn. Seedlings from the seed buried in the first 500 feet must mature and produce seed before the browse can advance further into the burn. Each cycle—each 500 foot advance in this invasion—may take 20 years or more. Meanwhile, less desirable plants usually take over the burned area, making it even more difficult for new bitterbrush seedlings to compete for moisture and nutrients.

Clearing for agriculture took large chunks of land out of deer feed production. As settlers moved into the arid west, they often tried to farm land which was entirely unsuitable and then moved on when they failed. Little of the mistakenly plowed land they left behind has become good deer range. Browse plants eventually become established on these abandoned farmlands in the same slow manner as on burned areas.

In both of these instances—burns and abandoned farmlands—artificial seeding of browse plants can shorten the time the land remains unproductive for deer.

There is another place for browse seeding—bringing back ranges so severely damaged by overgrazing that they are no longer capable of recovery. Sometimes the desirable browse is killed outright; sometimes its vigor is reduced to a level at which it is incapable of producing enough seed to reproduce. Herbage production falls off. Disease and insects also occasionally cause losses. Under these situations, the desirable browse is replaced by inferior deer food plants—juniper, perennial grasses, sagebrush, and rabbit-brush, to name a few.

Many of these ranges have deteriorated to the degree that even with complete removal of grazing animals, range recovery would take years. Browse seeding can be used to speed up the recovery of these ranges in the same manner it is used on burns and abandoned farmlands.

Care should be taken in selecting where to seed. Seeding is expensive. It costs about $20.00 an acre to seed using Crawler-type tractors, the brushland plow, and the rangeland drill. Obviously it is impossible to seed all of any particular winter range at one time. Where do we start?

On some ranges the deer are forced to spend each winter on exactly the same area because the only winter range available to them is a narrow band at the foot of a mountain range. Heavy snow delineates the upper edge and agriculture or urban development usually effectively delineates the lower edge. Not all winter ranges are restricted to a narrow band nor do the deer always winter on the same area. The California-Oregon interstate deer herd summers in Oregon and moves down into northeastern California to spend the winter. This winter range is a plateau. During normal winters the deer spread out over a fairly large area although they are more crowded than on the summer range. Only in heavy snow years is this herd forced onto a small, low-snowfall, critical range, where large numbers starve. The answer to where to plant is not the same for both types of ranges. Where the winter range is restricted and the deer winter on the same range each year, the only choice is to pick sites physically suitable for seeding. On winter ranges such as the interstate, seeding should start on the normal winter range and be deferred on the more critical range until better control is obtained over deer numbers. Until then, starvation losses on the critical range will continue to serve as a safety valve, although a cruel and inefficient one, to protect the all-important normal range.

WHAT IS A SUCCESS?

In northern California, natural bitterbrush stands average 778 plants per acre, and the maximum stocking found by E. C. Nord of the Pacific Southwest Station, was only 1,420. Some sites can support more plants. Grazing, fire, rodents, rabbits, insects, disease, and other factors, combine to keep natural stocking below the capability of the site. These same factors will influence the final stocking density of plantings, but initial stocking should be close to the number the site can support. The upper stocking limit on one of the better bitterbrush sites in northeastern California is about 2,200 plants per acre. With denser stocking, the bitterbrush plants compete with each other for moisture and nutrients. Many are damaged and some die. Based on our experience, any site suitable for planting will support at least 500 plants per acre. Any fewer produce too little herbage to be worthwhile.

What does 500 to 2,200 plants per acre mean to deer? We have found that it takes between 207 and 587 mature bitterbrush plants to feed a 100-pound deer for one month, assuming that it eats nothing but bitterbrush. This means that 500 plants will maintain a deer for .8 to 2.4 months. Maximum stocking of 2,200 plants per acre will maintain a deer for 3.7 to 10.6 months. Reseeding to produce plant numbers and deer use within these limits is certainly worthwhile.

Here, then, is another tool available to the land manager. It is an expensive tool. Before using it we should be certain that the range cannot be restored by known management practices or cheaper cultural methods. Next we must be certain that the range is important enough to the well being of a deer herd to warrant the high cost of reseeding. Leaving deteriorated or destroyed deer range unproductive may, in the end, be more expensive than spending the money for reseeding.

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DISCUSSION

MR. DALE H. ARNER [Alabama]: I would like to bring you back to the southern forests again. I was wondering if he has done any work with range grasses and legumes in the West. We have been working on controlled burns in Alabama and with the lower-cost soils and Piedmont soils, and sowing fescue, dry grasses, ball clovers, partridge pea and beggar pea for quail management; and we have been successful, without any further land preparation, by sowing directly on burns as long as we applied fertilizer at about the rate of 400 pounds of 0-14-22 to the acre, with the partridge pea and Kobe lespedeza. We were not successful with the fescue grasses or most of the clover or ball clover. I just wondered if anyone had any experience on western seeding with burns without any other land preparation.

MR. HUBBARD: Of course, in the West there has been a great deal of grass range developed by seeding. It is very valuable for the improvement of deer ranges in many parts of our state and throughout the West. We have gone to browse seeding on many of these winter deer ranges because the only trouble with grasses is that they grow low to the ground and get covered up with snow. Furthermore, there is a somewhat higher nutritional value in some of the browse. We have tried seeding on burns with browse and, of course, with grasses. This is a major effort. Any time we have a burn in California, one of the first steps is to try to seed grasses for feed but, more important, for the reduction of erosion.

MR. DWIGHT SMITH [Colorado]: Dick, you mentioned that you had planted some of these bitterbrush plants in what you call the normal ranges adjacent to or some distance from your critical winter ranges. I wonder if these have been planted long enough that you are able to tell yet whether you have been able to get the herds to move from the critical ranges and have thereby gotten some improvement of those limited depleted areas.

MR. HUBBARD: Perhaps I had best define what I mean by normal. It is winter range; it isn't summer range. On that interstate herd, the deer come from Oregon and come into the transitional zone between the ponderosa pine and the thick sagebrush, and this is where they winter in all but one year out of ten. When we get extremely heavy snowfalls, they are forced onto an extremely critical range where they usually die in large numbers if they have to stay there for any length of time. But this normal range I am talking about is not summer range: it is winter range.

MR. DIEM [Wyoming]: Dick, one of the things that has always interested me, partly because of some of our experiences in some of these western states, is this habitat improvement. It is well to talk about the problem that you mentioned, but I think you may have ducked around an issue which most game managers are concerned with. That is we can get these things up to the seedling stage, but I know of no instance where any state in a critical range situation has been able first to control and then keep under control the game and herd in concern long enough to evaluate the range habitat improvement program. Have you seen anything in your work out there concerning this? Have you been able to do this or has any state, on an elk or deer range, been able to achieve this? It is one thing to grow it to the seedling stage and another to get it to the stage where it is furnishing long-term production for the game animal.

MR. HUBBARD: Well, Ken, in reference to a well-stocked winter range, we have had more damage with animals other than the deer. Wheu we have fenced out the jackrabbits, we have gotten a good establishment and some of those stands are now producing sizable amounts of herbage for the deer. I was saying that our major problem has not come from deer. Our most serious grazing problem has come from jackrabbits. They take the plants too early. Once you get the plants on your winter ranges established they actually can stand a little grazing, but they are not so large but what the snow covers them up and this, in itself, protects them. If you get a good establishment of those plants, they can be grazed in two or three years, and it won't kill them.

MR. DIEM: The thing I am pointing at here is not this normal range you are talking about, but in the areas where we need to do most of our range improvement there are critical ranges. This is true with some of our elk herds in Montana, Idaho, and some of the deer range in California, and the establishment of these herd areas is the critical area. From what you have said, I just gathered that no one has tried to plant on these critical winter ranges.

MR. HUBBARD: Let me redefine my terminology. Instead of calling this normal winter range, let us now call it critical winter range and call ultra-critical what I would call critical ranges. As far as the well-being of the herd, I am convinced that the redefined critical ranges, by far, are most important to the deer. When that goes, our deer herd goes. This ultra-critical range is critical only during one year out of ten. I think what you are driving at is that we have got to get our deer down to numbers that are reasonable on the ranges before we start improving them. I certainly couldn't agree more. When a fire starts at one end of a town, it is silly to build more houses in the other end until you put the fire out.

MR. DIEM: This is exactly the point I wanted to make. I don't know of anyone who has had range problems who could work along the lines you have until we have gotten to that point. I am wondering if there is some place where they have actually done that. We just want the answers when you get to that point.

MR. C. C. SCHENCK [Oregon Wildlife]: One of the clubs in our area seven years ago undertook the project of emphasizing to the sportsmen the condition of the range. We have packaged from 10,000 to 30,000 packages of bitterbrush seed each year and distributed them among the hunters. If a bitterbrush never grows from that seed, it was impressed upon the hunter the need for browse.

MR. HUBBARD: I think that's a wonderful program. We have had it in California. You don't get much of the seed up, but it certainly gets a lot of people thinking about bitterbrush, and we like that.

TIMBER-WILDLIFE COORDINATION CONCEPTS FOR LARGE EASTERN FORESTS[1]

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In an age when success is measured in terms of security rather than service, when social acceptance requires wealth, when advancement must be made "over" rather than "around" or "with" people, and when the do-it-yourself craze has taken in "empire building," there is no wonder that the harmonious coordination of timber and wildlife management is such a perplexing problem. As everyone is "for" conservation and motherhood, so everyone is "for" coordination, but few care to go past the indifferent mumbling of "yea" in the manner everyone else voted.

This paper attempts to solidify and clarify basic approaches and problems to timber-wildlife coordination; to present concepts and proposals for resolving these problems; and to hasten the day of effective, efficient multiple-use under conservation. The emphasis of the paper is on National Forest land management for here the interest is or should be most keen. The principles have valid application for state and other public forests, and more application and value on large private holdings for economic, social, and public relations reasons than most land owners will accept or admit.

The guiding principle of coordination is the definition of conservation: wise use of resources for the greatest good to the most people over the longest time. The concept most difficult to grasp is that conservation necessitates concession. No one resource, no one user, no one period can obtain maximum total benefits under this program of entire resource use. All the conditions of the definition must be met by any decision for use of any one resource. The problems involved in balancing out the factors of such a complex principle are obviously oppressive. Oppression, however, is no excuse for surrender. The public's justice soon will not excuse those who through laziness, prejudice, or ignorance make decisions for resource use that result in resource abuse. The public expects effort. The days are passing when resource abuses, whether active or passive, will be tolerated. Land abuse is a crime against a society that now sees, hears, and responds; one that is now finding ways to throw up a guard before they feel compelled to strike out.

With the very definition of conservation begins conflict, for both the forester and wildlifer must make concessions from the start. This is a

[1]The early counsel of M. Leon Powell, USFS, Covington, Va., and editing of Dr. T. J. Peterle are greatly appreciated.

real, basic concept that must be faced or the principle of conservation denied. If denied, there cannot possibly be any coordination of these two systems of resource use. This concept is so basic that it must be explored further. It appears that land managers are conservationists or they are not, thus wise use or abuse. This is true, but side issues must be considered. Most university training in resource management is usually single-resource oriented. A man is graduated a forester, an agronomist, a wildlifer. This orientation is the major contributing factor to the problems of the wise use of the resources of the large forest. It can be corrected in the curriculum by properly-oriented university staffs, and by inter-resource seminars and problem-solving conferences. I make no brief for the training of generalists. The university's responsibility is to turn out specialists that are conservationists.

Resources of the large forest are rarely any longer abused by the logger, the miner, even the hunter. Abuses are committed by the manager who through the "muscles" of contracts, agreements, leases, laws and regulation, and supervision wields the resource user as if he were a great axe. The manager's skill is reflected in his marks on the forest resources. I do not believe this is shifting too much of the burden to the professional. He has sought the responsibility since he was ineffective at conservation education; he now has the burden and must pick it up and carry it. This fact, too, places great responsibilities on the university factories where land managers are produced.

Though improved university training will take care of many future problems, we are still stuck with our present battery of land managers, many dedicated men, all of whom profess conservation beliefs but who under careful scrutiny have special-interest resources and who do not agree that concessions are imperative. This group needs training, it needs strong policy, it needs enlightened leadership that must say, "You're a good wildlifer, Joe, but we must consider other resources in the management of this area. Until you can prove I'm wrong, you'll do the job this way. . . ."

From these needs arises the ageless problem of compromising principles. I, for one, shall never advocate compromise, but rather insist that the principle of conservation requires concession, *e.g.* a sacrifice of maximum timber harvest for continued streamside protection. Some foresters contend that their job is to provide the greatest possible economic wood and wood-product yields from a tract. If they maintain this attitude, they compromise the principles and underlying philosophy of conservation. Every state or federal forester who accepts this economic objective denies conservation and the present and future well-being of the people of the land who are his employers.

Coordination of the management of timber and wildlife within a forest requires a policy with a conservation base. It requires competent, well-trained resource specialists with a firm grasp of the principles of conservation and the willingness to make concessions in aspects and degrees of use to secure the objectives of the program. Strong leadership is needed to insure that sound policy, once established, is meaninfully enforced. Also required are mutual trust and respect among the specialists who are each expected to fully subjugate themselves and whatever personality problems they may have for the "good of the cause."

One of the greatest weaknesses in past attempts at coordination of timber and wildlife management is that coordination was planned and administered by men sensitive to the democratic wailings of an uninformed public. It is more fundamental to say that the personnel responsible for coordination of timber and wildlife on millions of acres of public and private forests have not yet fixed sound coordination objectives, confirmed their conservation definition, nor established scientifically based policy.

Complicating the problem has been the difference in esteem with which the public has held the two resources—timber and wildlife—and the people administering them. Foresters have reached a high stage of professional acceptance and they can authoritatively handle the timber resource. Wildlifers have little professional recognition, nor is the public willing to put the management of wildlife, a resource that is ecologically and recreationally as valuable as timber, into the hands of men as competent to manage game as foresters are to manage timber. Recognizing the problem is not enough. Realizing these limiting differences, foresters and wildlifers—the land-use partners—must work all the harder toward scientific plans, successful programs, and public acceptance to hasten the day of a fully-coordinated program of timber and wildlife management.

A great hindrance to the advancement of a coordinated use program is failure to imaginatively use existing knowledge of forest wildlife needs and to develop these into management directives. At first thought, the blame might be put on inadequate library facilities, but the truth lies with the manager who has not sought aid in securing literature nor has he used information easily available. Sharing an equally important role in this weakness is the administrator who contends that the only day profitably spent is in the woods. Managers must have time and take time to use information now available. Certainly, research is needed, but while waiting, we need to work with what we have. Work to be done is not for the research staff, but the management team who sees the needs, recognizes limitations, and can make modifications to fit existing conditions. The "applied ecologist" needs to start applying, not waiting for handouts from research personnel who have enough problems of their own. Managers must then share information on the results of their efforts with their colleagues.

The Multiple Use Act of 1960, P.L. 517, stirred up as much bustle in public resource agencies as an inspecting officer does in army troops. As in the army, the bustle reflects the level of accomplishment, extent of planning, and amount of work done previously. The inspecting public will one day inquire as to why the artificial rush for perfection was so evident, why obedience was not more willing, and why lip service had sufficed for critical thought and positive action. Now that the inspection has been made in the "crack" units, the public will soon turn its attentions to the smaller troops—the states. It is certain that they will not fare as well as the federal agencies under critical scrutiny.

Pious wildlifers have stood back for years, shaking their fingers disdainfully at foresters for not adequately providing for wildlife on their forests. Foresters are now asking for advice on how to manage widlife and are getting little. Wildlifers, now with the group, have fallen under their own judgment. Before, they easily overlooked their own shortcomings. Now the air has been cleared, scientific objectivity encouraged, and better understandings reached of problems in both field by both groups of specialists. Wildlifers, previously working in a partial vacuum, are now working in an atmosphere conducive to progress. The climate has been created for leadership. It will be interesting to see if the need is met.

Perhaps what I have said so far has not sat well with some of you. You perhaps agree with the quip that "the only person who thinks criticism is constructive is the person making it." I have made these statements because I know we recognize the need for coordination and I strongly feel that as land managers we are broad minded enough to want to improve. We want to see our weaknesses clearly, are willing to face up to them, and are anxious to work from today's situation toward strength in our program. As we look back on coordination efforts of the past three decades, the accomplishments have been great, we have been very busy; the progress has not been so spectacular!

SHIFTING EMPHASIS

It is regrettable that habitat improvement has come to connote widlife clearings, waterholes, and conifer plantations. These techniques of habitat manipulation have overshadowed all other efforts in past coordinated forest-wildlife programs. They have been given undue importance as techniques and have pacified wildlifers and foresters alike who were "doing something." They sufficed because they could be counted and reported, because no one knew what else to do, because they were an active approach to management.

The time has come to face up to the fact that the harvest of wood, a forester's function, has greater influence on game than any active technique available to the wildlifer. In one sale a forester can destroy more habitat, kill more game, break more nests, move more animals, and influence more cover over a longer time than a game manager with today's funds can create, plant, stock, raise, or import in a decade. The wildlifer, realizing the potentials of the wood harvest, must not only increase the effectiveness of his present practices, but must provide guidance for foresters so their efforts will not so strongly negate his efforts and can be made to complement them.

The management concept of "do a certain thing" in order to manage, must now embrace "do not do certain things." The emphasis must be switched from active to passive management.

THE PLAN

An extensive written plan for coordinating timber and wildlife management on a land unit comparable to a National Forest ranger district is essential for success. The plan should be prepared by both wildlifer and forester, preferably by the wildlifer whose influence is needed in changing existing patterns of forest use. The plan should be signed in approval by both wildlifer and forester and by higher authorities. The plan, besides providing concrete management directives and coordination measures, tends to stabilize resource decisions and to prevent land abuse by transitory, inadequately trained, or personal-gain-bent personnel; by political pressures; and by cut-quota demands. The general plan covering the policies, program, and practices for the entire forest area is supplemented by a base map and colored overlay maps from which accomplishments can be measured and needs may be inventoried.

A WATERSHED APPROACH

Progress has been made in the realization that under a system of multiple use management, optimum use cannot be obtained for every resource on every acre. A corollary to this premise is that all species of forest wildlife cannot be provided for or managed on every acre. Just as some areas have their greatest utility for recreation, for timber production, or for watershed protection, so do some areas have their greatest utility for bear, squirrel, grouse, or deer. Perhaps all these species do or can occur on the same area, but management and use of them must vary with the characteristics of the land and the needs of the people. To manage a large forest for deer would eventually reduce squirrel and turkey populations; to manage for squirrels would eventually exclude deer and grouse populations. We have tried the shotgun, all-species-everywhere approach long enough with little progress. The approach is now to prepare prescriptions for management of one or a few species on select watersheds.

The prescription is an attempt at wise, long-term management planning on natural land units. The watershed is the most natural and complete unit sensitively subject to vegetative change within its bounds. Populations of small game within watersheds tend to be stable and somewhat confined. All land lies within a watershed, thus eventually insuring total planned land management.

Under a multiple-use system, each resource is given importance or management consideration in proportion to its place in the objectives of conservation. Within the limitations imposed by a rigorous and not always realistic annual cut quota, each forest district has priorities for resource management based on community needs, resources available, resource quality, and other factors. These priorities establish fields of interest and consideration that color decisions in resource management. For example, an area of potentially high timber value and great water-retention needs in a high watershed priority area would undoubtedly be cut lightly or not at all to favor watershed quality.

Within an area such as an eastern National Forest ranger district, there may be three to ten major watersheds. These watersheds should be mapped, and within each, priorities assigned to resource development. Planning the management of small watersheds (100 to 500 acres) within these major sheds should be done by the forester with these priorities and guides in mind. For each small watershed a two-part written prescription is prepared in the field and office. The two parts are *description* and *action*. The first includes a brief general description of the area including its boundaries, soil, timber volume data, and discussion of understory and reproduction. The second part includes: timber sales and conditions, sale area betterment (TSI) instructions, and considerations for grazing, special uses, wildlife, recreation, water, boundary posting and surveys, roads and trails, rights-of-way, and fire, insect, and disease control. A brief summary emphasizes important considerations. Provisions for a compliance check and changes in the plan are included.

This brief written plan, for the individual watershed, besides securing the objectives mentioned previously, gives the forester ample time for reflection, research, and consultation, and causes him to be specific in his plans for the area. The plan is the responsibility of the land manager, *e.g.*, the U. S. Forest Service. It is the wildlifer's responsibility to advise and to direct him, pointing out how wildlife might be best benefited from certain practices and how these practices may be integrated into the prescription for the watershed, and how treatment of the watershed might be integrated with the treatment of adjoining areas for optimum wildlife as well as forest management benefits. Forest-wide marking guides that list species-specific practices are of value as formal directives, but must be supplemented by personal consultation in the field.

The "wildlife considerations" section of the prescription first recognizes that all species of game cannot be provided for on the same area. The section should include considerations of (1) habitat needs of different species, (2) needs supplied by the present forest growth, (3) what species different treatments would favor, (4) socio-economic demands of wildlife users, (5) possible conflicts of wildlife with other forest values, and (6) proportionate consideration of all important forest game species. Wildlife aims of the plan should be to provide game where it is wanted and can be used, where it can be managed, and where it will not create problems.

Figure 1 presents hypothetically one of eight major forested watersheds on an eastern National Forest ranger district. The component small watersheds are outlined; they range in size from 50 (I) to 800 (F) acres. Because of the town shown, watershed values are moderately high, both due to water supply and flood control though at present there is no water shortage nor flood threat. Pulpwood, timber, wildlife, and recreational values are high, ranking in that order in terms of economics and expressed public demand. A, H, and I, already heavily cut prior to acquisition, are used by deer and limited grouse populations. For recreational purposes, I and H are given high squirrel management priorities, attempts made to convert to mast producers, shrub understory reduced, and a mature forest encouraged. Of the manageable forest game species, squirrel can provide more recreation and sustain greater hunter pressure than any other species. A and B are maintained in short rotation hardwood pulp and firewood production with preferred deer browse species encouraged. Within areas A and B several small areas were clear-cut and developed into grass sods for deer and grouse benefit. A 20-acre ridge top stand of mature oaks was retained uncut as a mast-producing area for deer, for a seed source, and as "squirrel woods" near at hand to the city's several-hour-a-week hunters. Areas C and F were managed for sawtimber and secondarily for pulpwood. Here, the decision was to encourage turkeys and sawtimber. Several clearings were established for turkey brood and nesting sites, a closed canopy and park-like stand

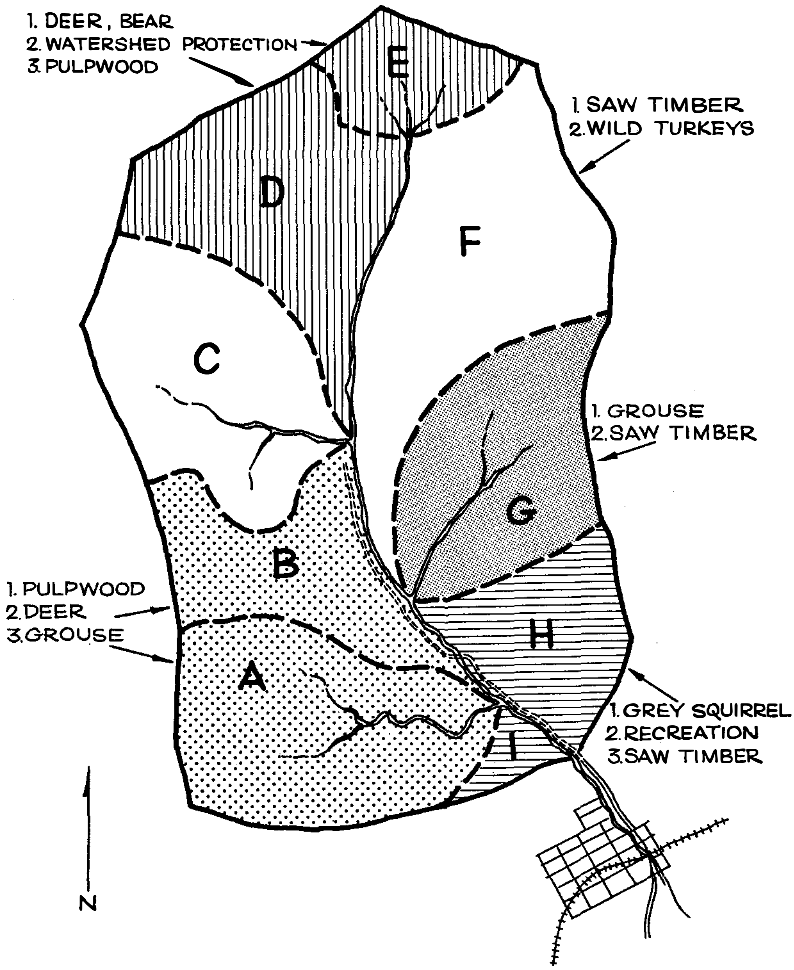

Fig. 1. One of eight major forested watersheds in an hypothetical eastern National Forest ranger district with minor watershed timber-wildlife management priorities.

encouraged; den trees were not particularly favored except as an "extra" for raccoon and opossum along stream sides since emphasis was on turkeys. High quality den trees are generally not in keeping with high-quality sawtimber production. D and E being poor dry sites were clear cut in small blocks with no between-blocks selective cutting. Mast production was high in this relatively inaccessible area of old, large, poor-quality timber. Deer and bear were the target species here with the area providing remoteness, mast, browse, and dense cover. Squirrels benefited, but this was of secondary importance for their chance of being harvested was slight. The plan for area G includes intensive grouse management measures which were planned in conjunction with additional grouse management on the adjoining eastern watershed (not shown). Grouse management was justified by the moderate grouse populations present, enthusiastic interest in them by many local hunters, accessibility of the area to hunters, and ease with which habitat conditions could be improved for them. Slashings were made; clumps of conifers were planted after clear cutting patches of solid hardwoods. Scattered hemlock and white pine were retained to provide a mixed stand with interspersed conifer blocks; several strips of nesting and brooding "lanes" were cut along the contour and later bulldozed and seeded for permanent sod and small annual grain plantings. Quality fruit and mast producers were amply provided for in selective cutting operations; sale area betterment crews operated from minimum standard guidelines for old and young mast and fruit producers to be retained per acre. Here grapevines and cover-providing tree species were encouraged, stream banks left untouched, and drumming logs provided. Foot trails were provided and marked; roads were closed except to wood users.

It is obvious from this example that concessions have been made. I feel that this approach most nearly reaches the objectives of conservation and is a more professional, business-like approach than we have used in the past. Foresters can no longer believe they are fooling the wildlifer or the public by boastings of leaving two den trees per acre, and four mast producers per acre. The real question that needs answering is: "Did your timber and woods products marking adequately provide for the needs of present and expanding populations of the target species for the area on which you were working?" Some areas need no den trees; others need every one that can be crowded onto them. The conscientious forester will see that certain areas have their greatest utility for game, others for timber. It is uneconomical, impractical, and inefficient to continue to try a standard forestry-wildlife coordination approach for all areas.

Briefly, the example just presented attempts to show some of the planning phases and considerations given to individual and groups of small watersheds in coordinating forest and wildlife management. Other resources must be similarly considered; target species must be realistically selected based on existing and immediately available habitat; adjoining watersheds must also be considered (especially for wide-ranging species such as turkeys); and prescriptions must be carried out.

Great harm can result if major alterations are made in these plans in less than 20 years. To do so is unethical and the objectives of the plan cannot be reached. Consider the results of a plan designed to sustain and increase deer populations by encouraging high timber quality mast producers on one watershed, on an adjoining watershed large volumes of browse. Altered five years later to provide that the browse area should be managed for squirrels and another area used for browse, the results are obvious. The original planner, doing a conscientious job with adequate guides, study, and trained advisers can, without question, prepare such long-term plans that will reflect to his credit and to the land which he manages.

Some administrators would be naive enough to think that once planned, anyone could "cook book" manage the forests. This is not true, for natural renewable resources are dynamic. It will require the best minds available to refine the prescriptions, to see that they are satisfactorily executed, and that when changes are required due to changing human needs, to changing land carrying capacities, and to changing resource use and management concepts, that these changes will be made within the framework of the existing plans with sound conservation objectives in mind.

SUMMARY

This paper attempts to solidify and clarify basic timber and wildlife management coordination approaches and problems and presents concepts and proposals for solving these problems. Major emphasis is on National Forest management but the concepts are applicable to most large forests.

Concepts presented and discussed were: conservation necessitates concession; though oppressively complex, coordination demands effort; universities producing single-resource specialists must insure that they are also conservationists; resource abuses today on the large forest are largely committed by the specialist; present staffs need training, strong policy, and forceful leadership to suppress existing special interests; foresters contending their job is to provide maximum economic forest product yields, deny the principle of conservation; mutual trust and respect are required between personnel besides total subjugation of personality problems for the good of the cause.

Failure of wildlife managers to imaginatively use existing information for forest game management directives is discussed with the managers blamed for not seeking needed literature and waiting for "research staffs" to do their work, and administration blamed for harboring the attitude that the manager's only good day is a day in the woods.

A climate for wildlife leadership has recently been created. The

question is raised: will wildlifers, who for years have criticized foresters for not doing more for wildlife, meet the needs?

Emphasis from the active "clearings, waterholes, and conifer clumps" to the passive "refrain from certain forest practices" is encouraged. Need for an extensive written plan for management coordination on a watershed basis is stressed. The advantages of the watershed approach are described along with outlines for "prescriptions" for management and land use within them.

The concept that all forms of game cannot be managed or provided for on every acre is presented with an illustrated example of planning for coordination of timber and wildlife on a large Forest Service ranger district. Small watersheds are assigned game species and wood-use priorities for management.

Extensive planning cannot make land management a "cook book" activity in the future. As land and human population demands are dynamic, so must the plan be to reach sound conservation objectives.

DISCUSSION

DR. A. B. COWAN [Michigan]: I would just like to point out that in the State of Michigan we have pretty close to what Bob has outlined in the way of a coordinated plan between our state foresters and our state game managers and that our district foresters and our district game managers share adjacent offices in the district offices. They nearly always coordinate any planning or any cutting program that is to be carried out in that district. In the state office of the State Forester, they have, at the present time, a pretty well established series of priorities for all of their state forest lands in which they have categorized the primary plus the secondary and tertiary allocations for the principal uses of their state forest lands. And I think that the thing that Bob has pointed out here is on its way.

I would like to say that we have to consider specific areas in the way we look at this. In Michigan, the way the demand for forest products is at the present time, they cannot sell enough of the timber to do as much timber cutting as they would like to do. If they could dispose of their timber, they would like to cut about 50% of the state forest land over something like a ten-year period in order to accomplish what they consider to be a good balance.

DISCUSSION LEADER LAY: That's a very interesting comment on the status of forest economics. It hasn't been mentioned, but we have a similar problem in the South. Pine trees are very difficult to sell in some areas, and we are intensifying our forest approval.

Bob, do you have any comments on that? Are there any other comments? If not, we'll move along.

BIG GAME MANAGEMENT IN HAWAII

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Most residents of the mainland United States are familiar with Hawaii's status as a famed tourist attraction — Honolulu, Waikiki Beach, and Diamond Head are well-known names throughout the country. However, few non-residents (and a surprisingly low portion of Honolulu residents, as well) realize that our newest state offers another attraction in the form of excellent hunting, and that an active series of game management programs are being carried out by the State Government's Department of Land and Natural Resources through its Division of Fish and Game. This paper is presented in an effort to explain, briefly, the extent of the various programs of big game management in the Islands.

The State of Hawaii is made up of eight major islands, seven of which are populated—the eighth, Kahoolawe, is controlled by the military and used as a bombing range. One of the remaining seven, Niihau, is privately owned and not open to the public, nor to the State Government for natural resource management. Thus, there are six islands in Hawaii where resource management, including wildlife management, falls under state control to varying degrees.

About 78 per cent of Hawaii's human population is concentrated on the island of Oahu, which contains the city of Honolulu, and which makes up only 9.4 per cent of the state's total land area of 6,435 square miles. The remaining 22 per cent of the population is scattered among the other six populated islands, including only 10 per cent on Hawaii Island, which, with an area of 4,030 square miles, is larger than all the others combined.

With this pattern of human population distribution, the state has proportionately large areas of thinly-populated land, and many completely uninhabited areas of wilderness, large parts of which offer suitable habitats for several species of large game mammals.

Although big game management in many portions of this habitat—such as on privately-owned lands, and lands under the jurisdiction of other government agencies—is not under the direct control of the Division of Fish and Game, there are 22 game management areas and public shooting grounds where wildlife management is entirely the responsibility of the Division. These 22 public hunting grounds are distributed over the six major islands—Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai (ranked in order of size)—and comprise a total area of 475,747 acres, or about 745 square miles. They range in size from the little 600-acre Waimanalo Game Management Area on Oahu, to the Mauna Loa Game Management Area on Hawaii which encompasses 186,511 acres. They include habitat varying from hot, dry, semi-desert country along leeward coasts, through wet, dense, fern-choked rain-forests and temperate, open park-like forests and pasture lands of the medium altitudes, to the barren lava and cinders of the sub-arctic, high-altitude mountain peaks up to 13,784 feet of elevation.

Some of the game management areas are state-owned land, managed exclusively for wildlife by the Division of Fish and Game, but others are privately-owned or under the jurisdiction of other governmental agencies, with only the wildlife management thereon falling under the direction of Fish and Game. Thus, although all these areas are considered public hunting grounds, many problems arise concerning the opening and closing of hunting seasons, depending on the seasonal requirements of the landowners for other land uses such as cattle grazing, military operations, etc. Each game area must be managed as a separate package, with game populations and hunting seasons determined not only by biological conditions in each of the extremely varied areas, but by the pattern of other land uses as well. This condition leads to a necessary, but rather complicated, and sometimes confusing, series of hunting seasons throughout the year, particularly in the case of big game.

Of the 22 public game management areas, 13 contain populations of big game animals and are periodically opened for big game hunting. Others also contain big game, but, for various reasons, are not generally opened to this type of hunting. Other areas within forest reserves, although not game management areas, are periodically opened for big game hunting with these seasons being run by the Division of Fish and Game.

Big game populations are also found on many private lands in the state, where, in most cases, they are under the complete control of the landowners and may be hunted or protected at will, with Fish and Game having no jurisdiction other than requiring all hunters to possess a valid hunting license. Big game hunting in many of the state's forest reserves is controlled by the Division of Forestry, not by Fish and Game. This practice is now being evaluated and will possibly be changed soon.

The complete story behind these diversified systems of big game control and management is a long one, and is mentioned here only briefly in order to illustrate some of the rather unique problems facing the game manager in Hawaii.

The most intensively managed, most highly-prized, and only true "wild" big game species now hunted in Hawaii is the axis deer (*Axis*

axis). This beautiful deer, also known as the chital or Indian spotted deer, was brought into the Islands from India about 1868, and liberated on the island of Molokai. Subsequent liberations were made on Oahu and Lanai, and large herds eventually built up on all three islands. Uncontrolled hunting led to the almost complete eradication of deer on Oahu, but huntable populations now exist on both Molokai and Lanai. This species is presently the best understood of all big game in the state due to a recently completed study of its life history and ecology, and, because of the knowledge now available and the exceptionally high hunter-demand, it is also the most carefully managed of all big game.

On Molokai, axis deer are considered the property of the landowners where they occur on private lands, but are under the control of the Division of Fish and Game on three of the public game management areas on that island. Management consists primarily of manipulation of hunting seasons and harvest on these public areas, though it is made somewhat difficult by the uncontrolled hunting in adjoining, privately owned areas.

The herd available to public hunting is estimated at about six hundred and fifty animals on Molokai. Its habitat includes the dry and rugged leeward slopes of the island from sea level to approximately two thousand feet of elevation. Food is abundant all year long; there are no disease or parasite problems; predation by wild dogs is relatively low; and the herd reproductive rate is high for a species that normally has single births. The major problem here is poaching, which apparently keeps the herd well below the optimum level on two of the game areas. Law enforcement is diffcult and not too effective due to the mixed control of deer on neighboring public and private lands, ease of unauthorized access into the public areas, and public apathy. Because of this, the population remains more or less static at a suboptimum level on these two areas, although it does provide some hunting during the annual seasons.

The remaining, and largest, game management area on Molokai is under more adequate control, and its herd has been increased to where it is presently at about the maximum size to be in balance with its range. Two areas are privately owned, while the third is under the jurisdiction of another government agency, and only the game management is under the control of Fish and Game. The areas are used primarily for cattle grazing. Consequently, deer hunting seasons must be set at times suitable to the interests of the landowners, which, so far, have coincided nicely with biological requirements.

The annual harvest of deer, based on estimates of herd size and reproduction, is established by limiting the length of the hunting season, the number of hunters who may participate, the number of days each may hunt, and the area in which each may hunt. The latter three factors are determined for applicants through public drawings for the limited number of hunting permits available. In the 1961 season, for example, each applicant whose name was drawn was allowed to hunt one weekend, only, in a specified area, and was allowed to take one deer of either sex. The season ran for four weekends in September, and was limited to 160 hunters in all, 40 of which were allowed to hunt each weekend. The landowners required that all hunters be accompanied by guides in order to assure protection of livestock.

Other deer management on Molokai has included construction and maintenance of access roads into deer habitat, a small amount of water development, and protecting nearby alfalfa fields from deer depredations through fencing.

The entire island of Lanai, although privately owned, has been turned over to the state for game management purposes, and about two-thirds of the 90,000-acre island are used almost exclusively as wildlife habitat. All wildlife, including axis deer, are under Fish and Game control, and there are no problems of conflicting game ownership. Deer inhabit all of the lower slopes of the island in habitat very similar to that on Molokai, and food is more than ample all year long. No livestock is raised on the island at present. Poaching and predation are practically nil, no parasite or disease problems exist, and reproduction is high. The deer herd has been allowed to increase—through complete protection from hunting for several years, then through carefully regulated hunting seasons—to what appears to be optimum numbers under present range conditions, and was estimated at about seventeen hundred animals in the summer of 1961.

Hunting seasons are managed similarly to those on Molokai, with the number of deer to be harvested being determined from the results of combined aerial and ground counts made before the season. The number of hunting permits to be issued is based on the number of deer available for harvest and the expected hunter-success. Permits are then distributed to hunters through public drawings, which determine who will hunt and when. No guides are required on Lanai, nor is there any restriction as to what area the hunter may use—other than certain closed areas or shotgun-only areas.

The two restrictions imposed by the island's owners are that the hunting season must not be held between May and September, and that hunting must be confined only to Sundays. Deer seasons are usually held in October, the only month available that fits in with biological needs. In 1961, the deer season ran for five Sundays in October, with each hunter being allowed to hunt one Sunday and to take one deer of either sex. Five hundred permits were issued, but only 447 hunters actually hunted, taking 293 deer for a success of 66 per cent.

There are also certain areas on Lanai set aside for archery, only, with a year-long season and a limit of one deer per hunter per year. This season is taken advantage of by only a few archers, and only one buck has been taken in the past four and one-half years! Axis deer are extremely alert, and not easy to stalk.

The island as a whole is very dry and rugged, and natural water is scarce, so pipeline-fed water troughs are maintained for big game where possible, and rain-catchment units where no water lines exist. Rough "jeep-roads" must be kept passable in order to reach and maintain water units, as well as to make it possible for hunters to gain access into hunting country.

Future management of axis deer on Lanai will probably continue along existing lines. The herd appears in good condition and is under proper control, so that it promises to provide good, though limited, hunting for years to come with no major problems foreseen. Depending on range trends, it might even be possible to increase this herd in the future so as to provide more hunting. The future of Molokai's deer herd is somewhat more doubtful, and depends largely on the wishes of those owning or controlling the game management area lands.

Hawaii's leading game animal, numerically speaking, is the feral pig, or "Hawaiian wild boar," which is found on all major islands but Lanai, and which is harvested by hunters probably in greater numbers than all other species combined. It is the least understood of all big game, however, and is under very loose control, with management on public game areas consisting of little more than setting seasons and bag limts "by feel."

Feral pigs, originally introduced by the first Polynesians to reach Hawaii, and later mixed with many varieties of escaped domestic swine, are extremely adaptable, and are found in all types of habitat in the state. They range the dry algaroba forests along the seacoasts, the dense fern forests of the intermediate elevations, open grasslands and parkland forests of the ranches, and the high montane forests up to, and above, timberline on the higher peaks.

In areas long isolated from the influence of domestic hogs, such as the slopes of Mauna Kea on Hawaii, the pigs appear to have reverted in form to that closely resembling their original ancestors, the European wild boar (*Sus scrofa*). They are predominantly black in color, have heavy coats of long bristles with a woolly undercoat, high shoulders and sloping hindquarters, long snouts, large, hairy, pointed ears, and long, tufted tails. Old boars develop formidable tusks and heavy "shields" along the shoulders and rib cage, and the young are often born with the longitudinal brown stripes typical of the young of the European boar.

In less isolated areas, where the "wild" pigs have been interbred with escaped domestic swine, they take on many forms and colors, ranging from those described to those more typical of pure domestic animals. Some grow to very large size, particularly in wet forests; one was recently weighed at over 450 pounds, while reputable hunters state that they have killed much larger ones. Even small boars are fierce fighters, commonly maiming and killing hunting dogs and even horses, while at least one case is on record of a large forest boar having killed an armed hunter.

In game management areas, hunting seasons are periodically opened for taking wild pigs, and methods and bag limits set. On several game areas, the season is open all year with a daily bag limit of two per hunter, while on others, it is much more restricted. Unfortunately, little is known of the life history and ecology of these animals at present, so hunting regulations are based more on guesswork than on scientific facts. It appears, however, that pig populations on the game areas are increasing—or at least holding their own—under present "management."

In addition to regular hunting seasons and areas where firearms are allowed, there are several game management areas on Hawaii Island open only to bow and arrow hunting. These are well used by the archers on Hawaii, and many pigs are taken by this method. Hunting pigs with dogs is not generally allowed on public game management areas.

Far more pigs are found on private lands and in forest reserves than occur within the public game management areas (primarily because of the types of habitats involved), and these are hunted with almost no control and by any means seen fit by the hunter. It is not known how many are harvested each year from these areas, but the numbers must run into the thousands. Such continued and unregulated hunting has caused a decline in pig numbers in some of the more accessible forests, but, for the most part, populations appear to be withstanding it very well and even increasing in some places.

A long-term ecological study has recently been initiated and is now in progress in an effort to learn more about the wild pig in Hawaii. Although it will take a number of years to complete, the results of this study are expected to provide the information needed upon which to base sound management plans in the future, at least on areas under Fish and Game management.

The second most numerous and most heavily hunted animal found on game management areas is the feral sheep, although they are outnumbered in the state as a whole by goats. These animals, first introduced into the Islands by early explorers in the latter part of the eighteenth century and allowed to run wild ever since, are of indeterminate breed and are available only on Hawaii Island. They have long coats of shaggy wool, and are not handsome beasts, although old rams grow heavy horns much sought after as trophies by local hunters. They provide excellent flesh, however, and are avidly hunted as a source of meat as well as for sport and trophies. Their principal habitat is on the upper reaches of Mauna Kea from 7,000 feet to well above timberline at 10,000 feet of elevation, although smaller herds range Mount Hualalai and the lava flats between Mauna Kea, Mauna Loa, and Hualalai.

Mauna Kea Game Management Area, 80,102 acres in size, is the state's second largest, and is managed primarily for sheep hunting, although pigs and goats are also available. It is divided into eight hunting areas, each with a mountain cabin at its base where hunters may camp for one or more night. Six of these areas are open only to guided-hunting, and a government approved guide must accompany each party of hunters (up to six in a party). These sections must be reserved ahead of time so that no more than one party will be in any section at once. This not only provides safety by preventing overcrowding and lost hunters, but assures each group that the game in its area will not be disturbed by other hunters while they are there. The remaining two areas do not require guides, but are also limited to six hunters a day in each.

In past years, sheep were under-hunted on the mountain, and, with little predation and a very high reproductive rate, the herds grew to a size where they were doing extensive damage to the forest and soil. The situation has greatly improved and the herds have been reduced by increased hunting pressure, brought about by providing easier access into sheep range and increasing bag limits.

Each year, a census of the sheep population in this game area is made, and the total population estimated. By comparing the annual harvest with the population and range trends, bag limits and other regulations are determined for the coming year. The population now appears to be decreasing (from an estimated four thousand in 1960 to thirty-five hundred in 1961) due to increased harvest (2,300 in 1960 and 2,700 killed in 1961), and range improvement in many areas is apparent. The herd reduction is not as great as it might appear on the surface, however, because of the high reproductive rate, and further reduction still seems advisable.

Four other game management areas on Hawaii have lesser herds of sheep, and are open for archery hunting most of the year with a similar bag limit of two sheep per hunter per day. No guides are required in these areas. Occasional firearms seasons are proclaimed if it is determined that the archers are not harvesting a sufficient number to keep the herds in balance with their range. Sheep also occur on some private lands on the island, but here they are the property of the landowner, to be hunted at will, and are under no control by the state.

The remaining big game species presently hunted is the feral goat, found on all of the islands. These were also introduced by early explorers, and allowed to roam at will ever since. Goats generally prefer relatively open habitat, and, in most areas, inhabit cliff-faces and steep canyon-slopes, although they are sometimes found in more gentle terrain where it is isolated from much human activity. They range from sea level to above timber line on the higher mountains.

Goats are highly prized by some hunters for food, and by others for trophies and sport, but management varies widely from island to island and depends upon the location of goat herds, range condition, and hunter-demand by the public in each area. Within the Mauna Kea Game Management Area, for example, they are not much in demand by hunters and occupy extremely difficult terrain; hence, they may be taken in unlimited numbers by the few hunters seeking them. In the adjoining Mauna Loa Game Area, however, they are eagerly hunted and so are considered desirable game animals and managed accordingly.

On Lanai, goats are very much in demand by local hunters, and must be carefully managed to prevent the herd from being decimated by over-hunting. The status of this herd is determined by a yearly census, and an annual hunting season is opened for a few weekends with a seasonal bag limit of usually one or two goats per hunter. Three to four hundred are taken each year from a basic herd of some twelve hundred animals.

On Kauai, goat hunting is managed by Fish and Game in two forest reserves, neither of which is actually a game management area, and one regular game management area. In these areas, goats are classed as desirable, and hunting is managed so as to perpetuate the herds at a safe level. Large populations of feral goats occur on private lands and forest reserves, where they are frequently considered pests by the landowners and shot at every opportunity.

The introduction of new game species forms a large part of the game management program in Hawaii. Introductions are made for two primary purposes: to stock areas not presently inhabited by big game and which could support a huntable population of a suitable wild species, and to eventually replace less desirable feral species with good-quality wild animals which would provide better hunting while being easier on the range.

The species first introduced under Fish and Game direction was the mouflon sheep (*Ovis musimon*). A small number were released on Lanai in 1954, following the removal of all feral sheep from the island, and additional releases have since been made there in order to build up the small herd. These wild sheep have adapted themselves very well to local conditions, and the herd has grown to at least 40 animals, and possibly many more. Management consists of complete protection from hunting and predators (feral dogs), water maintenance, and periodic checks to determine their status. Counts, both aerial and ground, have not been very successful due to terrain and ground cover, and it is probable that there are many more sheep present than have been counted.

Although the Lanai introduction of mouflon has apparently been successful, a similar one on Kauai failed. No follow-up releases were made after the initial one, and the few sheep eventually disappeared. No plans have been made to attempt another sheep-release here.

An interesting program has been going on for almost five years on Hawaii Island where it is planned eventually to replace the feral sheep on Mauna Kea with mouflon hybrids. Hybrids, closely resembling the pure mouflon, would make much more attractive game animals, and it is believed that they will be much less damaging to the range than the feral sheep now present. Instead of trying to build up a pure herd of hard-to-get mouflon, which would take many years, mouflon rams are being bred to easily obtainable feral ewes. The female offspring are then bred back to pure mouflon rams to produce three-quarter mouflon hybrids. If necessary, back-breeding will be carried on for another generation in order to produce animals closely resembling the pure mouflon, although indications are that the three-quarter hybrids may be suitable. To date, few three-quarter hybrids have been produced, but the practicability of such a program has been clearly demonstrated.

The second species introduced was the pronghorned antelope (*Antilocapra americana*). Thirty-eight were released on the grassy plains of Lanai's central plateau in December, 1959, after having been trapped from wild herds in Montana. Initial losses following the release left 18 antelope alive after the first few months, but these became acclimatized to their new habitat and began reproducing the following summer. By November, 1961, the herd had grown to 44 animals, and the introduction appears a success. If possible, more antelope will be acquired and released in order to speed up the herd's growth to a huntable size.

The third, and last, big game introduction to date has been the black-tailed deer (*Odocoileus hemionus*), brought from Oregon and released on Kauai Island. Only 10 deer were in this shipment, which was made in the summer of 1961, but they appear to be adapting very well, with the known loss of only one buck so far. They have, to all appearances, become established in their new home, and it is expected that the first fawns will be born in the late spring of this year. Additional releases are planned on Kauai if more animals can be obtained.

It is possible that other big game introductions will be tried in the future; Hawaii certainly has ample range and habitat types in which to support a much larger and more varied big game population than now exists, and an ever-growing supply of hunters demand satisfaction. However, there are several small, well organized groups who are opposed to any new releases of big game. Unless this opposition can be overcome, it is somewhat doubtful whether any new species will be tried in the near future. Introductions will probably be limited to supplementing those already made, and in the same general areas.

Future big game management plans call for more research on established species so that they can be better understood and more carefully managed. So far, only the axis deer has undergone a reasonably complete study, the results of which are making it possible to manage that species in a scientific manner. An investigation of the ecology of the wild pig is now in progress and will continue for a number of years. Studies will have to be made of both the feral sheep and goats if they are to be managed efficiently as game animals in the future. Plans also call for continuing follow-up studies to be made on the introduced species in order to ascertain their progress and to learn how best to manage them in Hawaii.

Other big game management for some years to come will probably follow the lines previously mentioned: keeping track of herd sizes through annual censuses, kill trends, range trends, etc., and adjusting hunting seasons and regulations to meet conditions found; increasing herds of introduced animals by further introductions and by protection; removing undesirable feral species and replacing them with exotics as the populations of exotics increase.

Additional management will consist of continuing maintenance and improvement of water supplies, where needed, access roads, hunting cabins, and other facilities needed for the production and harvesting of game.

DISCUSSION

MR. THOMPSON [Wisconsin]: I would like to ask about the algaroba and axis deer. First, is there any previous relationship between these two? They are both introductions to the Islands.

MR. NICHOLS: As far as I know, there is no previous relationship because the algaroba came from South America and the axis deer came from India.

MR. THOMPSON: In the relationship between browse and mast as supplied by the algaroba, what per cent is used for browse and what per cent is used for mast?

MR. NICHOLS: In our food study, we made no differentiation between browse and mast because the deer eat both in quantity. They live on the beans when the beans are available. It seems to make no difference which is available. They can live on either or both.

MR. THOMPSON: It's a pretty important point. You could have an overpopulation feeding on mast with no damage to the range, whereas if you had an overpopulation with browse it would suppress the production.

MR. NICHOLS: That is true, but in our deer areas where we don't have livestock, such as on Lanai which has no livestock, the deer are not nearly cleaning up the mast that is falling. We have several other leguminous plants which are deer food. They pick up the seed pods from the plants, which don't generally fall. There is no browse line. It's darn hard to find where a deer has taken a bite off a leaf. There seems to be no food problem whatsoever.

MR. THOMPSON: Aside from your responsibilities, what measure is being taken to preserve some of the native flora and fauna in the islands?

MR. NICHOLS: Quite a number of measures are being taken in other islands where there are native forests, and they are having quite a bit of trouble in introducing large game animals. There is a lot of smoke over that. As far as our axis deer are concerned, we have proven through research that they will not readily enter native forests. They prefer low lands and dry forests. They don't like heavy dense forests. They have an opportunity on both Molokai and Lanai to enter these. There's nothing stopping them. They won't go into the main forest at all. It is just too tight for them.

TECHNICAL SESSIONS

Wednesday Morning—March 14

Chairman: HARLAN B. BRUMSTED
Associate Professor of Conservation, Cornell University, Ithaca, New York

Discussion Leader: W. LESLIE PENGELLY
Director of Wildlife Extension, Montana State University, Missoula

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CONSERVATION INFORMATION AND EDUCATION

RADIO AND TELEVISION IN OHIO'S CONSERVATION PROGRAM

DAVID L. HANSELMAN[1]
Ohio Department of Natural Resources, Columbus

ORGANIZATION

The Ohio Department of Natural Resources was formed in 1949, bringing together under one body the various agencies of state government dealing with Ohio's natural resources. Today the department is composed of the Natural Resources Commission and eight divisions—Forestry, Geological Survey, Lands and Soil, Parks, Reclamation, Water, Watercraft and Wildlife. In addition there is a Waterways Safety Commission, the Ohio Water Commission, the Wildlife Council, a Real Estate Section, an Accounting and Budget Section and an Information and Education Section. It is the purpose of this last branch to keep the residents of the state well informed concerning the entire natural resources field.

NOTE: This paper shows how the Ohio Department of Natural Resources initiated its radio and television activities. It is prepared in the hope that similar organizations also working under budget and personnel limitations may profit from these experiences and methods. The author will be happy to provide any additional information or to lend samples of radio and TV releases upon request.

[1]In the absence of the author, this paper was presented by Thomas M. Stockdale, extension specialist in wildlife conservation, Ohio State University.

CONSERVATION EDUCATION MEDIA EMPLOYED

The Information and Education Section employs every available means in carrying its message to the people. Activities include a monthly conservation magazine, weekly news releases, publication of maps, booklets and brochures, an extensive and ever changing selection of exhibits, still and motion picture production and library, a speakers bureau and, the latest addition, a Radio-TV Sub-Branch.

The Information and Education Section employs both specific and mass media, the reasons being as follows:

(1) The Conservation Bulletin and other technical and popular publications are sent only to especially interested people by request or subscription. The Bulletin, for example, has a circulation of about 30,000. Those who read it probably comprise the best informed segment of the state population. But this represents less than one per cent of Ohio's population.

(2) Films, speeches and exhibits also reach a large number of Ohioans each year. But again, this is only a small part of the total population, and use is primarily by special interest groups.

In our total information and education program, we could not do without the above two groups of services. But still we must try to reach the vast majority of our citizenry who are not brought in contact with these media. Thus, we rely on the *mass* media:

(3) Weekly news releases going to newspaper, radio and TV editors. The average adult spends 30 to 45 minutes a day reading newspapers —about three to five hours a week.

(4) Radio programs. The average in-home radio listening time is just under two hours a day.

(5) Television spot announcements. In the average American television-equipped home, the family set is in use for an average of 5.01 hours each day.

THE DECISION TO USE RADIO AND TELEVISION

Ohio was not the first state to use radio and television in its conservation education efforts. However, the decision of the Ohio Department of Natural Resources to employ these media involves the same factors as have been and will be faced by many other agencies. There can be no denial that radio and TV releases are expensive. But what is the value received for the dollar invested? How susceptible are people to information presented over these media?

Since around 1950, between 97 and 98 per cent of all homes and between 65 and 70 per cent of all automobiles have been equipped with radios. The Television Advertising Bureau estimated that as of Janary, 1960, 88 per cent of all American homes had television sets.

Throughout the nation there are far more families which have television sets than have telephones, more than have electric refrigerators, far more than have bathtubs! And there are considerably more American homes that have television than receive a daily newspaper.

The average man, woman, boy or girl spends at least 20 hours a week listening to radio or television. How does this compare with time given to other media? *Combined,* reading, movies, church attendance, public meetings, attendance at sporting events and all other agencies of information or entertainment claim less than 10 hours per week—just half the time devoted to radio and television. What better media than radio and TV can be found to reach the mass audience?

There are other factors, too. Advertisers (and our goal is not unlike that of an advertising agency) find the broadcast media especially successful because the listener to radio or television is in a situation making for a high degree of suggestibility. He is at home, relaxed and has no reason to be critical, analytical or "suspicious" of suggestions made or thoughts presented. He sees with his own eyes and hears with his own ears the people presenting these ideas. The approach is much more personal than that made by "cold print." Arthur Godfrey and Gary Moore become trusted personalities and if they say it's good it must be so. Then too, the radio and television industry, despite recent scandal, has created an image of integrity.

Considering the foregoing information,[1] the Ohio Department of Natural Resources felt that radio and television were needed in their information and education efforts. Certainly, there exists no better means of getting the message into the homes of our citizens.

Only one question remained. Would the commercial and educational stations use our materials voluntarily as a public service? A preliminary survey was made by personal contact with stations and by questionnaire. The answer was overwhelmingly "yes" if releases were kept short and quality kept high.

GETTING STARTED

Once the decision had been made to initiate radio and television activities, plans were quickly implemented. The author directed his entire efforts to the new operation, survey questionnaires were sent out and returns were evaluated, a recording studio was constructed and equipment was purchased.

The first contact with the Ohio broadcasting industry was through the Ohio Association of Broadcasters, a professional organization representing most stations in the state. Under the guidance of their ex-

[1]The author has relied heavily on information prepared by Prof. Harry Summers, of the Ohio State University. Data have been taken from the A. C. Nielsen Co.

ecutive secretary, a questionnaire was mailed to all Ohio radio and TV stations. A letter explained that we were about to start producing radio programs and TV spot announcements. We asked the stations what subjects they would like covered, what length of material they could best use, how often they would use such material, whether they wanted the program with introduction and conclusion, or "open-ended" (no formal introduction, just the interview, leaving the local station announcer to introduce and conclude the program segment). We asked where in the broadcast schedule they would most likely use our programs (farm program, sports show, etc.), whether they (TV stations) were equipped to use 35 mm black-and-white slides and whom we should contact in mailing materials. The covering letter stated that our releases could be used on a sponsored (commercial air time) show in any ethical manner, the only stipulation being that use of materials be reported and tapes returned.

About 70 of Ohio's 110 radio stations and 14 of the 24 television stations responded. Based on the suggestions of the stations, and our own objectives and limitations, we arrived at the following services:

1) Each month one seven-inch (1200-foot) tape is mailed to every station requesting our radio releases. Programs are recorded full track at 7½ inches per second.

This tape includes five *Under Ohio Skies* 4½-minute radio programs and a sixth *Forestry on the Farm* program, also 4½ minutes. Each program has a 40-second music and voice introduction, but is so constructed that a station wishing to use the show "open-ended" can cue the tape at a pause between the introduction and the body of the program.

Under Ohio Skies programs cover subjects ranging from stream gaging to duck hunting, reclamation of strip-mined land to programs offered in state parks. In short, this series covers all of the conservation activities of the eight divisions—not just wildlife.

Some cooperating stations use these shows as a regular weekly feature. Others employ only the body of the recording (less introduction) as if it were originating directly from their own studios as part of an existing program.

Forestry on the Farm is a monthly production of the Division of Forestry and deals with timely forest practices (marketing, ordering seedlings for reforestation, disease and insect control and timber stand improvement). This show is used most frequently during farm programming time. For simplicity, several farm program directors have requested and are receiving separate tapes with this feature.

2) Design, production and mailing of timely TV spot announcements each month to all 24 Ohio television stations. These spots con-

sist of announcer script and 35-mm black-and-white slides to illustrate. Often, a choice of lengths is offered. Some stations prefer a 20-second spot while others use only 10-second or 30-second materials. Thus, we often prepare two or three announcer scripts for one slide or series of slides. The spots cover all activities of the department. In one month's mailing there was a spot reminding people to get their new fishing license and another to use caution during the spring forest and grass fire danger season. A third spot showed the dangers of housing development in flood plains and pointed out the wisdom of zoning in such low-lying areas.

Although many TV stations have requested sound motion picture spots and shorts, budget and personnel limitations have to the present restricted this type of service. However, a pilot series was produced in cooperation with the State University. This series of five 30- and 60-second spots dealing with hunter safety was released prior to the hunting season. The effort met with excellent response and at present we are investigating means to produce more filmed spots.

3) Release of full-length sound motion pictures for TV use. New films are now being designed with TV in mind. We currently have several 13½-minute wildlife films which are enjoying a high degree of use by stations. A new film on Ohio's water problems is also being edited for broadcast purposes.

4) Production and release of "special" radio and television programs and spots. Examples include a series of radio announcements publicizing the annual State Fair and a locally recorded program dealing with one county's hunter safety training program for use by two stations in that area.

5) Finally, like any classification of this nature, there is a wide range of activities which must be lumped together under a "Miscellaneous" heading. Sounds and narration for exhibits, a taped "know the birds by their voices" program for use by the State School for the Blind and many other diverse creations fall into this catch-all.

These are the activities decided upon. And this is what the Radio-TV Sub-Branch is engaged in now. Let us return to other aspects of "getting started":

With one exception, we started from scratch. The department owned no professional recording equipment, nor had any facility for producing radio or TV materials. However, provision was made for our talented staff artist and photographers to devote a portion of their time to the production of TV spot illustrations. Everything else had to be bought, built or created.

An area 17 by 13 feet was available for developing a studio and recording control room. The wisdom of consulting experts in acoustic design and broadcast electronics cannot be over emphasized. Because studio design varies with the location and intended use, I will not attempt to describe the acoustic design of our set-up. I will, however, briefly describe our equipment, all of which has very adequately met our demands in budget, quality and versatility.

Microphones: For the majority of our studio recordings, we use two low impedence Byer M-16 directional mikes. Both participants are thus individually and closely miked. For in-the-field and location recordings we also rely upon an Altec #661A and an Electro-Voice #605.

Console Mixer: For mixing two or more microphones, background sounds, music, and the like, a five-channel mixer is recommended. We have an Altec 1567A into which we feed two or three microphones, the twin turntables and two or three tape recorders. The output goes to the record head of all five tape recorders and to the monitor amplifier, an Ampex 620.

Recorders: Our master tape is prepared at 15 inches per second on a Magnecorder M-90. This particular machine was chosen because we were able to buy it used in good condition. It has remote controls so that it may be operated either from the control room or from the studio. Original recording at 15 ips is recommended for highest quality and for ease in editing. If it is necessary to cut out a muffed word, the tape length of that word is just twice as long as if recorded at 7½ ips.

Four Ampex 601 recorders are used for mixing sounds, voices, and the like, and for making duplicates of the master tape. The master tape plays on the Magnecorder, through the mixer to the four Ampex machines. Thus, we can make four copies at one time. The Ampex 601 is an easily portable, highly versatile and very professional machine selling new for about $600.

A Mohawk 500 professional battery powered recorder is used for many of our field recordings. Selling for about $500 with the necessary accessories, this binocular case-sized recorder does a very acceptable job. (Since purchase of this machine several comparable models have appeared on the market. They deserve consideration before making a selection.)

Degausser: Before reusing any tape which has previously been recorded, it is best to erase the previous signals completely, using a bulk eraser, or degausser. The erase head on even the best tape recorder cannot be expected to completely remove the previous sounds. For our purposes, an Ampex #111 is used in the studio and a portable Amplicorp Model 200C on location.

Tape: Whatever tape is decided on, standardize and use that type only. All of our machines are aligned for Scotch #175 (formerly 311) Tenzar tape. This particular brand is moderately priced, tough and not affected by changes in humidity (and tapes mailed back and forth are subjected to hard use and frequent humidity changes).

Each tape to be used for sending programs to stations is marked with a number and the department's address. Accurate records are kept as to which tapes a station has and when a station falls behind in returning them, a gentle "reminder" letter is mailed out. Others tell us that we are doing well; our loss is less than 15 per cent.

Each division chief was asked to select one employee to serve as division radio chairman. This person is responsible for all radio and TV topics from his division. The chairmen and coordinator of radio and television activities meet once a year to plan the radio and TV releases for the following year. A schedule is then duplicated and sent to every participant. Then, two weeks before a recording or spot deadline, a reminder is sent to the chairman concerned. Although changes are necessarily made throughout the year, this method insures equitable distribution of time to the various activities and programs of the department. It further insures adequate time for preparation.

MONTHLY PROCEDURE—RADIO

Deadline for making the original radio programs is the 15th of the month preceding the month of release. The person making the program prepares a script or outline and goes over it with the coordinator. A date is then set for a studio or location recording. Usually two or three "takes" are made and often all three are edited to produce the one master program. The five *Under Ohio Skies* programs and the *Forestry on the Farm* program are spliced together to make up the "master" tape from which 60 copies are made. A printed description of each program is prepared. This (sample) form is preferred by our cooperating stations:

RADIO PROGRAM RELEASE FOR March 1962

Program Series: UNDER OHIO SKIES Presentation of Ohio Department of Natural Resources.

Speed: 7½ ips

Track: full

NOTE: Although this material may be edited to fit your needs, please do NOT alter this reel.

Please complete and return the enclosed card; circle programs aired.

PLEASE RETURN TAPES PROMPTLY!!

* * * * *

Program No. 1*
Topic: IRRIGATION IN OHIO
Persons: Dave Hanselman, of Ohio Department of Natural Resources, visits with Francis Baker, of Division of Lands and Soil.
Place Recorded: Columbus
Time (including opening and conclusion which may be edited off): 4:29
Opening: "On July 23rd, 1847 . . ."
Closing: ". . . of Natural Resources."
Remarks: Suggest use first week March.
*Six such programs are described in release.

* * * * *

In addition to this descriptive sheet, a return report card and a return address sticker are placed in the tape box. The tape box is then enclosed in a cardboard mailer and sent to the cooperating stations on or before the 25th of the month preceding the month of release. By printing "Contents Educational Recorded Program" on the mailing carton, a tape can be mailed either way for only nine cents postage.

After using the tape, the station fills in the report form, pastes the return sticker on the carton and mails back the tape.

MONTHLY PROCEDURE—TELEVISION

Deadline for submitting the TV spot is the first of the month preceding the month of use. The person responsible for a particular spot meets with the coordinator of radio and TV activities and the staff artist. During this conference the idea is turned into a short audio-visual spot. Usually two or three illustrations or photographs or combinations of art work and photography are decided upon. The artist and photographer go to work on the visual elements, the coordinator writes the accompanying script. The following (sample) form is used:

OHIO DEPARTMENT OF NATURAL RESOURCES
TELEVISION SPOT ANNOUNCEMENT

Slides: F-25
Topic: SMOKEY REMINDS OHIOANS OF SPRING FIRE DANGER SEASON
Time: 0:20
Release Date: March 1, 1962 - May 15, 1962
Remarks: Suggest use during dry and windy periods during spring season.

* * * * *

TIME SEGMENTS	VIDEO	AUDIO
0:00	F-25	SMOKEY CONGRATULATES OHIOANS FOR THEIR PART IN REDUCING THE NUMBER OF FOREST AND GRASS FIRES DURING 1961. HELP MAINTAIN THIS GOOD RECORD. WHEN YOU MUST BURN DEBRIS, DO IT THE SAFE WAY—WHEN THE WIND IS CALM, AFTER A RAIN AND IN THE COOL OF THE EVENING. NEVER LEAVE A FIRE UNATTENDED. FIRE PREVENTION IS LARGELY COMMON SENSE.
0:20		

* * * * *

NOTE: This material need not be returned. We would, however, appreciate knowing of your use of this material and any suggestions for improving this service.

Upon completion of the 11"-by-14" illustrations, they are taken to a local TV station. We found it advantageous to contract with this station to produce the 100 to 150 35-mm black-and-white glass-mounted slides which we need each month.

When the slides are delivered they are code numbered (see sample form above), placed in individual envelopes, which are also numbered and stapled between two protective layers of cardboard. Two copies of each script (one for announcer and one for control room) are inclosed and the sets are mailed in envelopes on which is printed, "TV Photographs. Hand Stamp Only. Time Value — Do Not Delay." A word of advice may be in order here. There are rather definite video requirements made by TV stations. Slides must be glass-mounted, must always be horizontal and must be in shades of gray with very little if any true black or white tones. Also, the essential information must be kept well centered with plenty of margin. Detail must be bold; lettering must be limited to just a few words.

In both TV and radio our approach is one of simplicity and brevity. We try to limit any one release to the development and discussion of a single point. At all times we must remember that the listening and viewing audience varies tremendously in interests and background.

RESULTS

The only justification for presenting an analysis of results in having materials aired is to give some indication as to the results another agency might expect from a similar venture. Therefore, these comments will be brief.

Three points must be kept in mind when evaluating the use made of public service programs and spot announcements. First, for any station to remain on the air, it must have a large audience. In our opinion, if just one station uses a release, the time and money that went into that release are justified. Our expenses to produce and duplicate one radio show or TV spot may reach a cost as high as $75. But there are very few radio stations where $75 will buy five minutes of air time. And a single 60-second commercial advertisement on a local TV station may cost from $75 to $350. We are not paying for any air time; Ohio broadcasteres are using our materials as a public service.

Second, we are not in a "popularity contest." Some of our topics by nature hold more "listener appeal" than others. Our objective is to take each program idea and make it as interesting as possible without diluting the message. Then too, our releases are in competition with dozens of public service time releases from other non-profit and charitable agencies.

Finally, broadcast stations handle hundreds of programs, spots and advertisements each week. It is difficult even with our return report cards to tell the degree to which materials are being used. TV stations especially tend to avoid non-commercial spots when the agency in back of them badgers for reports as to when and how the material was used. Less than 75 per cent of our cooperating radio and TV stations return use report cards, and yet we know that many times use is being made even though it is not reported.

During a six-month period (the last time a total tabulation was made) the cooperating radio stations reported a total of 443 airings of our programs. Undoubtedly other programs were used but not reported. Taking $20 per air minute, a conservative average rate, means that we know of $20,000 worth of air time devoted to our messages during a six-month period!

Taking an example from television, one large commercial station has just reported that during 1961 it used $17,700 worth of air time for the presentation of our spot announcements. Other stations have submitted reports nearly as striking.

Judging by the number of inquiries received from various corners of the state as a result of spots and radio programs, we are convinced that the message is getting to the people.

As has been stated earlier, we are not trying to choose subjects on the basis of listener appeal. We expected, and it has proven true, that some topics are by nature more interesting and thus receive greater use. Programs dealing with parks, wildlife, natural history and water (in that order) received the highest use, while topics concerning geology, soil, watercraft and forestry (order not conclusive) received slightly less use.

We certainly appreciate the splendid cooperation shown by our cooperating stations. Saying "thank you," we feel is an important part of maintaining this good relationship. Annually we comprise a list of both radio and television stations which have faithfully used our materials during the past year. A parchment certificate of appreciation is prepared, affixed with the gold state seal and signed by our director. A list of stations receiving these awards is sent to the Federal Communications Commission—the agency determining station licensing. We are sure that this gesture is appreciated by every cooperating station.

CONCLUSION

The Ohio Department of Natural Resources is nearing the end of its second year of radio and TV operations. We are "sold" on these media and would encourage other states not now using radio and TV to investigate the opportunities. Radio and TV materials can be produced even on a very modest budget.

We would further emphasize the value of consulting people in the broadcast industry for advice as to equipment, program and spot style, type and length, frequency of releases, and the like. A great deal of our success, we feel, is because our releases are of a length, style and quality requested by the broadcasters. Being more proficient as a conservationist than as a radio and TV producer, the author took advantage of several radio-TV courses offered by The Ohio State University. Where possible and when needed, this type of experience would be advisable.

THE RECREATION BOOM— A CHALLENGE TO CONSERVATION EDUCATION[1]

STANLEY A. CAIN[2]
Charles Lathrop Pack Professor of Conservation, the University of Michigan, Ann Arbor

Conservation has been gradually giving more attention to the services that can be obtained from natural resources. This is a shift from the earlier nearly exclusive concern with what seemed to be imminent shortages of crucial materials. This broadening of interest is a consequence of our growing experience with the discovery of new supplies, more efficient production, and the development of substitute resources for those which are in short supply. Another phenomenon is our increasing technical and economic competence to utilize resources formerly uneconomic, as in the case of lean ores and land needing irrigation. Also, there has been a general shift of the economy to a state in which services account for more than a third of the Gross National Product. There do remain important and difficult problems in the supply of materials needed by a developed economy, and a need to emphasize that there are two classes of national income, goods *and* services, and among the services from natural resource complexes are the recreational uses.

The central point of this paper is that conservation education, at all levels, has the problem of educating Americans to recognize the value of non-materialistic services which can flow in perpetuity from some combinations of natural resources (as may be found in outstanding natural areas such as the major national parks), and that these flows can also be cut off, dried up, or destroyed if we don't recognize them. Just to recognize the existence of such flows (in less well known areas than the national parks) will require a big effort, and often the inversion of present value systems. To analyze and measure these service values require an even higher degree of educational effort, as does the development of managerial and technical competence to maintain the flow of such services.

In emphasizing that services as well as commodities can flow from natural resources, especially in the context of a discussion of recreation, I would like to be explicit that among the services are the amenities of the environment. The question is not just that of land as a resource for active recreation but includes also among the services the

[1]The present draft of this paper has benefited greatly from the comments and suggestions of some of my colleagues at Michigan. I am happy to express my appreciation to Professors Lyle E. Craine, G. Robinson Gregory, Richard L. Meier, and Richard L. Weaver, and to Louise G. Cain.

[2]In the absence of the author. this paper was presented by Dr. Richard L. Weaver, associate professor, The University of Michigan.

attractiveness of the landscape—natural and cultural. Are we maintaining an environment in which it is pleasant to live? Is there a refreshment of strength and spirits that recreates us?

As population has grown, as leisure time and expendable income have increased, and as urbanization has involved more and more of us, outdoor recreation has entered a boom period. This boom is evidenced by all kinds of statistics, including the increases in park and forest visitors, campers, boaters, water and snow skiers, hunters and fishermen, and motorists. It is also seen, of course, in the number of persons engaging in indoor recreation, such as bowlers, but our attention today is directed to outdoor recreation and its challenge to conservation education.

Outdoor recreation is making its bid for land along with several other alternative uses of land. In some cases the competing possible uses are incompatible on the same tracts of land. In other cases the multiple use of land, including the recreational use of it, requires a level of planning and willingness to compromise single uses that is making all kinds of conflicts and headaches for private property owners and public officials alike.

Such problems are bringing to our attention the fact that land, as space for certain uses, frequently is a scarce natural resource. And it is typical of a natural resource scarcity that the price goes up as the scarcity is increased. Also, recreation land is no exception to the dual system of allocation of a scarce resource to alternative uses. One system is that of the open market, the free price system, in which the use is allocated to the person willing to pay the most for it—no questions asked. The other system is a public allocation in which the government— including the gamut from town to nation—determines the use on a basis of the public interest.

The use of wildland frequently illustrates the collision of systems of allocation. As long ago as 1916, Stephen Mather, the first Director of the National Park Service, recommended establishment of an Indiana Dunes National Park. At that time twenty-five miles of uninhabited shoreline could have been obtained for public use had Congress been willing to appropriate the necessary funds or had philanthropic citizens been willing to purchase and donate the land to the government. In the meantime, private residential and industrial developments have taken place and much of the natural scene destroyed, yet today there still is interest in using the beach and dune remnants for public recreation. S. 1797 is a bill before Congress "To provide for the preservation of the Indiana Dunes and related areas in the State of Indiana, and for other purposes." If a public-use area is to be established in this locality, which is of national interest and handy to millions of people in the Northern Indiana and Illinois metropolitan agglomeration, conflicting views concerning the highest and best use of the land will have to be resolved. Continuation of the free-market, private-use allocation of the land will end with the complete destruction of the natural area and the exclusion of the public from it except for the small and wholly inadequate Indiana Dunes State Park. An alternative is the public-use allocation proposed by S. 1797.

Even within the system of public allocation there may be competing uses for land. This can be illustrated at the public level by a city council that decides to build a public structure—perhaps a school, library, auditorium, museum or parking lot—in a city park. It is really the cost of buying land elsewhere in a convenient location that causes the public officials to sacrifice the park for the parking lot. The public allocation of the land resources, and recreation resource, to competing uses in this case is little different from that of the private economy, for it goes to the collective pocketbook of the taxpayer rather than to what an individual might pay, or fore-go, for a given use.

A different case is found in the admixture of uses in a state park when drilling for oil is allowed, or in a national park when cattle and sheep grazing are permitted. The public and private uses are commingled through the dual system of allocation.

Yet another instance of the problems that arise from the planning process on the part of public agencies is found in the modern highway system, which is an example of an over-riding single use. Modern roads are devoted to the single use of transportation by automobiles and trucks. They are engineered for safety, speed and economy, although the latter is sometimes difficult to appreciate; but they are not planned with regard to the values and uses which road construction precludes, including frequently a loss of recreational land.[3] Neither does road planning include some real recreation possibilities that could be incorporated at little expense and with little if any loss to speed and safety of motor traffic. I refer here to paths on the rights-of-way that could be used for walking, bicycling and horseback riding, provision of access to streams crossed by roads, access to lakes, woods and other natural areas adjacent to roads, and certain roadside stops for other than the elementary needs of comfort. The multiple-use concept has not reached highway planners. Even the potential beauty of a road lying conformably on the topography is seldom attained. Too often landscape architects, when used by highway departments, are given only the job of dressing up as best they can the scars of construction

[3]This statement would not be true if *all* the values of land were capitalized into the price paid for land by road departments. However, to give two examples, the amenity value of land, as pleasing scenery, seems rarely to be included in the price and wildlife values seldom so.

whereas their more rational use would be in the first stages of highway location so as to maximize the aesthetic possibilities of the road as it lies on the land. Here, too, the conservationist might play a role (what road department has one?) in pointing out the cost in values lost to farm, forest, natural areas, wildlife habitat and recreation space. Highways themselves, of course, are an important aspect of recreation, as has been shown by the Outdoor Recreation Resources Review Commission, for motoring is the form of outdoor recreation indulged in by more people than any other activity.

There is no need to develop these introductory remarks any further. Outdoor recreation — the recreation that brings the human resource and the natural resource into conjunction—has become a matter of prime concern to conservation and, of course, to persons interested in conservation education. The educational effort, not only in schools, colleges and universities, but as carried on by public agencies and private organizations, has a growing need to study and teach about the use of natural resources for the provision of services as well as of goods. As much as any other phenomenon, the post-war boom in recreation is a challenge to conservation education.

Of the many relevant kinds of outdoor recreation and kinds of land needed for it, I would like to confine myself here by way of illustration to a particular challenge to those of us concerned with conservation education.

The Outdoor Recreation Resources Review Commission in its report a few weeks ago proposed a classification of outdoor recreation resources in six categories. I wish to limit our attention to Class IV—Unique Natural Areas, which are described as "areas of outstanding scenic splendor, natural wonder, or scientific importance," and Class V—Primitive Areas, which are described as "undisturbed roadless areas, characterized by natural, wild conditions, including 'wilderness areas.'" These two classes of outdoor recreation resources can be lumped together for our purposes under the epithet "natural," in order to stress the minimization in them of human constructions and other modifications of the land. These are not necessarily virgin lands, but they are lands where in the main nature is being allowed to take her course and where depletive and commercial uses of the land are proscribed and guarded against.

Persons opposed to the preservation of natural areas and their dedication to non-depletive uses, whether they be small tracts in local and state parks and other reserves or the vaster national parks and forest wildernesses, often are opposed because as individuals they stand a chance to make a private profit by the use of certain natural resources, or they are opposed for reasons of political and economic philosophy that are based firmly on a belief in the right of private enterprise to use all natural resources for private benefit. It is interesting to note, in this connection, that there is little criticism of privately owned natural areas, whether they be small family holdings or the extensive estates of wealthy individuals or clubs. It is the undeveloped public property that comes under attack.

The basis of the argument is that resources are being locked up; that they should be put to use for the human benefit that results from the use of iron and copper, and of timber, water and soil. Such persons are for private enterprise and against public controls. They are for marketable, tangible products and favor these to the exclusion of services not valued in the marketplace. They may admit the value of natural areas in principle, but be against them at a particular place where they happen to have a private interest. They are usually willing to settle for a park or a wilderness area somewhere else.

The arguments of the resource depleters are not easy to meet, at least on a basis of their economic criteria and in view of our national commitment to private enterprise. It is more difficult to show the dollar value of natural areas for human pleasure then it is to show the jobs and wealth to be created by mining, lumbering, water impoundment and real estate development.

The case for the customary economic use of natural resources is well understood. The case for preservation and the non-depletive recreational use of natural areas needs to be made more objective than has been. The problem starts, perhaps, with a clarification of the philosophy of the different value systems. It leads to an examination of the consequences of actions based on one viewpoint or another and it must involve a study of both the ends of human goals and the means to those ends. An examination of ends brings us directly up against the difference between personal and social goals, individual and collective rights, short- and long-term goals, and provincial and general goals.

In any specific case, the conservationist as the proponent of natural area preservation and the allocation of certain land and water resources to public recreation, has a certain burden of proof placed on his shoulders. For example, it is incumbent on the conservationist to see that economic studies[4] reveal accurately and fairly the economic consequences of allocating certain land resources to park and recreational uses. The resulting data need to pertain to local, regional, and in some cases national economic consequences of one type of use of natural resources in comparison with other possible uses. Here one is

[4]If the conservationist himself does not have the requisite economic competence, it is incumbent on him to seek the aid of persons with the required degree of economic skill.

confronted not only with economic utilities produced, but also with goods and services foregone by making one allocation rather than another, or some combination of uses.

This is merely one way of saying the benefit/cost studies of the non-depletive uses of the complex land resources need to be set beside the benefit/cost studies of commercial use of the same resource.

This leads into a very difficult area for which data are embarrassingly scarce. That is the field of human motivation and satisfactions, the study of which requires the careful and competent use of the techniques of the social psychologist and the survey researcher. Some way must be found to quantify the values attached to services. In a benefit/cost analysis the conservationst needs a measure of the non-market values.[5]

Yet another set of skills is called for. These are the skills of the landscape architect and the recreation resource planner who must find some answer to the built-in contradiction of preservation and the pleasurable human use of natural areas. Concentrated use of parks, for example, with poorly designed and located roads, trails and camps can deteriorate the qualities of the land resource and result in the management of it failing both the goal of preservation and that of human pleasure in nature. Put more simply, the recreation land resource is for human use and the problem is to minimize the depletive impact of such use on the resource base itself. The problem, then, is the familiar one of use without prejudice to future use.

These examples, limited to one problem complex, suggest something of what the conservation educator and researcher are up against. The time has long since passed when emotion and the profession of a love for nature are sufficient to determine allocation of the complex land resource to non-commercial uses. There may be exceptions, in cases of already preserved areas that are threatened by development, when a flood of emotional letters are sufficient to tip the balance in Congress in favor of preservation of a national park. But in general the nature protectionist, or those endeavoring to set up seashore recreation areas, for example, need to arm themselves with pertinent data.

Conservation education, confronted with the recreation boom, must help build the bridge between the science-based technologies on one side of the turbulent waters and the complex societal forces on the other. This "bridge-building" function seems to be a proper role for conservation, and in order to serve it, conservation must use appropriate concepts and methods for the integration of data and the resolution of conflicts.

[5]If certain benefits are truly intangible for an individual, and by definition non-measurable, there remains a need for a determination of the degree of consensus that may exist concerning the benefit.

In a general sense, conservation education must enter the field of regional analysis. Recreation resources are always complex resources, that is, they are land areas with numerous inter-related natural resources which as single resources and as resource groups are subject to different kinds of use. Recreation must take its proper place among the many possibilities and in some cases find itself high in any priority list and in others find itself in a low position. After regional analysis, which involves the analysis of the natural resources and the social forces at work, conservation must move on to the fields of planning and management. These are decision-making fields in which policy formulation is a required precursor if rational and reasonably satisfactory decisions are to be made.

It has probably occurred to you that I am speaking of conservation education, training and research at the graduate level, and in part this is true, but I also believe that the ideas expressed here are amenable to college-level teaching and in many cases equally necessary for general education as carried out by agencies and associations. The concepts of inter-relations in nature and integration in action, as related to natural resources and recreational demand on them, are certainly not beyond the average man when they are clearly posed. And when I look at the way that basic concepts of mathematics, physics and biology are being taught in the schools, I have a feeling that the bright youngsters are equal to any challenge that we can throw at them in the conservation field. In any case the point is a vital one, because conservation decisions are being made all the time whether or not conservation educators are playing their appropriate role.

APPENDIX

Studies and activities in conservation education related to recreation, Department of Conservation, School of Natural Resources, The University of Michigan.

This paper states that conservation education, as it confronts the problem of recreational use of natural resource complexes, has incumbent on it the making of studies and teaching about several phases of the problems. Among them are the following: 1) the clarification of the philosophical differences between public and private market allocation of land to recreational use, and the consequences of actions based on one viewpoint or another; 2) to reveal accurately and fairly the economic consequences of allocating certain land resources to recreational use, including an evaluation of non-market values; 3) to enquire into the field of human motivation and satisfactions in recreation, and the relations between activity types and the natural resource base; and 4) to concern itself with the fields of planning, administration and policy as they concern individual tracts of land and water and the development and use of urban and regional resource complexes.

How these matters can be approached will be illustrated by the brief history in this field of the Department of Conservation with which I am associated. It is not meant that this particular academic unit be taken as a model. The purpose is to show how a conservation education unit dealing in a general or broad way with resource use gets involved in one use class—recreation.

STUDENT STUDIES

The following studies, entirely or partially dealing with recreation, have led to Master's or Doctor's dissertations:

Einar H. Hendrickson (1953)—Recreation Land in Washtenaw County, Michigan.

James P. Gilligan (1953)—Policy and Administration of Wilderness Areas.

Arthur T. Wilcox (1953)—The Summer Use of Public Campgrounds, Northern Michigan.

Charles Gebler (1955)—Study of Nature Trail Interpretation in Yellowstone National Park.

Robert McIntosh (1955)—Wildland Planning Procedures.

Walter Criley (1956)—Reservoir Shoreline Development in the Tennessee Valley.

James J. Brady (1956)—The Echo Park Dam Controversy.

Alice Scheffey (1958)—The Origin of Recreation Policy in the National Forests: A Case Study of the Superior National Forest.

Walter Sebald (1958)—Public Fishing Sites in Metropolitan Southeastern Michigan.

Daniel H. Henning (1959)—Integrating Conservation into a Naturalist Interpretive Program.

I. R. Hunter (1960)—Land Use Trends and Their Impact upon Wildlife and Hunting Trends in Rock County, Wisconsin.

Robert Twiss (1960)—Public Hunting and Private Land: An Organizational Approach.

Audrey Pressler (1961)—Fishing Trends in Frederick County, Maryland, from 1931 to 1960.

Nicholas Barth (1962)—Conflicts of Interest Arising from Competing Resource Uses in the Allagash Region on Northwestern Maine.

The following studies are currently in advanced stages of preparation of salient questions raised by the organized opposition to the

Frederick R. Gehlbach is developing principles concerning the interrelations between natural features and nature interpretation. This is based on a case study of the design of an interpretive program for a national park.

Richard Hartesveldt has completed studies of the human impact upon *Sequoia gigantea* and its environment in the Mariposa Grove. This study moves from the ecology of the Big Tree to park management principles.

Fred Hubbard is finishing a study of planning and control of public recreation use on inland lakes. This is a study to determine and help establish criteria of significance in controlling recreation use of public inland lakes in Michigan and to devise a plan for providing a more satisfactory allocation of recreation uses.

Stephen J. Maddock is engaged in a study of the controversy that has developed from the proposal to establish a National Recreation Area in the region of the Sleeping Bear Dunes. This is an investigation of salient questons raised by the organized opposition to the proposal.

Leslie M. Reid is using for a dissertation data from the ORRRC Study Report No. 5, The Quality of Outdoor Recreation: As Evidenced by User Satisfaction, in which he participated.

DEPARTMENT INSTRUCTION

Several graduate courses have units on the recreational use of natural resource complexes or treat the recreational use along with other uses in considerations of development, administration, allocation, planning, economics, and education practices and procedures. These courses include: Workshop in the Teaching of Conservation (Weaver), Natural Resource Economics (Gregory), Conservation Trends Seminar (Cain), Integrated Resources Planning and Administration (Craine), International Resource Development (Cain), Natural Resource Policy (Craine), Conservation of Natural Resources (Weaver), Conservation Field Studies (Weaver and Staff), Resources Allocation and Planning (Meier), Regional Development Workshop (Meier), and Economic Problems of Resource Management (Brinser).

In some cases teaching is enhanced by direct staff experience on public policy bodies such as the Conservation Commission of the State of Michigan, The Secretary of Interior's Advisory Board on National Parks, and the Intergovernmental Committee on the Huron River Watershed.

Natural resource based recreation is a consideration in some courses, research and activities of other departments of the School of Natural Resources, including Fisheries, Wildlife Management, and, especially, Forestry. In the latter Department Dr. Grant Sharp teaches three recreation oriented courses: Recreational Use of Wild Lands, Methods of Natural History Interpretation, and Recreational Land Management and Administration. Elsewhere in the University recreation matters come into some courses and provide topics for research, as in the Department of Economics and in the Physical Education program.

DISCUSSION

DISCUSSION LEADER PENGELLY: Thank you, Dr. Weaver. I am sure that though Dr. Cain was the author of this paper, Dr. Weaver was certainly familiar with it, and I am going to ask him if he will entertain questions from the floor.

DR. BERNARD FRANK [Formerly in the Department of Agriculture]: I am now at CSU, Fort Collins. I have heard these discussions many times and used them myself, but it seems to me there is one weakness in his approach. Dr. Cain puts the evaluation problem of so-called intangibles or non-market values on the defensive. I think we must spend a lot more time appraising and evaluating very critically the premises behind the so-called market or monetary evaluation. I have had a lot of experience with that work. Now, when you analyze all the various premises behind the so-called evaluation as applied to public projects, you will find that the evaluation is full of holes. I would like to say that the evaluation in so-called economic terms is just as weak and just as highly subjective, in my opinion, as any evaluation we might attempt on an emotional or similar psychological basis.

DR. WEAVER: Well, Bernie, I agree with you. In fact, when Stan sent the paper around for us to comment on the first draft, this was the point I was making. I am not enough of an economist to argue on that ground, but I did argue that this was difficult. But he pointed out that we can't run away from the problem of trying to compete with the materialists at whatever level we can. The problem is there. They are going to be confronting us with these statistics. We are confronted with the dilemma of trying to defend our point of view in the same way that they are. Ours are harder to defend because of the social factor. At the University of Michigan we are in a complex of survey research people and we can't run away from this problem, even though we admit that it is difficult.

DR. FRANK: In 1941 I wrote an article in the Journal of Land and Public Utility Economics, in which I suggested case studies by teams of economists and other social scientists of areas where we had good data that would give us an idea of what conservation expenditures had done for the community, In another article by one of the agricultural economists in the USDA, the desirability was admitted, but so far as I know, nothing has been done yet. It seems to be an inability on the part of economists. If I am being unfair, let someone take the floor. There seems to be an inability to work with economists, to work with other social scientists. Maybe the economists might learn something—I don't know.

DR. WEAVER: Well, we certainly work through our economists directly and now through research and, I believe, we are going to come closer by having these folks who are hybrid natural scientists, social scientists, tackle it as a team. At least, we are trying it.

DISCUSSION LEADER PENGELLY: Thank you. Dr. Frank has pointed out the lack of skill on the part of conservationists to understand economic problems. I think what we are doing here is bringing up this basic issue, Bernie. We could get involved in the intangibles for considerable depth. We do need to coordinate and get people with the social interest to deal with us in the social conservation movement. I think we need to get some communication between the two parts and perhaps that is the area we should pursue.

RESOURCE USE EDUCATION IN URBAN AREAS: A CASE FOR COMMUNITY NATURE AND CONSERVATION CENTERS

JOSEPH J. SHOMON
National Audubon Society, New York City

During the past ten decades the growth of our population, the unwise exploitation of our natural resources, including much of our wildlife, have made imperative a greater understanding of conservation problems and issues on the part of our American people.

Around the turn of the century dynamic leaders, such as Gifford Pinchot, Theodore Roosevelt, Gilbert Pearson and, later, "Ding" Darling, Aldo Leopold and Hugh Bennett, called the attention of the nation to our needs, and through their leadership an effective national policy of natural resources conservation was launched in this country —a policy that gave to our nation many of its national forests, parks and wildlife refuges. It stimulated some effective conservation legislation and began a movement of nature appreciation and resource use education. It led many states to establish worthwhile programs in forestry, wildlife management and outdoor recreation. Today, however, with a shorter work week, a higher real income, more leisure time, better transportation, and more and more people, the capacity of our national outdoor areas has become greatly overtaxed, and if the trend continues, these facilities will become wholly inadequate in a few years.

All this suggests that, more than ever before, the local community must now take greater initiative. In comparison with national and state efforts, relatively little has been done by our cities, towns and counties to provide for more outdoor recreation and education facilities for their own people. While we have many federal and state outdoor recreation facilities at present — and more are planned — these facilities are wholly out of balance with the centers of population. They are not present or near enough to the cities who need them most. To strike a better balance, the city and the urbanized county must now make more effort. To add to the local dilemma, there has been a serious attrition of local park lands in recent years. The rate at which our urban communities are growing and populations exploding is alarming. It is not merely that the countryside is vanishing but in many instances the subdivisions of one city are meeting those of another.

Coupled with the many problems of urbanization arises the new dilemma of how to make conservation meaningful to the great majority of our citizenry who are losing ties with the land, with our natural world and with Mother Earth as a whole.

Conservation presupposes a knowledge and understanding of our renewable and non-renewable natural resources and how they relate to human progress. Education in conservation leads to an identification of resource problems and issues and what measures are necessary to translate the *needs* of people into corrective action. Thus, as people sacrifice country life for city life with all its concrete, asphalt, noise and tensions, as they lose contact with the natural world, they lose something of themselves—and loss of kinship with nature can be tragic for a people. Today there is still much apathy toward conservation. We are criticized for developing a loss in will and courage. Could it be that much of this is attributable, at least in part, to our infrequent contact with the soil, water, forests and the wild creatures of God's world? Could it also be that much of what we have lost in rugged individualism and much that we have acquired in mental illness, crime and juvenile delinquency can, in considerable measure, be traced to man's going "indoors" from an outdoor world?

Today there is a hunger afoot, a hunger not of food, for in America we're throwing much food away, but a hunger of mind and spirit. With more free time on his hands, man is yearning for a type of intellectual, moral and spiritual advancement yet unknown for his species. The hunger that we see today is seeking fulfillment. Unfortunately, however, much that is sought, much that is pursued, is superficial, artificial, purposeless.

One important way to improve our sense of fulfillment in the world is to devote more time and energy toward an advancement in personal moral character and in an enlargement of our spiritual capacity. Another way is to develop a greater sense of individual awareness and perception as to our place in the universe and of our ecological relationship to the animate and inanimate world about us.

Certainly one very simple way in which men, women and children can develop a greater sense of personal values is to open their eyes and hearts to the dynamic outdoor world around them. To do this we must have natural lands and places and things for them to see. Furthermore, we must give them help in interpreting what they see and hear and feel. Only when this is done with a majority of our citizens will the practice of conservation and, more important, the philosophy of conservation become really meaningful. For, as Aldo Leopold once put it, conservation and "recreational development is a job not of building roads into lovely country but of building receptivity into still unlovely human minds."

Here is where the community nature and conservation center, or, for want of a better name, the outdoor conservation education classroom, presents both an opportunity and a challenge. It is here that conservation education—embodying in its philosophy an understanding, an appreciation, a respect and reverence, for all living and nonliving things—can become the guiding light for a new geobiotic ethic in America. And it is in the urbanized environment, where more than three-fourths of our people live and where more will continue to live, that conservation as an attitude and a way of life is in greatest danger In a republic such as America, dedicated to the principles of representative democracy, the will of the majority prevails. It is the *majority* attitude and *will* that shapes and sustains policy.

Therefore, if we can raise a generation and succeeding generations of Americans imbued with resource knowledge and understanding, with appreciation and respect for property and the rights of others, including individual responsibility toward the land in general, our future will be safe. If, on the other hand, we choose to ignore the education challenge that confronts us, we can look forward only to a dreary, man-made, artificial environment where even one parcel of natural land may one day be a novelty.

If each of America's 2,000 cities (those that support a population of 10,000 or more people) could set aside at least one 200-acre tract of natural land and then establish thereon a real, dynamic nature and conservation center or outdoor education classroom, the total effect on resource use education would be great indeed.

WHAT A NATURE AND CONSERVATION CENTER IS AND DOES

A nature and conservation center, as visualized and understood by the Nature Centers Division, National Audubon Society, is, first of all, a concept in ecological conservation. The philosophy embraced here is that man is a product of the land and a steward of nature. The physical earth, fauna and flora, all were here before man. When man emerged, he was part of the biotic world complex. The world was not created just for man alone and so man cannot morally usurp all natural resources entirely unto himself without dire consequences. Only by being a part of and working with nature can man hope to realize his full potential on this planet.

The building of proper attitudes and that of an ecological conservation philosophy, then, is perhaps the greatest value of a nature and conservation center. Unless people have the right understanding and appreciation of nature and conservation, the *will* to *protect* and *conserve* cannot be created and the people concerned stand to lose the very thing they hope to preserve. In other words, unless proper attitudes are built in the minds of people, there exists the continued likelihood of overdevelopment, overuse and eventual loss or deterioration of our whole natural environment.

A nature and conservation center is an institutional device which brings land and people together on intimate terms, where the young people as well as the old—under the inspiration and guidance of trained interpreters—are taught to see, hear and feel something of the natural world about them, where they can develop the kind of personal values and conscience they need in order to live as better citizens.

In a practical and specific sense, a nature and conservation center can be defined as an area of undeveloped land near or within a city or town and having on it the facilities and services designed to conduct community outdoor programs in natural sciences, nature study and appreciation, and conservation. It is, in essence, an outdoor classroom where the citizens of a community can enjoy a segment of the natural environment and learn something about the interrelationship of living and non-living things, including man's place in the ecological community. It is an area comprising anywhere from 50 to 5,000 acres of natural land where the people of a community can learn about soil, water, native plant and animal life and ecological conservation, where they can get to know their natural resources intimately, where both an appreciation of and a respect for these resources can be developed.

People won't safeguard what they don't know, let alone what they don't understand. They don't protect and treat kindly what they don't appreciate. A nature and conservation center is designed to help them understand, to learn, to see, and to become good stewards of the land and of all our natural resources.

The typical center has an educational building as a focal point, plus a system of trails which takes the visitor into different habitats. In most cases, expert teachers take school classes and other groups out on organized study trips. Each trip is designed to tell an ecological and conservation story. Visitors learn by direct experience. For those who prefer to learn alone, there are self-guided trails. Each trip is an adventure.

REQUIREMENTS FOR A NATURE AND CONSERVATION CENTER

To get a community nature and conservation center established is not an easy and simple task. Several conditions or requirements are needed if a center is to become a reality:

1. There must be local interest and responsible leadership.
2. There must be natural land available.
3. There must be a sound plan of action and an effective community organization to do the job.
4. There must be money available for the project, and, finally,

5. There must be the implementation of the program itself.

These are details that cannot be dwelt upon here. It must be sufficient to say that where these requirements are met, a community nature and conservation center is not only possible but very probable.

EVALUATION AND CONCLUSION

On the question of evaluation of present nature and conservation centers developments, not much can be reported since so little factual information is known. While it is true that some nature centers, such as the one at Stamford, Conn., began more than 25 years ago and many junior museums have had outdoor education classrooms in various stages of development for some time, the community nature and conservation centers movement is still in its pioneering stage.

The National Audubon Society has been interested in nature education for many years and has had in operation a number of successful nature centers. Two are located in Connecticut, at Greenwich and Sharon; a third is near Dayton, Ohio, known as the Aullwood Audubon Center; and a fourth is at El Monte, Calif. At these centers nature education and ecological conservation are stressed for young people, although persons of all ages visit them. During the past decade, close to a half-million young people have received instruction, and inspiration, at these four centers alone.

The Society has long realized, however, that it cannot do the job of nature and conservation education alone and so it recently embarked upon a new and vigorous program of encouraging independent community nature and conservation centers. Last year the Society merged with the relatively new *Nature Centers for Young America, Inc.*, in order to throw combined weight behind this program. Today the new Nature Centers Division of the Society is less than a year old but already it is working on conservation education projects with 72 separate communities in 15 states. In this effort local communities have already set aside more than 18,000 acres of natural land and have spent in capital outlay alone (buildings, equipment and land averaging $500 per acre) a total of $10,254,000.

A new concept always requires a period of pioneering and trial and error before a breakthrough is possible. A real breakthrough is possible if all conservationists and educators will put their shoulders to the wheel and help back this program. When 2,000 community nature and conservation centers across America have been established, what will the effect be in terms of moral and spiritual re-creation? What will it be in terms of awareness, self-reliance, personal discipline and individual responsibility?

This we know: that all that is great in science, all that is good in technology, all that is noble in literature, music, philosophy and religion has come about by the individual's striving to realize himself and his worth. If personal responsibility, courage and vigor, the pioneering spirit and rugged individualism seep out of our people, America will be dead.

The countdown is near zero, the hour close to midnight. If all conservation-dedicated groups—local, state, national, government and private—will close ranks and meet the challenge that faces us in resource use education, particularly in our growing urban social order, we in this great country will have developed the kind of conservation conscience we need and, most justifiably, deserve.

WILDLIFE EXTENSION—PAST, PRESENT, AND FUTURE

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It is the purpose of this paper to critically examine the past performance and present status of wildlife extension programs in the United States and, on the basis of this examination, to suggest its most productive future role. Obviously we are "sold" on wildlife extension and it is our hope that through a critical examination and a reorientation, more states can be encouraged to adopt wildlife extension as an educational and management tool.

First, we should briefly explain the Cooperative Extension Service. It is primarily an educational service, organized with offices and professional staff members on a federal, state and county partnership basis. It was created by the Smith-Lever Act of Congress in 1914 and originally aimed primarily at the rural populations. Extension now aims to serve all of the people and it has been broadened to engage in program planning on a broad, long-term basis.

Extension is the off-campus arm of Land Grant Universities. All Extension Services have a staff of specialists in a wide variety of fields —agronomy, agricultural economics, radio and television, veterinary science, sociology, farm planning, recreation, and so on. The services of this staff are made available to the public through the County Agents. County Agents in turn are generally among the most influential and respected men in their communities.

Obviously, this is an extensive organization with its nerve center on a university campus, grass root ties in local communities and channels extending to the nation's capital. Here is an organization that is in touch with every agricultural activity, and with its expanding program it will soon touch on every phase of community life.

THE PAST

Wildlife Extension is one of the newer subject matter fields covered by the Extension Services. It was only natural that as wildlife was included within the extension program, it would fall into the traditional extension approach. Originally, and over much of the nation at the present time, this approach was one of in-service training and providing direct assistance to either individuals or small organized groups. Originally the wildlife extension worker, following the pattern of the agricultural extensionist, made new findings available through pamphlets and by bringing information on wildlife to a small segment of the public through public appearances and the traditional farm visit.

Faced with changing times, changing patterns of land-use, a shifting economy and a rapidly expanding population, extension is taking a fresh look at itself. It is now in a period of evolution. Extension has learned that the traditional approach is inadequate. Wildlife extension, caught up in the same impetus, is going through a similar process.

Wildlife extension faces an even newer set of problems peculiar to the resource. Wildlife management was once concerned with protective legislation and law enforcement, control of predators, and the stocking of fish and fowl. These were operations over which game departments had direct control and were able to handle. These functions also took place at a period in our history when there was more open land and fewer people. Game departments now, however, are faced with problems and situations over which they have no control. The use of pesticides, drainage, highway planning, pollution, and a score of other accelerated activities directly affect wildlife. Game departments and other wildlife management agencies have little or no control over such activities. We have arrived at the time when these management agencies cannot solve wildlife problems alone. Wildlife resource needs must be considered in a broader sphere by industry, education and agriculture.

THE PRESENT

With newer and broader problems the sphere of activities, responsibilities, and techniques required of wildlife specialists has been enlarged. If we believe otherwise, if we believe we can restrict ourselves to the old traditional extension approaches alone, we are fooling no one but ourselves.

Believing that although we may not think *alike,* we should at least think *together,* questionnaires were recently sent to Extension Wildlife Specialists and to Fish and Game Departments in states having a wildlife extension program. The replies were illuminating, constructive, and largely encouraging. Questionnaires were also sent to Federal Bureau chiefs of related agencies.

Replies were received from fifteen extensionists in fourteen states. Seventeen states are known to have individuals employed in this type of work. Specialists are financed in a variety of ways. Six are paid entirely from fish and game department funds. Two are financed by extension funds alone. Four are financed jointly, although not necessarily in equal amounts, by Extension Service and fish and game department funds. Two are financed jointly by fish and game department and university funds. One is jointly financed by Extension Service and Agricultural Experiment Station funds.

Twelve specialists stated adult education was their primary responsibility. Obviously, adult education has many facets. Classification of the various attitudes, philosophies, and procedures entailed in this phase will be discussed later.

Two specialists considered youth education their primary responsibility. One specialist named animal damage control as his major area of operation. Other major activities named included farm pond management, coordination and liaison, and in-service training. Obviously, the majority of the specialists operate in the area of adult education.

What are they attempting to do in this area? Their objectives are summarized as follows:

1. *Present* people with factual information about the interrelationship between wildlife management, soil, water, plants and people.
2. *Develop* appreciation of the recreational, esthetic, and economic values of wildlife.
3. *Stimulate* ecological approaches to land management activities and problems.
4. *Create* appreciation, understanding, and willingness to properly utilize the wildlife resource and support sound management principles.
5. *Influence* the adoption of land and water use practices that provide consideration for, and are beneficial to wildlife.
6. *Discuss,* with agencies, organizations, and individuals, the public issues affecting resource use, thus broadening the understanding and cooperation on these issues.

Apparently the approaches of wildlife specialists are to present, develop, stimulate, create, influence, and discuss wildlife resource problems. Selecting key phrases from the broad objectives previously summarized, these techniques will be applied in the areas of (1) factual information, (2) recreational, esthetic and economic values, (3) ecological approaches, (4) utilization, (5) land and water use practices, and (6) involvement in public issues.

We believe that these objectives are valid and progressive. However, objectives mean little unless they are attained. How to attain them? Replies from the various wildlife specialists were varied, but the main ideas can be summarized as follows:

1. Place greater stress on mass media methods of communication.
2. Do not scattergun information—concentrate on training county extension agents.
3. Involve local people in local problems, in developing goals, and initiating action programs for settling their own problems.
4. Require better program direction and coordination of specialists between states by direction from wildlife specialists at federal level.
5. Require that specialists be better trained in the areas of adult education and public relations.
6. Specialists must take the bull by the horns—one way, instigating and promoting research in areas where factual information is lacking or questionable.
7. Specialists must have better comprehension of the extension role, structure, function, and proprieties. Extension has a long history of not attempting to "sell" any specific program. Stay detached from agency policies, procedures, and programs; sell resource management, not someone's program unless they coincide.
8. Do not subjugate the development of projects and programs to informational type activities.
9. Develop active, cooperative programs with other personnel in and out of Extension. Encourage appointment to committees, boards, commissions, etc.
10. Avoid duplications of activities of wildlife techniques—broaden scope of activities to include more esthetic and non-harvest aspects.
11. Call a spade a spade; do not compromise principles.
12. Keep abreast of developments in own field; interpret and adapt them to needs of clientele.
13. Extension wildlife specialists should be administered by educational institutions, not resource agencies.
14. Get dynamic people for a dynamic program; people with better than adequate training and experience. Work on big issues, do not fritter away time, energy, and money on rat-hole projects of a trifling nature.
15. Specialists must use all legitimate means at their disposal to

influence agencies and policies, including the traditional educational approach, but with more emphasis on influence and pressure. Obviously this must be carefully done. In attempting to influence agencies and policies the specialists must maintain their respect by holding firm to an objective, unbiased position.

16. Develop aggressive administrative support on a par with commodity groups—including support at Federal Extension Service level.

17. Develop specific educational programs which face the *issues* in wildlife resource development.

The foregoing suggestions are wide ranging and varied; from training, through technique, to philosophy.

Obviously no single idea represents a complete program that will fit all occasions, and they were not intended to. The majority are complementary, some are contradictory. We skate on thin ice for a moment in an attempt to apply these ideas to the construction of a wildlife extension specialist and a wildlife extension program from the component parts submitted.

The specialist will have more than adequate professional experience and technical training with equivalent skills in communication and educational techniques. He will be a dynamic individual with the courage to stick to principles in spite of personal and political pressure. He will be an astute diplomat with the ability to remain objective and unbiased. He will be able to evaluate research findings and promote and instigate research where required to further his educational program.

The wildlife extension program will be based on sound objectives and established priorities as determined by proven needs and developments. The program will include the traditional educational approach, but also recognize the advantages of applying legitimate influence and pressure through the medium of committee, commission, advisory board, and personal contacts, both inside and outside the extension service. His program will be based upon sound principles of wildlife and related resource management, which may or may not coincide with current policies of resource management agencies or users of natural resources. His program will attempt to resolve such differences when they occur. His program will recognize the competitive demands upon soil, water, plants and space, and intimately relate the wildlife resource to total resource development. His program will be based upon the conviction that the wildlife resource is a recreational, esthetic and economic asset to our nation and is worth fighting for.

It is axiomatic that the educational responsibilities of the wildlife specialist cross the lines of management responsibility legally assigned to a variety of public agencies. Among these agencies, state fish and game departments are most directly involved.

If we are to follow our own recommendations regarding bias and objectivity, the state fish and game departments should be heard from. Consequently, questionnaires were sent to fish and game administrators in those states known to be employing extension wildlife specialists. Replies were received from thirteen states.

One of the questions asked state wildlife administrators was "what do you believe the current and future role of wildlife extension programs should be?"

All replies followed one main theme. Wildlife extension programs should utilize other extension specialists and county extension agents to the maximum degree. This would not only take advantage of an already existing, widespread organization, but would encourage the dissemination of sound land use and wildlife management to a portion of the public directly concerned with natural resources, but often not reached through regular wildlife department channels.

Several administrators either stated or inferred that wildlife specialists should assume the responsibility for providing adequate inservice training to extension personnel, thus to provide coordination and prevent chaos.

We are frankly surprised that only two fish and game administrators discussed the potentialities and values for coordination and liaison inherent in the wildlife extension program outside the extension organization itself. In the words of one, "I feel wildlife extension should continue along the present levels of educating the county agents and the farmers to encourage them in good wildlife practices. However, I think there is a real challenge for the extensionist to work with certain influential groups, such as the editors of newspapers, policy making people of different departments and bureaus, etc. They can certainly aid the wildlife management program by helping these people to understand wildlife problems and establish their programs so they are compatible to wildlife."

Insofar as only two of thirteen fish and game department administrators discussed either the efforts put forth or the potential involved in liaison and coordination activities of wildlife specialists in their states, we believe a question is appropriate. Why does this discrepancy exist between the emphasis placed by specialists on this type of activity and the apparent recognition of its value and desirability by fish and game administrators? One answer may be that specialists are giving lip service, but little action to this type of activity. An additional deduction is that fish and game administrators feel this type of activity is of so little importance that it does not merit comment, or on the other hand, they believe this activiy is an inherent part of the extension process, and no discussion is required or expected. Last, cooperation and coordination between fish and game administrators and wildlife specialists may be so poor that each does not know what the other is accomplishing.

Some objective self scrutiny by administrators and wildlife specialists in the various states may be appropriate on this question. On the basis of the questionnaire, replies from both state administrators and specialists, there is evidence that there is considerable room for improvement in the area of formal coordination and cooperation between the state fish and game administrators and the specialist. This may provide a partial answer to the question.

To summarize the questionnaire replies from both sources regarding cooperation and coordination a bit further, the majority indicated the level was good to excellent, but usually with reservations regarding certain areas. The remainder suggested there was considerable room for improvement, with no reservations. We gained the distinct impression that cooperation and coordination was most active at field levels and tapered off, rapidly in some instances, as administrative levels were approached.

In spite of the obvious deficiencies in this area, eleven of the thirteen administrators answering the question, "Is wildlife extension aiding you in accomplishing your management goals?", answered in the affirmative. One state indicated aid was limited and one declined to answer.

In reply to the question "Is wildlife extension an effective educational tool in your state?", nine administrators answered in the affirmative, two felt it was not what it could be, two declined to answer the question.

Several of the miscellaneous ideas forwarded by administrators relating to the last two questions may be of interest. Some indicated lack of coordination required rationalizing a positive affirmative answer. Others felt affirmative answers were appropriate only if applied to certain specialist areas of operation. Two suggested that the extension programs would be more effective, management-wise, if the specialists restricted themselves more to adults and specific problems.

Obviously, the area of coordination requires more attention, insofar as deficiencies in this area are being reflected in evaluation of program effectiveness. However, as one state administrator pointed out, "It is realized that there can be no compromise in teaching a good wildlife management practice. However, in actual practice, the department cannot always place into effect the practice that the best management would dictate because of lack of public understanding."

The fact that a state fish and game department is basically a political organization must be recognized by the wildlife specialist. Snap judgments are inappropriate coming from either the administrator or educator. The objectives of both can only be served by mutual understanding and consistent and aggressive efforts leading toward a mutual objective.

THE FUTURE

Our survey reveals that wildlife extension is not well understood and does not enjoy the cooperation of the extension services or the game departments in some states. Furthermore, Wildlife Extension has made no obvious impact on the leaders of responsible Federal resource agencies. Under such circumstances it cannot be expected to perform effectively. It is incumbent upon the university, the extension service and the game department to join in a cooperative effort. Developing such cooperation is largely a responsibility of the specialist, but there must be a favorable climate among the cooperators. This is not always the case.

Several extension programs are focused on a small facet of wildlife resource management. They fail to "probe the heart of basic problems."

Obviously, wildlife extension has a most important future role to play. Also, this will be an expanded role as time goes by and complexities increase. It is equally obvious extension is not meeting present needs in some areas and is not geared for its future challenge in others.

Cooperative extension, including wildlife extension, cannot adequately meet today's or tomorrow's needs using the old, conventional and traditional tools in extension any more than in outer space investigations. There is urgent need for a reorientation of objectives, priorities and approach.

In terms of objectives, extension must attempt to reach areas not covered by the responsible management agencies. Here it must define its specific problems and shape its working program to accomplish these objectives.

Priorities must be carefully examined and selected in any program whether it be wildlife extension or wildlife management. There are far more needs than can be satisfied, far more activities than can be successfully pursued. It is only through careful selection of a limited number of high priority needs that careful aim can be taken and a fruitless waste of time and energies be prevented.

Now, what are the legitimate areas of concern to wildlife extension? Land use planning is a high priority with involvement in public issues such as pollution control, the proper use of pesticides, the impact of highway planning, and urban and rural development deserving of equal attention. Here there is need for creating an aware public and for influencing policy determinations. Here the Extension Wildlife Specialist can bring the talents of the Extension Services and the university as a whole to bear on problems beyond the normal scope of the management agencies.

The tremendous boom in outdoor recreation, including fishing and hunting, provides an opportunity, in fact demands attention from the Wildlife Specialist in fully developing the economic potential of our wildlife resources. Fishing and hunting are now important to rural and urban communities. They can become more so. This is a challenge in land use and outdoor economics that will require a joint effort with the specialist assuming responsibility for consideration of the wildlife resource.

The new rural area development program provides a special opportunity. Fishing and hunting are built-in attractions that can mean more in rural area development and in community development programs. This too is a field that should receive the time and attention of the specialist.

Obviously, and to repeat, the traditional extension approach is inadequate for an effective contribution in these areas. It is physically and practically impossible to effectively reach an adequate number of people. More reliance must be placed on the use of mass media in creating an informed public.

Extension must turn more to influencing opinion leaders. This might be termed the legitimate use of influence and pressure. The extensionist must maintain the necessary contacts to secure committee assignments, maintain good working relationships with key community and organization leaders, and, the more difficult qualification, that he remain respected and influential without antagonizing these various groups.

The involvement in land use and other issues is a legitimate function and one where a concrete contribution can be made through the definition of objective policy and through influencing policy makers and the public at large.

Extension has a role in reaching publics not normally reached by the management agencies and for attacking problems not normally within the scope of these agencies. This will require a fresh approach, a reorientation, and a continuing evaluation. Once this evaluation is accomplished with the full cooperation of the universities, the fish and game departments, and other responsible agencies, extension can begin to perform its proper role in the management of our wildlife resources. This responsibility must rest equally upon the cooperators, but responsibility for initiation remains with the existing wildlife extension program.

BROADENING GRADUATE CONSERVATION TRAINING

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The title of this paper was originally "Inter-Disciplinary Graduate Programs in Natural Resources Conservation." But this seemed a little long. However, the words "Program" and "Inter-Disciplinary" were there for a reason. In order to gain an understanding of resources conservation or resources management, you cannot confine your studies to simple courses in single subjects in single departments. You need various courses which supplement each other so that they add to the general field of resources knowledge in an orderly fashion —hence a *Program* of Study.

The word "Inter-Disciplinary" is there to characterize the programs because the courses of study taken—if they are to lead to a comprehensive knowledge of resources management—must touch upon many academic disciplines and represent a number of recognized professions. To illustrate this, I would like right here to tell you a little story, a true story. It is not a funny story but a rather sad story. It only too well points out both the need and the difficulty of the interdisciplinary approach. Because of the Conservation Foundation's work in this field, we have a great many young people coming to us for advice about careers in conservation. They wish to know what they consist of, how to get into them, and whether or not he or she is adequately equipped. Unfortunately, not one out of ten is adequately equipped without taking at least a couple of years' graduate work. One young fellow came in to see me a year or so ago whom I have never forgotten. It was obvious that he was an exceptional fellow. He was assured, intelligent, had lots of personality. He said that he knew what he wanted but was being frustrated in his attempts to get it. This was his story: He was attending law school in one of our largest and best known Eastern Universities. He expected upon graduation to be admitted to the bar in his home city of Spokane, Washington, but here was his interesting and intelligent approach. He said that in practicing law in Spokane, Washington, he expected he would be dealing mostly with the timber industry and forest land owners, and he felt that his law practice would be greatly enhanced if he knew a little forestry. This made a lot of sense to me, so I asked him why he didn't take a course or two in the forestry school, especially as the university he was attending had one of the best. He said that that was just the point—he tried. He had been to the Forestry School and had seen the dean and talked with some of the professors. No go — no jumping around from law school to forestry school. No, sir. The Forestry School was interested only in foresters. The Law School wouldn't put in a word for him because it was out of their field. Of course, the Forestry School people told him that he was welcome to sit in on their lectures, but no laboratory, no field work and *no credits*. The young man said his schedule was so tight that he could not afford to sit in on a course unless he could do the whole works and get his credits. So he asked me, "How then do I obtain a working knowledge of forestry for use in my law practice?" I had no good answer except for him to take another full year, which he could not afford, neither time nor money, and besides it would give him more than he needed. It was just too bad that this university had no "Institute of Natural Resources," whose seminars would be open to all with full credit or that the Forestry School did not have enough vision to create a general course in forestry for just such students from other schools and departments. I tell this episode because it is so typical of inter-disciplinary problems, and this young man is so typical of those in a recognized profession—in this case law—who would be practicing their profession primarily in the resources field. It is this problem, and similar ones, which I wish to discuss in this paper.

First of all, if we are going to talk about graduate work in conservation, let's give some thought to just what this field is. Most of us accept Paul Sears' very broad definition of conservation as being "man's attempt to come to terms with his environment." This implies conscious management of our natural environment and conscious management, in turn, requires a knowledge — at least a working knowledge — of many disciplines and professions. The practice of conservation can, therefore, mean natural resources management, a field of activity within which one may work and be creative. But such a field of work requires a field of study. It requires training and this training means touching upon so many fields and disciplines that the usual academic setup is often not adaptable to it without considerable and sometimes painful adjustment. However, some universities about fifteen years or so ago saw the need and made the first pioneering attempts to set up programs for natural resources training. There were, of course, many already established departments and schools within various universities training exclusively in one or another resource such as forestry, soil conservation, wildlife, etc., and the term conservation was sometimes applied to them. But general conservation or resources management was pretty much a new and untried field of study. From the very outset, the absolute necessity of the inter-disciplinary approach produced difficulties. The neat pigeonholing of individual departments such as the department of economics, biology, etc., to say nothing of the larger divisions into Schools of Law or Schools of Forestry were not conducive to easy cross fertilization and the broad base necessary for resource training. Also the very few institutions that recognized the need for this training and had the courage to pioneer with it were not too definite as to just how to go about it—or what were the real objectives. What sort of trained people were required? There was a lot of hopeful talk for the need of "generalists" in conservation and a lot of the first applicants for training were quite unprepared to define their objectives or often didn't have much of an objective beyond a hazy idea that conservation was a field that they wished to get into. Many had no training in depth in any special field. Yet they would become a "conservationist," a "generalist" and go out and get a job as a "conservationist." But the chances were that they couldn't define a conservationist or give their prospective employer any clear idea of what he could do.

It was at this point in those early days of resource training that we of the Conservation Foundation felt we might be helpful. It seemed to us that a number of questions must be satisfactorily answered and the answers pretty well agreed upon before sound programs could be created. We decided to call a small conference composed of people active in the universities, in industry, and in government who were interested in the problem so that we might thrash out some basic concepts. During our preliminary preparations Stan Cain and Paul Sears worked very hard and long with us. We held such a gathering (35 or 40 of us) at Ann Arbor in April 1956 with Sam Dana as Chairman, and for two days we struggled with the development of a conceptual base for graduate training in natural resources conservation. I think I should say right here that in the audience today are a number of those who worked with us at that conference and who have continued to work with us in this field ever since. They will find that what I have to say here is for them pretty much old stuff because they are the ones who helped to develop those basic concepts. At this first 1956 conference we were especially concerned with answering certain fundamental questions—questions which we all felt were so basic that without firm answers, resource training could not develop into the kind of study it needed to be.

The first question was, "Is conservation a profession?" We came at this conference to the conclusion that it definitely was *not*, because there has not been developed an organized body of technical knowledge, the application of which demands a standard of competence in a definable field, but rather it is an area of human affairs in which the application of many disciplines, especially in recognized professions, must be applied even though emphasis may be placed upon those more directly concerned with one's particular objectives. The biological sciences and their various applications, agriculture, forestry, wildlife management, etc., engineering, economics, public administration, planning, law, teaching—in fact, nearly every field of human endeavor can be related to conservation and the active participation of helping man to come to terms with his environment.

A second question was ,"What is the 'generalist' in conservation?" Is there a place for him? Does he need depth in some particular area in order to make the best use of his broad conservation training? It seemed apparent to us at this first gathering that the graduate from a university conservation program cannot go out and expect to be hired simply as a "Conservationist." No, he must apply on the basis of what he can do in a recognized employable field, and this usually implies depth in some subject, some particular skill or training—in a profession. For instance, a graduate from a school of business administration does not call himself a business administrator and get a job as such; rather he is hired for what he can do as a production manager or as a sales engineer, etc. So we came to the conclusion that the student attending a graduate conservation program must either before, during or after his conservation training, acquire depth and/or skill in a recognized field, the field in which he expects to apply his general resource knowledge. It is interesting to reflect that people working in this field today seldom call themselves conservationists. The term when used is usually given them by others — their employers or by the groups in which they are active. Think of the people you know who are creative in the conservation field. Most of them you will find started out and established themselves in some branch of the biological sciences, or perhaps as a forester or wildlife manager or as a lawyer or an economic geographer, or as a teacher, etc.

So this led us to an effort to define clearly what sort of objectives are involved when a student takes courses in general conservation. We found that these objectives fell into three clearly defined categories. The three classifications which I will describe need to be carefully considered because they give orientation to the student. They likewise give direction to the university by enabling it to more clearly classify the students in this field and also to determine which one or more of the three objectives they are best prepared to meet.

The first one—and we will give it little time in our discussion—may simply be called one of "general interest." By this I mean a person

—perhaps fresh out of a liberal arts under-graduate curriculum—who is interested in nature and is intrigued by all that to him or her conservation implies. So he spends a couple of years in a graduate conservation program. So long as he has the time and the money, this is a legitimate category. The only trouble was in the early days of resource training and before the following two objectives were thoroughly understood by either the students or the universities, there was a tendency for conservation programs to be somewhat overbalanced in this category. Thus the general interest category may or may not lead to a career and the creative application of what the student has learned. Nevertheless it must be accepted. I have known some very brilliant students who fall in this category. As a matter of fact, I have known some who have made a profession of being a student and have gone on and on rather than going to work and applying what they know. University conservation programs should be careful not to let this category overbalance their enrollment. Of late years they definitely are not doing so.

The next two categories of students are, I think, the important ones especially from the point of view of having conservation principles of resource management actually practiced in the many fields of human endeavor by properly trained people. The first of these is the student who is specializing in one resource. It may be agriculture—such as soil conservation or forestry, wildlife management, watershed management, fisheries, etc., down the list. It may be in the applied field of one of the biological sciences. The student has specialization, he has depth in a given area. He expects to work in this area and develop a career which depends upon his capacity in this specialty. However, either upon finishing his formal training in his own specialty or quite likely after a few years' work experience, he realizes that his specialized area is only a part of the greater whole and that if he is to get ahead to higher positions, he must understand the relationship of his single resource to all resources and also to the social, economic and political environment in which he will find himself involved. He realizes that he must broaden the base upon which his specialty actually depends for its existence. He can achieve this broadening process by graduate work in general resource management or conservation, and he picks his institution according to the emphasis it gives in the direction of his own needs. A person going into graduate work is not a young college undergraduate. He must know what he wants and how to get it. Now take for instance a person with a degree in forestry—he is a forester. Maybe he is working for a paper company and finds himself responsible for helping local woodlot owners to improve their woodland and to cut and market their timber in such a way that they not only help themselves but are a better supplier of pulpwood for his company. He finds himself dealing more with people and with land-use principles, and with soil conservation districts than with technical forestry. He discovers he is working more with people than with trees.

With the watershed manager, the same is true. He needs to know not only his own specialty in which he has depth such as river basin development and engineering, but in equal measure he must know about the effect on other resources—forests, farms, wildlife, recreation, etc. He also must be able to work with people in the social order in which he solicits support for his river basin objectives. He must understand the politics of his community (public administration). He must thoroughly understand the economic environment, and also he must work with the planners. Last but not least, he must be able to reach people and therefore be able to speak and write effectively. This latter — speaking and writing — is important even within one's own organization. How many highly trained and capable specialists never get far because they simply are not articulate and cannot even submit a good report (verbally or in writing) to their superiors? So the specialist in one resource tries to broaden himself and fit his specialty into the whole environmental complex. If you recall the many fields I just referred to, you realize that this requires considerable interdisciplinary work, much cross-fertilization and a working knowledge of many fields. But all of them can be oriented to emphasize, to enhance and to make more effective the specialty of one's choice. Many universities are finding this new and difficult.

So to repeat, let's say that this category is one wherein the student with a specialty goes into general resource graduate work in order to *broaden* the base of his specialty.

Now we come to the category which is just the opposite. Take a person in a profession—either one for which he is just trained or one in which he has had some years of practice—I refer particularly to such professions as economics, law, public administration, planning, teaching, engineering, and many others. If such a professional person wishes to practice his profession in the resources field, then he must know something about it. The university graduate programs in natural resources conservation can give him what he needs. But the barriers between departments and schools must be lowered if the program is to be truly useful. We need resource economists, we need lawyers specializing in water rights, zoning and land use. We need resource planners and resource engineers; we need teachers in our schools who can give boys and girls an understanding of man's relationship to his environment. It must be remembered, however, that the profession comes first—for instance, when a school teacher teaches conservation in one of our schools, he is primarily a teacher—that is his profession. So this category is the opposite from the one wherein one has a specialty in a resource and wishes to *broaden* his base. In this category the person has a profession, a recognized profession, and wishes to *narrow* the field of practice. It is well for both the student and the university to be well aware of this distinction. It gives guidance to the student in picking the institution that will give him what he wants, and needs, and it is a guide to the institution as to what type of student it can best serve.

Now this brings us to the university itself. How can it furnish the sort of training we are talking about? Which category of student that we have defined is it best adapted to serve? Can it provide the necessary courses, or seminars? Can it provide cross-fertilization between the departments and schools which should contribute to the program, or does the administrative setup and interdepartmental competition and jealousies make this virtually impossible? Last, but far from least, are the necessary funds available? These and many other questions must be thoroughly considered before a university embarks upon a program of resource training. The combination of circumstances necessary just are not available to every university any more than every university can have a law school or a school of public administration. However, every program for training in natural resources management need not be elaborate. There are many ways by which they can be established. For instance, a rather simple approach is the situation where only one already existing department orients its direction toward resource training by giving special courses or by giving emphasis to this training in already existing courses. This usually comes about through the interest and initiative of one or more individuals in the department involved. This has in many cases been effective and may consist not only of special courses and seminars but can often develop the "case study" approach in which the cooperation of other departments is definitely involved. This can be a very effective method—the department in question makes a case study which involves resource development, analysis and planning. Students from cooperating departments and other disciplines take part. Perhaps if the originating department is one of Geography, then the cooperating departments might be Economics, Law, Planning, Biological Sciences, etc., which participate so that the end result is a coordinated whole rather than individual and disassociated parts. Each student in this way sees the relationship of his special contribution to the resources picture as a whole. A good example of this approach is the Geography Department in the University of Chicago, also the land use seminar previously given at the Harvard Littauer School but now transferred to the School of Natural Resources at Michigan.

Another and somewhat similar approach is the single resource department such as forestry, wildlife management, fisheries, soil conservation, watershed management, etc., where the department wishes to broaden the base of the student's specialty and trains him to understand how and where his particular resource work fits into the overall conservation and ecological complex. For this purpose many of these departments at specialized schools are adding special courses and seminars in General Resource Conservation. Here, too, the help and cooperation of other departments is needed. Some departments have even added the word "conservation" to their title such as "Forestry and Conservation." Of course, here the objective is to serve the type of student we have described earlier: the student specializing in one resource or one aspect of resource management, and who wishes to become more effective in his work by receiving a broader training in the general resource field. Some good examples of this approach are the watershed management departments set up in southwestern universities. Especially is this true of impressive work being done here at Colorado State under Professor Bob Dils. Another is the good work of the Department of Conservation at Cornell which is an outgrowth of its wildlife work. The forestry schools as already mentioned are in some cases broadening their base of instruction. The concept of multiple use and the Society of American Foresters' educational study are giving impetus to this trend.

A third and very effective method is the creation within the university of an "Institute." This offers various forms and great flexibility. Usually it is initiated through a committee made up of interested professors and heads of departments from various disciplines who are interested in coordinating their own discipline into an overall general conservation program. If it eventually is recognized as an official part of the university, it becomes thereby an official agency, can receive funds and can do research work in its own right. If such an institute develops, it usually conducts a general seminar with the object of coordinating the various disciplines and their interaction within the conservation complex. The committee originally forming such an institute may have a chairman from one of the departments involved, or as it develops may take on a staff of its own devoted entirely to the institute's functions and activities. The setup may be simple or complex. It is a very flexible administrative arrangement, and has worked out well in many cases. It depends for its effectiveness, of course, upon the cooperation and enthusiasm of the departments involved. This is truly an interdisciplinary setup and simply will not work if department barriers can be crossed only with great difficulty. Also there is a two-way flow in such a setup. Those students in both categories we mentioned earlier are able to get the training which they need through the institution's coordinating seminars and special courses. The law student, the student of economics, planning, etc., can attend the institution's program and thereby develop an area within which they can practice their profession, and the student specializing in one resource can obtain his broad background. There are many good examples of the institute approach. One of the earlier examples of this type was that of Ohio State, which is now well established. I am sure most of you are familiar with it. A committee has been formed at Berkeley and they have raised funds to develop a coordinating seminar and it is hoped that eventually an institute will be created there and be recognized by the university administration. Much depends there upon the lowering of departmental barriers to interdisciplinary work.

The last type of program I wish to speak of is unique in that as far as I know there is only one. That is the separate school, an integral division of the university like a law school or a school of public administration. This only one is, of course, the School of Natural Resources at the University of Michigan with its departments of forestry, wildlife management, fisheries, conservation, etc. I do not need to discuss here its very great influence on graduate resource training everywhere. But what I do wish to point out is that this setup simply is not possible as yet for most institutions although it is conceivable that some of the good programs which began in other ways might evolve to this place. The University of Michigan School of Natural Resources came about through a most fortunate and rare combination of circumstances and people, a combination which would be hard to duplicate. Most of you, I am sure, know the story. Here the interdisciplinary approach—while not easy to achieve in any university—has been developed to a high degree, even to formalized agreements with other schools and departments which have resulted in close coordination and even to the giving of combination degrees. Through its manifold approach, it covers the objectives of the various methods I have already discussed. The story of the School of Natural Resources at Michigan is a story in itself.

So now let me go back to that first conference we had at Ann Arbor in 1956. Here we thrashed out those basic concepts of natural resource training, which I have endeavored to outline to you. A full report of that conference together with introductory chapters by others working in this field came out in a little book published by the Conservation Foundation entitled "Resource Training for Business, Industry and Government." There are copies here if you care to look at them. It is now nearly out of print. But if you wish a copy, write to the Conservation Foundation—we have a few left. Most of you, I imagine, have seen it.

After this 1956 conference we felt that progress was being made, and we wished to keep up the steam. So we asked some of those working with us to form a committee which we called "The Natural Resources Study Committee" to meet at intervals and advise us. I want to read to you the names of those on this committee because they represent not only various fields in which conservation training is important, not only because they represent business, industry, education and government, but because they are individually and collectively dedicated to our common objective of encouraging natural resource training in our universities. We in the Conservation Foundation worked with that committee very earnestly, and they spent the time and travel to join with us frequently. If we at the Conservation Foundation have been of any assistance in this graduate training field, then it is due primarily to the efforts of this committee. It consisted of (besides myself) Stanley Cain of the University of Michigan; Paul M. Dunn of the St. Regis Paper Co.; Ed Graham of the Soil Conservation Service; Walter Gumbel of Monongahela Power Co.; Bill Kleunder of the Chicago and Northwestern Railroad; the late Vince Madison of Detroit Edison; Lloyd Partain of Curtis Publishing Company; and Paul Sears of Yale University.

We again had a conference at Ann Arbor in January 1958 at which we related the conservation movement to planning and discussed how we should educate so that resource training can be a part of that field and recognize that land as space is also a natural resource.

By now there was so much interest in the graduate field of conservation that those working and endeavoring to establish this work in their own institutions turned to us at the Conservation Foundation to call together as many as possible of those working just in this educational field for a few days in order to informally exchange experiences and ideas and become better acquainted with each other's programs. This we did late in 1958 at the Berkeley campus of the University of California where Starker Leopold of the University made the arrangements for us. This meeting had only enough formal schedule to keep the discussions on the rails. The three days we met there were highly productive in that almost everyone in this educational field was present and there was great freedom to express ideas and exchange experiences. Although methods varied with each university, it was apparent that those basic concepts which we have been discussing were the underlying approach of each program. Proceedings of this 1958 conference, which we call the "Berkeley Conference," are also available at the Conservation Foundation, also a collection of follow up letters from various universities a year later telling about the developments in their own programs during the intervening year. At this point it was apparent to us in the Conservation Foundation and the Natural Resources Study Committee that the basic concepts we had developed through these various conferences were by now pretty well established and that graduate training in resource management was a healthy and robust new element in our educational system. It seemed to us that our job now was to keep constantly in touch with it, and to develop useful tools for it wherever possible, but not in any way to interefere with the individual universities' affairs and problems. With the fundamental purposes and approaches generally accepted, the methods and administrative techniques employed were strictly each university's own business.

As we see it, the only real handicap to strong and productive programs in natural resources training in those universities which have the necessary disciplines is this matter of lowering departmental barriers so that a student in any one department is able to get what he needs from any other department, regardless of which department he matriculates in. There are just too many universities which have everything needed for this training with the important exception of this interdisciplinary approach. Of course, we have to divide our institutions into schools and departments in order to achieve an orderly administrative organization. But the system should not act as a barrier to the student who needs what different departments can offer him.

I have found that, with some fortunate exceptions, the universities on the east and west coasts are the worst offenders in this regard. Those in the middle west and mountain states are much more flexible.

I feel that the complexities of modern civilization demand this interdisciplinary approach in many fields of endeavor and sooner or later our universities are going to have to adapt themselves to it. Certainly it is one of the key conditions for a successful graduate program in resources management. Fortunately, many programs—after hard fought early battles—have managed to achieve workable interdisciplinary procedures. The results are that more and more resources training at the graduate level is becoming a recognized and well established field of study. More and more are well trained people taking their place in all types of activities where this training is so essential.

In closing, let me give you one very good example which I have already mentioned briefly and which is from right here in your own State of Colorado. Some four years ago the Pack Forestry Foundation made a grant to Colorado State University at Fort Collins to establish a program in Watershed Management. Professor Bob Dils was chosen to initiate and direct this program. How it has grown and how a sound and creative program has been established with a background of general resource training is best illustrated by my quoting from a recent letter he wrote me in answer to some questions I had asked him. He wrote and I quote:

"I sincerely feel that our program in watershed management is an excellent example of a very successful interdisciplinary program. We are now in our fourth year and have gone from 2 the first year to 23 graduate students this year (plus an additional 4 working on their research in absentia). Five of our students are foreign students from Austria, Switzerland, Iraq, Turkey and Taiwan. The last three are here on ICA programs. Of the 23 students in residence, 11 are doctoral candidates . . . The quality of graduate students we've been getting has really been outstanding.

"Our program is really interdisciplinary in nature and was approved by the Graduate School on that basis. All of the students are required to have had or take certain core courses specifically in watershed management and, in addition, hydrology, meteorology, land or resource economics, and logic and the scientific method. Beyond these the course work program is very flexible and depends primarily upon the research the student elects for his thesis or dissertation and upon his individual interests. The same is true regarding the student's research. If weaknesses are apparent in his preliminary examinations, he may be required to take additional work to shore up these areas. Although most of our graduate students come to us with prior degrees in forestry we have in addition students who were first trained in range management, civil engineering, mathematics, physics, meteorology and soil science. We would certainly welcome others as well particularly those with training in geology, geography, botany, etc.

"In part due to the success of our program I anticipate several additional interdisciplinary programs on this campus in the near future. Joint programs in natural resources, public policy and administration, and in forest and range soils are under discussion now. We are currently in the process of establishing a natural resources institute here and at least an interdisciplinary master's degree in natural resources is under serious consideration. The latter would likely be somewhat comparable to the program in Conservation at the University of Michigan."

With such programs as this we can look forward with confidence that the management of our natural resources is going to be in good hands.

HOME STUDY COURSES IN CONSERVATION—WHAT ARE THEIR POTENTIALS?

CARL A. CARLOZZI
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Two years ago I undertook to prepare a home study program for newly appointed Game Protectors in the service of the New York State Conservation Department. The course was weighted heavily in the direction of the principles of wildlife law enforcement and fish and game management. But, it also included material on the development of conservation philosophy and programs, as well as information on the basic resources of water, soil, and forests. In order to assure that the trainees in this program had a background in the fundamentals before they began to read selections from more technical works, I wrote five essays on the basic material with which I wanted them to be familiar. These essays covered the development of the conservation movement, the history of conservation law, ecological principles, present day techniques in wildlife management, and a brief sampling of contemporary problems in soil, water and forest resources.

Having completed the series of essays for the Game Protectors, I consulted with my colleagues and members of the New York State Conservation Department about the advisability of working the essays into lesson form and offering them to the general public as a home study course on the conservation of wildlife resources. This had never been tried before in New York. The consensus of opinion was that there may be a few people around the state, primarily sportsmen, who would be interested in enrolling. Since much of the ground work in writing was done it seemed worth trying at least once. I organized the material into what I thought would be a meaningful discussion of the basic principles involved in wildlife conservation. The general approach taken in this course was to present the material in such a way that the student would develop not only an understanding of how we manage wildlife, but also why we manage it, and what role he as a citizen may play in influencing sound policy and programs concerning the development of the state's wildlife resources. The emphasis was placed on the wildlife resource picture as it pertained to New York and the northeastern states, but the material did not ignore the more pertinent national programs.

The original five lessons were published in mimeographed form. Each lesson was accompanied by two or three sheets of questions. The questions were divided roughly half and half between objective questions (true-false, or multiple choice), and essay questions which could be answered in one or two short paragraphs. Generally the questions, whether objective or essay type, were designed to test the student's understanding of a certain concept or problem rather than whether he knew the specific facts. The students enrolling in the course had four and one-half months to complete it.

Since the course was to be a trial program it was our desire to keep enrollment at a modest level. I arranged for no other announcements of this course other than a brief newspaper release which simply stated the registration dates for the course, a brief summary of what it contained, and where to apply. We enrolled 170 people in the course within two and one-half weeks. This number is small relative to the total population of New York State. But more significant and more impressive to me than the numbers of the original student enrollment has been the continual flow of inquiries into our office about the availability of the course, and requests for enrollment. These inquiries have proceeded throughout the months since the course was first held, despite the absence of any further announcement to the public that the program was still available. The inquiries which have come in after the course and the immediate response in enrollment during the first registration period convinced me that there was a large unexplored interest in this kind of education program. Also, there have been some other factors which inffuenced me in my belief that the potentials for the program are high. These factors became apparent when I analyzed two aspects of the make-up of the students who participated in our first offering.

The first of these factors was the high number of completions among those who enrolled in the course. One hundred and thirty-three out of the one hundred and seventy students received certificates of completion, or 77 per cent of the original enrollment. This is not only significant in that the precentage is considerably higher than the average completion rate for Cornell home study work (56%), but also in that the students who completed the course did so with virtually no form of special encouragement to finish being supplied by our office. No one was reminded of tardiness with regard to the completion of the various lessons at any time during the course. All students, regardless of the state of their progress, were simply reminded once of the deadline date for completing the course.

The second factor which I believe is significant is the kind of people who enrolled in the course. In order to gain some idea of who was interested in the course, I included a brief form which the students filled out that provided some information about themselves. This included not only such standard information as address, age, sex, but also included some questions on their educational backgrounds, occupation, and recreation activities which might give insight into the reasons for their interest in the course.

An analysis of this information indicated that there was no special group of citizens to whom the course appealed more than others. Surprisingly, twenty per cent of those who enrolled were female. The educational background ranged from one person who had gone no further in formal schooling than the fourth grade to fourteen people who had completed educational work beyond the baccalaureate degree. The age range ran from 16 years to 73 years.

I believe the very absence of an identifiable expression of interest by a particular segment presents us with some real food for thought. The need for understanding just why all these many different people would sustain an interest to the point of paying the sum of ten dollars and submitting to the mild discipline of preparing brief answers to questions caused me to examine further the possibility that perhaps the course was appealing to a group of people whose occupation or avocations brought them in more intimate contact with natural resources and attendant problems. At the occupational level I found this was not the case. The occupations listed by the students, with the exception of a block of New York State Game Protectors, represented what might be a cross section of adults in any state. However, the real key seemed to be found in the avocations of these people. All who took the course engaged in one or more forms of outdoor recreation. Most of the people, 73 per cent, indicated that they participated in hunting and/or fishing. The other 27 per cent seemingly gained their interest in wildlife conservation by participating in such outdoor activities as amateur ornithology, camping, hiking, or nature photography.

I believe that it is here that we find the key to the apparent high degree of motivation which sustained the 77 per cent of the students who completed the entire course of study. For the appeal of the material and the initial interest would seemingly be generated not by the things that the students were doing to earn their living but rather through activities that often bring the greatest amount of enjoyment and satisfaction—that is those things which people do for recreation or hobbies. It is for this reason that I believe that great movement of people towards an interest in outdoor recreational pursuits gives us an opportunity to carry out successfully educational functions which require something more on the part of the student than simply being exposed to material which is essentially intended to inform and which is written to entertain. I believe the American people are becoming prepared to expect something beyond our traditional magazine articles, popularized books and newspaper reporting.

Our experience in New York led me to a decision to determine whether or not other states were experiencing an interest of the same sort. In December of 1961 I began a survey in the 50 states and the 10 Canadian provinces to attempt to gain some indication of the extent to which there might be an apparent interest in home study work in the field of natural resources, and the extent to which this interest was being met by existing programs. Survey questionnaires were sent to directors of I and E sections of all the state and provincial conservation departments, to all the land grant colleges, and to Canadian universities which offered work pertaining to natural resource education. In all 120 questionnaires went out and 116 of the institutions responded. There was at least one respondent from every state and every province.

The questions asked on this survey were concerned with one, did the state offer any home study opportunities for the general public, either through the state conservation department or the university system, in the field of natural resources. Respondents answering yes to this question were further queried on the kind of course that was offered, the number of years it had been in existence, the average enrollment of the course, and the cost of the course to the student. Those who an-

TABLE 1. SURVEY OF THE EXISTENCE OF AND POTENTIALS FOR HOME STUDY COURSES IN CONSERVATION AMONG TWO KINDS OF EDUCATIONAL INSTITUTIONS IN THE U. S. AND CANADA. MARCH 1962. (116 OF 120 INSTITUTIONS SURVEYED REPORTING)

1A. Existence of Home Study Courses in Conservation

	Have Courses	Do Not Have Courses
Land Grant Colleges, U. S. (50 of 50 reporting)	8	42
Canadian Colleges (selected) (11 of 12 reporting)	0	11
State I & E Divisions (47 of 50 reporting)	2	45
Provincial I & E Divisions (10 of 10 reporting)	0	10

1B. Evaluation of Public Interest in Home Study Courses in Conservation by U. S. and Canadian Institutions *Not Presently Offering Courses.*

	Total Not Having Course	Aware of Public Interest	Not Aware of Public Interest	Don't Know of Interest
Land Grant Colleges	42	27	13	2
Canadian Colleges	11	2	3	6
I & E—U. S.	45	24	18	3
I & E—Canadian	10	6	3	1

1C. Willingness of Conservation Education Institutions Not Presently Offering Home Study Course to Begin Home Study Programs if Course Materials Were Available.

	Total Not Having Course	Would Offer Course	Would Not Offer Course	Don't Know	No Response to Question
Land Grant Colleges	42	13	9	17	3
Canadian Colleges	11	4	4	2	1
I & E—U. S.	45	12	14	19	
I & E—Canada	10	2	3	5	

swered "No" to the first question were asked their opinions on: one, were they aware of any expressed interest by the general public for work of this kind; and two, would they be willing to engage in such work if materials were prepared.

Those reporting from colleges indicated that only eight out of the 59 colleges offered home study work in the field of natural resources. Of the fifty-seven respondents from state I and E divisions only two reported offering home study opportunities.

But most significant I think was the appraisal by the respondents of the public's interest. Those reporting from the colleges stated that in 51 per cent of the cases they were aware of an interest in their state for home study work. Fifty-five per cent of those reporting from I and E divisions indicated they were aware of such an interest. When responding to whether or not they would be interested in conducting such a course if materials could be provided the answers were much more problematical and only a modest percentage (33 per cent in colleges and 25 per cent in I and E) gave an unqualified yes. Most of the respondents indicated on their survey forms a conditional kind of answer in which staff limitations or budget was the great unknown. Certainly I am not satisfied, nor do I expect you to be satisfied that these results represent a truly accurrate analysis of the situation. However, I am convinced that they represent a fair evaluation by those who are involved in the business of educating the public in the field of conservation.

An analysis of enrollment in the few programs which are being offered I think produce some encouraging signs. These programs have been in effect for more than a few years, (in fact one state began its home study work in natural resources conservation back in 1892) and average annual enrollments in these programs range between 12 to 2,000. This would indicate that interest is sustained where courses are offered. While I made no effort to obtain some evaluation of how well the home study work in the other states was received by the students I did have an opportunity to examine some critical statements made by the students who took the course which was offered in New York. The notes and the letters which the students sent me after the course was over indicated some significant things.

Critical comments were not limited to any specific group with the enrollees. I received notes and letters from students who represented all degrees of educational levels, age groups, and sex. In all but two of the forty-one letters received from the students there was a positive degree of satisfaction shown in the course and an interest to continue this form of educational program. This indicated to me that there was every reason to believe that subsequent efforts along these lines would be productive.

There was one aspect of the evaluations presented by the students which was especially interesting. Only one lesson of the five was devoted entirely to subject material or other topics such as water resources, soil, land use, and forests. But 30 of the 41 letters contained special expressions of interest in this particular lesson and urged that more work be offered on these subjects. This apparent maturing of interest was significant to me because it seems to indicate that even though the impetus to engage in learning about natural resources comes from the popular concern over animal life, if properly presented, the basic resources can be related to this interest in such a way that the student recognizes the more fundamental natural resource problems and becomes desirous of learning about them.

We are currently preparing to offer this course again beginning on April 15th. But we are making some substantial changes in content since last year. The changes were based in large part upon comments from the first group of students. The course is expanded to seven lessons, and four subject areas—soil, water, forests, and use—are given considerably greater attention than in the first course. The outline for the course currently being offered is as follows:

Lesson I—History of Conservation in North America
- A. Meaning of Conservation
- B. History of the Conservation Movement
- C. New York State Conservation Department

Lesson II—Principles and Problems in Water Resources
- A. Characteristics of Water
- B. Importance of Water to Man
- C. Major Water Problems
- D. Resolving the Problems

Lesson III—Principles and Problems in Soil and Land Resources
- A. Soil and Soil Problems
- B. Soil Conservation Programs
- C. Principles of Land Use
- D. Major Land Use Problems

Lesson IV—Principles and Problems in Forest Resources
- A. Characteristics of the Forest
- B. Importance of the Forest
- C. Current Forest Problems
- D. Resolving the Problems

Lesson V—Wildlife Law
- A. Historical Basis for Present Laws
- B. Extent of State and Federal Jurisdiction over Wildlife
- C. Problems in Wildlife Law Enforcement
- D. The Job of the Game Protector

Lesson VI—Ecological Principles
- A. Biotic Communities
- B. Energy Flow
- C. Population Phenomena

Lesson VII—Principles and Problems in Wildlife Management
- A. Importance of Wildlife Resources
- B. What is Wildlife Management
- C. Techniques used in the Management of Game Fish, mammals and Birds
- D. Major Problems in the Northeast (with a special section on animal damage and nuisance control)

In addition to including new material we are using a multilith process which will allow us to include art work and photographs in the text. The decision to include illustrations was prompted by comments made by the first group of students and recommendations by staff members in the College of Agriculture's Department of Extension Teaching and Information. We have made every effort to make the new publications as attractive and durable as possible so that they may make good additions to a home library.

Acknowledging that the source of interest is established and that good motivation exists toward learning, the next question is why home study. Certainly we recognize that in general home study has many serious limitations. Most educators agree that of all the various devices for learning home study is among the weaker. But, home study, I submit, is better than our more traditional ways of reaching the general public with the message we wish to deliver. I think we must accept that while mass media (excluding educational television) provide us an opportunity to reach large numbers of people, we have every reason to believe that our efforts strike home in a lasting way for only a very small percentage of those that we reach. I think this is because there is a reluctance on the part of the public to look to the mass media for anything more than information on a day-to-day news level and for entertainment. Home study, however, gives the student an opportunity to read a well structured and logical presentation of subject material. This kind of presentation is not evident in mass media reporting where bits and pieces, however well written, are often unrelated and lack the positive construction of a point of view. In addition home study imposes some discipline upon the participant in that he must read the material well enough to be able to express himself when completing tests or question sheets. The more serious student also can gain from having a knowledgeable person evaluate the quality of the thinking which he does when answering the various questions.

As our country proceeds in its movement towards greater and greater urbanization, and as more and more of our citizens become divorced from the association created when man works on the land, we in conservation education need to be constantly alert for those aspects within our culture that can substitute for the passing man-land relationship. I think we have found one such substitute in the increasing interest in outdoor recreation. I believe that we should not miss the opportunities which arise from this interest and we should develop our educational efforts to take advantage of these opportunities. I have offered this discussion today not because I think that home study programs are the one answer but rather that they are one of many answers, and one for which the times seem right for experimentation and innovation.

DISCUSSION

MR. ERNEST PROVOST [University of Georgia]: I should like to make one comment and tie it to a question. One, I am certainly in favor of, and I think most of us agree that our wildlife problems hinge upon human population problems. In connection with that, I would like to ask the speaker if he used any kind of extension text in his course and if he has given any thought to environmental control which is the only conservation book that I am aware of that does directly hinge on the home study level?

MR. CARLOZZI: The course has been briefly annotated so they can do further research if they care to, but we have not made any attempt to recommend specifically any one particular text. But they will have some opportunity to see where they can go to get further and more detailed information in particular areas. I realize this doesn't answer your question with respect to the book. I must admit that I hadn't included a book quite that technical.

DISCUSSEN LEADER PENGELLY: We have had the personal approach of mass media, and then we have the very limited personal contact which is typified by some programs. Here is a new area, the intermediate or the home study approach which you have mentioned. I am sure it has great potential.

CAN BIOLOGISTS BREAK THE BOTTLENECK?

JOHN M. ANDERSON
Winous Point Shooting Club, Port Clinton, Ohio

Somewhat less than 2,000 years ago, a young man named Jesus Christ was preaching by the Sea of Galilee. Apparently he had something to say and knew how to say it, for people gathered from miles around. They poked each other and murmured, "Never man spake like this man."

But, from the events that followed, there is no evidence that they understood him. He proposed a new era based upon human equality, but they argued over who would get the chief advantage from the revolution. He urged a change in the hearts of men as a starter, but the masses were thinking of a change in ownership of material things. They were captivated by his charm, but failed to get his message.

In spite of that, he made the rulers uneasy. They didn't like his popularity; and, above all, they hated him because he presented new ideas—a challenge to the old order. Persons of influence had him arrested. The judge admitted he could find him guilty of nothing, but said, in effect, "Sorry, son. But you've got to go."

Less than five years ago, a young man named Ingalf Bue became the head of wildlife management in North Dakota. He brought to the position about eight years of college training and ten years of experience in the field as a wildlife biologist. There is little doubt that he knew what to do, and how it should be done.

He proposed a system of wildlife management based upon the relationships between living things and their environment. He proposed to discontinue techniques which, for 2,000 years, had failed to bring about the desired effects upon various wild species. A native son of North Dakota, born and raised within sound of fowling pieces, he was a hunter, fisherman, and scientist. He spoke the layman's language, and they were delighted by his Scandinavian accent. But, from the events that followed, there is no evidence that they understood him.

In spite of that, he made the rulers uneasy. They feared him because he represented new ideas, a challenge to the old order. Persons of influence secured his ouster. The Governor of North Dakota, admitting he could find Ingalf Bue guilty of nothing, said, in effect, "Sorry, son. But you've got to go."

A few years before that, the same thing happened, for the same reasons, to Thomas Schrader in South Dakota. It has happened many times, in many states, and will continue to happen until the barrier between the hunter and the professional wildlife manager is removed.

Many of you biologists, with one, two, or three college degrees, fancy yourself wildlife managers. You are mistaken. You are merely the men who were trained to do the job. With very few exceptions, the final responsibility for management rests in the hands of druggists, lawyers, physicians and business men of various brands and sizes who serve on wildlife commissions.

I do not criticize these individuals. Most of them are sincere; they do their best to make wise decisions. But the best a lawyer, or business man, can do in a field for which he has no training is not good enough. Consequently, a huge slice of the sportsman's dollar is still being spent for bounties, game farms, hatcheries, and enforcement of obsolete laws.

Many states have far more personnel in enforcement than the situation warrants. Kentucky, for example, has 122 counties, with a game warden in each county. I doubt that many wildlife commissions, as they are now set up, would seriously consider streamlining enforcement crews, using fewer, but better trained and better paid men, who could do a better job of education.

In many cases the game protector has been given a state car and a fancy uniform, but no understanding of such fundamentals as carrying capacity of the range, predator-prey relationships, and the real effect of the gun. Instead of removing the barrier between the hunter and the wildlife biologist, many enforcement officers effectively widen it.

This is understandable. In Ohio, for example, the old game warden, who remembers the dense flocks of pheasants back in the "thirties." remembers also that he used to patrol many small, scattered refuges. He carried bushels of corn all winter, shot foxes, pole-trapped owls, and rigidly enforced the 10-14 day season of two cocks per day.

Now his little refuges have been discontinued; winter feeding is not advocated; hawks and owls are protected; the season is lengthened to 20 or 30 days, and the pheasant population has gone downhill.

It is of no avail to point out that many more nesting hens are killed now because dehydration mills enable farmers to mow alfalfa at night; that pheasants do occasionally suffocate in blizzards but almost never starve; that most hunters go afield only on opening day and the first weekend regardless of season length; and that every bit of cover has been removed from many farms.

So what? He is convinced that pheasants are down because biologists are crackpots. It is easy for the hunters to agree with him; and the commissioners wish to keep the hunters happy.

So long as the unteachables are in the driver's seat, I can see little likelihood of change.

Our forefathers brought forth upon this continent a new notion, conceived in anger, and dedicated to the proposition that plant life belongs to the landowner, but wild animals are the property of all the people. This notion allows the hunter to forget that land use practices determine the quality and quantity of plant life, which in turn determine the animal life, so the landowner is the real wildlife manager, whether we like it or not.

But, the hunter considers the state and federal government as wildlife management agencies, capable of producing game. When the game farms and Pittman-Robertson habitat improvement programs do not pay off, the hunter demands new faces in the conservation department —somebody with "practical experience."

Practical experience has taught most state wildlife administrators not to lead the pack. If the voting hunter wants pen-raised quail, give him pen-raised quail. If he wants to exploit the ducks and over-protect the deer, don't argue. This policy may enable the administrator to stay in office seven or eight years instead of the usual four or five; but it will never develop an ecological conscience among the hunters.

It has been pointed out by Berryman and others that governmental agencies cannot hope to acquire enough land to accomodate more than a fraction of the would-be hunters. If the landowner does not develop a sense of wildlife husbandry, the hunter must continue to rely on over-crowded public hunting grounds on which he gets nothing but angry.

In northwestern Ohio the landscape is still dotted with small woodlots with good fox squirrel populations. Every year, however, the bulldozers remove more woodlots, and agricultural crops replace the burr oak trees. Wherever drainage is very poor, clumps of cattail and bluejoint grass harbor concentrations of pheasants and cottontails. But, with assistance from various U. S. Department of Agriculture schemes, the wetlands are being converted into croplands, on which the landowner will eventually be paid not to raise crops.

What's wrong with raising a crop of squirrels, pheasants, or rabbits? The answer is obvious. The landowner loses money on it! The population explosion is driving land values and taxes ever higher. The farmer will allow less and less of his high-priced land to be taken over by wild plants and animals.

But, if the hunters would lease the land directly from the farmer, or pay him handsomely for his crop of wildlife, he would soon want to produce more of the scarce wildlife, and less of the surplus grain.

He is now embarrassed by these wild patches of weeds, brush and trees. He feels the Joneses are snickering at him. If he could point with pride to the $1,000 he received for the harvest of 100 pheasants, he would tell the Joneses to go to hell.

Being human, he would not be satisfied with a modest amount of easy money. His natural tendency would be to seek ways of increasing the wildlife crop in order to reap more of the long green cash. If so, the wildlife biologist would, *at last,* be looked to for advice, and his dream of someday being a wildlife manager would come true.

It's true the lad who expects that somehow the state will buy him a place to hunt and dump out some pen-raised birds for "free" will be disappointed. Alas! His wife or girl friend should explain to him that the best things in life are never free. To get a desired combination of quality and quantity, he must set it up, and expect to pay for it.

Even if the hunter's license fees were increased twenty times, it is doubtful if his wildlife agency could compete with the billions the U.S. Department of Agriculture is already handing out to encourage the destruction of wild land.

Does the I & E Section of your wildlife agency dare to point out to the duck hunters that if they would take part of the $500,000 they are sending north of the border annually, and hire a professional lobbyist to ensure passage of H. R. 8520 (to stop subsidized drainage), they would get more ducks for their money?

Unfortunately, the wildlife biologist, himself, shies away from any form of pay-as-you-go hunting. He feels his duty lies in helping the one-gallus hunter get his share at no cost. But the individual who is doing a half-way job of holding up his pants will give the wildlife manager the same kind of support. While we spend our time trying to help the lazy and unskillful hunters, the wildlife habitat is disappearing.

The hunter who sincerely loves his sport, who considers wild geese more important than television, or as Aldo Leopold said, to whom "the chance to find a pasque-flower is a right as inalienable as free speech," —this type of hunter will certainly find the means to enjoy his sport, regardless of cost. Our job is to get the landowner to view his wildlife crop as an asset, rather than a liability. Our job is to preserve the resource right now, and worry about "equitable distribution" later.

No amount of incentive, however, can produce wildlife on land covered with roads and buildings. The wildlife profession is giving practically no support to Dr. William Vogt's struggle against our irresponsible birth-rate. Of all people, the wildlife biologist should be the first to see that man is destroying his own environment and that of the wild creatures through over-population.

Our national leaders are afraid to sponsor birth control for fear of being unpopular. President Eisenhower consistently dodged the issue. Interior Secretary Udall points to the terrible overcrowding of our national parks in his plea for more lands. He neglects to say that even if he gets all the land he asks for, the human hordes will soon over-run them unless we cut the fuse of the population bomb.

The state I & E sections are doing nothing about this. The biologist should prevail on his professional societies to come out with a policy statement endorsing birth control research, and attacking the problem of how to get new developments translated into population control.

We are for more more recreation through less procreation. If we don't have guts enough to say so, then isn't it rather silly to argue about two ducks per day, or to do research on reproduction in the cottontail rabbit?

The bottleneck which has so far kept the wildlife management balloon from ever getting completely off the ground is still one of education. It appears that people get the kind of education they want and are willing to pay for. The loyal alumni of Ohio State University would not permit their football team to stay in fifth place for five minutes. But, as far as salaries for the faculty go, the alumni are quite content to let OSU remain in fifth place in the Big Ten, or lower. If this be typical college graduate behavior, is it any wonder the general public is so slow to learn the relationships between wild creatures and their environment? Can we wait indefinitely for them to catch up?

The hunter is trying desperately to make the first half of the twentieth century over-lap the second. Instead of teaching him it can't be done, many biologists and I & E programs encourage him in this futile attempt.

As philosopher Max Otto said, "We need to be educated to want facts. . . . We need to be educated in reverence for the human quest, in realistic idealism which is this reverence concretely applied."

I do not think the landowner, who is the real wildlife manager, wants any facts which will enable him to produce a crop on which he loses money. But, pay him enough, and he'll not only want facts, he'll get them.

I do not think the game warden wants any facts about a program which de-emphasizes law enforcement unless he can be shown that his own importance need not be de-emphasized along with it. Before we can educate the hunter, we must educate his teacher.

I do not think the wildlife commissioner wants to learn that he is not a wildlife manager. But, the Information and Education Sections could teach the hunter to place the responsibility for management squarely on himself and the landowner.

In cases where the government owns the land, they must manage. Otherwise, the state should divorce itself from any pretense at management, and do a competent job of research, education, and enforcement.

Can the biologist break the bottleneck? He can if he will cease to be a part of it.

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AN APPRAISAL AND CRITIQUE OF THE PROGRAM OF THE 27TH NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE WITH COMMENTS ON SIGNIFICANT TRENDS, AND PREDICTIONS

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Fifteen years ago, in San Antonio, Professor Aldo Leopold opened his "summarization" with the trite comment: "Only a fool or an angel would attempt to summarize this conference. I need not tell you in which category I belong."

Until today I did not fully appreciate Aldo's comment. In that erudite summation Professor Leopold took the liberty to point out some of the subjects that had not been included in the conference discussions.

In 1958 Dr. Ed. R. Kalmbach approached the matter differently. As the basis for his illuminating review of the 29 conferences for which printed transactions were available he developed "The Kalmbach Law of Program Appraisal," backed up with pie charts and graphs.

Two years later at Dallas I was privileged to present a synopsis of important advancements in the conservation movement, and particularly the important accomplishments that could be traced largely to the conference deliberations, starting March 1, 1915.

SIGNIFICANT TRENDS OF THE PAST

It is not my intention to apply any of these approaches today. Instead, I propose to point out a few significant trends, the impacts, and make a few predictions.

The "firm building blocks to progress" can be subdivided roughly into three epochs of about 15 years each. Significantly, this represents the average period necessary to sell the public a new idea or program in conservation programming. Sometimes, as in the case of hunting antlerless deer, it takes two such periods to really get general acceptance.

The first period (1915-1930) was concerned chiefly with building up our badly depleted wildlife breeding stocks, especially the big-game herds; with introducing exotic species to replace those driven out by civilization; setting up basic non-partisan administrative machinery; securing adequate legislation to control the cheaters; and obtaining funds to do the job.

During the second epoch (1931-1945) we began serious discussion of the necessity for materially strengthening the non-partisan policy making regulatory and administrative machinery; the importance of working closely with private landowners in our wildlife management programs; the urgent need for developing trained manpower to obtain basic information with which to manage fish and wildlife resources; the promotion of broad land rehabilitation programs; and, as always, to fight for funds to administer fast-growing responsibilities.

RECREATION NEEDS CAME TO FORE

The third epoch (1946 to the present) has been the period during which public opinion was consolidated behind programs to tackle the problems long neglected.

Among them were a courageous frontal attack on the elimination of water pollution; a more effective plan which, if implemented, could head off the drainage of wetlands; coordinated planning in connection with flood control, reclamation, and hydroelectric projects to assure reasonable flows in natural stream beds to safeguard fish, wildlife, and recreational values; and the management of all publicly-owned lands on a multiple-use basis.

It was during this period also that we firmly established in the public conscience the fact that we face a water crisis in many parts of the "land of plenty," and that sufficient outdoor recreational opportunities for the fast-growing population of North America has become a primary concern. Hence the theme of this conference: "NEW HORIZONS FOR OUTDOOR RECRATION."

BRIEF APPRAISAL OF PRESENTATIONS

There have been so many fine presentations at this conference that it is most difficult to include even the outstanding highlights.

Senator Lee Metcalf of Montana, long recognized as one of our most ardent conservationsts in the U. S. Congress (who substuted for Laurance S. Rockefeller, chairman of the Outdoor Recreation Resources Review Commission), thrilled his audience with a clear-cut presentation of the "Recreational Needs in Years Ahead."

"The time is ripe for a national recreation and conservation effort," he said. "Today's challenge is to assure all Americans access to their outdoor and resources heritages. I earnestly hope and expect that the 1960's will be known as the decade when that challenge was met."

Metcalf urged the conference to support vigorously the recommendations of the Outdoor Recreation Resources Review Commission, released January 30. He commented that the decade of the Sixties can stand out as the most important decade of the Century in conservation and recreation history if federal, state and local governments, and private groups, see that recent national water resource and outdoor recreation recommendations are implemented.

The Senator warned that the fight for water resources planning may be lost if state governments and special interest groups succeed in their efforts to amend the proposed National Water Resources Planning Act so as to shackle the Federal Government in the water resources field; that pollution will go unabated, needed reservoirs will be left unbuilt and unplanned; and that recreational uses will go down the drain piecemeal if certain selfish forces succeed in emasculating the proposed National Water Resources Planning Act.

He lauded the President's support of this proposed act, as well as the recommendations of the ORRRC to develop a comprehensive outdoor recreation program, and stated that presently more than 20 federal agencies have some responsibility for outdoor recreation, but their programs are poorly coordinated.

Senator Metcalf delighted his large audience with the statement that in his opinion no mass transfer of lands between federal agencies need occur in connection with proposed recreational and other federal projects. Furthermore, he said such projects should not remove large areas from hunting and fishing, or from the jurisdiction of the state laws and regulations governing hunting and fishing.

Recreation in College Curricula

One of the most heartening statements at the opening session came from Dr. Julian Smith, who assured us that outdoor education is fast becoming an established part of our national educational system to equip our young people with the proper knowledge, skills, and attitudes to enjoy the outdoors.

His assurance that institutions which train teachers are greatly expanding their outdoor training programs was most encouraging to all of us who have long labored to have conservation and the wise use of natural resources included in public school programs.

Now our one hope is that while these increasing numbers of teachers and students are learning how to enjoy the outdoors they also may become properly indoctrinated in the niceties of outdoor behavior.

The technical session on Wetlands and Inland Water Resources brought out some of the many problems that confront us in the management of our continental waterfowl resources, especially what is happening on important breeding and wintering grounds.

Wisconsin's experience in managing the harvesting of Canada geese on the periphery of the famous Horicon National Wildlife Refuge was very illuminating. It proves what many of us have experienced;

namely, that such management operations are both difficult and expensive if done well.

One of the most helpful of those discussions was an explanation of the ways fish and wildlife management can best be integrated in small watershed developments.

The technical session on Disease, Nutrition and Control covered a wide range of subjects, and developed provocative viewpoints.

The opening presentation proceeded to kick around a very old subject, pest control. The speaker said that vertebrate pest control is still a "highly disorganized and largely neglected field of science." He said there are no such things as good animals and bad animals, and that the classification depends entirely upon one's own relationship with them.

The explanation of the functions of the new Federal Pest Control Board presented a concise expose of the manner in which the Federal Government is at last trying to put its own house in order, especially to resolve the inter-agency conflicts. As pointed out, one of the most important functions of the Board is to encourage needed research.

He frankly admitted that any contemplated use of a pesticide chemical should first be evaluated as to the good its use is expected to achieve, the harm that may result, and the precautions necessary to minimize harmful effects.

One speaker at this session presented new techniques, which may be helpful to many researchers, for determining, through stomach content analysis, the quality of the range for big-game animals. However, like other techniques, the researcher's conclusions probably won't convince the average layman that animals on the same range are starving.

New Problems and Old

Again we heard about an old problem, the controversial Jackson Hole Elk Herd. The author frankly admitted that "many of the problems that were present thirty years ago continue to plague the four agencies responsible for management of these elk and their habitat."

Apparently, the four agencies (National Park Service, Fish and Wildlife Service, Forest Service, and the State of Wyoming) are doing a good job of agreeing upon management procedures, but they have difficulty in securing the active cooperation of the hunters. Might it be safe to conclude that with four cooks in the regulatory kitchen, the broth may not be as palatable as it should be?

The technical session on Field and Farm Resources had its share of controversial subjects.

For example, Kentucky reported on the soil bank program and its lack of acceptance, especially the wildlife habitat practices. It was found the Agricultural Conservation Program has not actually benefited wildlife in the Blue Grass State because too many of the authorized practices "resulted directly or indirectly in wildlife habitat destruction."

The authors of this critical analysis frankly say, "It appears that soil conservation, as Dr. Hugh H. Bennett thought of it, is a thing of the past. In modern times there can be no conservation of soil unless it is coupled with a drainage project."

It was found that even where plans, plants, and technical assistance are provided a landowner will not necessarily avail himself of the opportunity to improve wildlife habitat on his land. The conclusions of this paper should immediately be transmitted to Washington where wildlife aspects of the ACP and other agricultural programs now are being reviewed.

From Montana came a report on "Wildlife Economics on Private Lands" that has much to commed it. The authors, reporting that since cash payment for hunting rights on private lands is widespread throughout the United States and becoming increasingly common, recommended that payment for hunting on private land be made public policy and encouraged by public agencies, to provide a real incentive for the enhancement of wildlife habitat.

This session also had an interesting report covering an intensive study in Minnesota on a tract of native prairie to determine how best to maintain favorable habitat for wildlife. It was found that fall or spring burning once every four to five years will maintain prairie vegetation to provide good nesting cover for puddle ducks and upland game birds.

The same session heard for the first time the results of a study in Washington to ascertain the effects on wildlife of radioactive iodine released into the atmosphere by the Hanford Atomic Plant.

A New Look at Population Dynamics

Another State of Washington worker handed his fellow biologists a jolt on wildlife population dynamics. He said the old theory that reproduction attempts to replace losses must be abandoned and replaced with the concept that reproduction causes losses.

The technical session on Coastal and Marine Resources dealt with both old and new problems. The discussion on manipulating coastal marsh impoundments in Louisiana produced helpful new information from the standpoint of increasing waterfowl carrying capacity. Likewise the discussion dealing with saline soils and brackish waters in wildlife management along the coast of South Carolina provides useful guidelines. Another paper dealt with the long-standing problem of standard procedures for evaluating the comparative worth of both the commercial and sport fisheries.

The analyses of the special survey of salt-water angling as an adjunct to the National Survey of Hunting and Fishing, 1960, provided an amazing array of statistics, which should reduce some of the prolonged frictions between the commercial fishermen and the ocean sport anglers.

The technical session on Forest and Range Resources rehashed some hot potatoes. For example, the use of herbicides as related to wildlife management got another going over. The authors stated frankly that widespread herbicide treatments, by airplane or mist blower, are sufficiently general in the Southeast to be a threat to wildlife management unless suggested modifications and methods of treatment are adhered to.

Browse seeding in range management studies indicate that we have learned how to seed bitterbrush, and how to get the bitterbrush seedlings above the ground. But what to do with them thereafter introduces other problems: rabbits, deer, livestock, rodents, insects, high soil temperatures, fungi, and other factors.

But such reseeding isn't cheap. It costs about $20 per acre for site preparation, seeding, and the purchase of seed.

A new method to evaluate wildlife conditions in various forest types, developed and tested in the Ozarks in 1961, seems to hold considerable promise to speed up the collection of such information on relative carrying capacities and habitat improvement.

A report from Ohio stated bluntly that failure of wildlife managers *to use imaginatively existing information* on game for management directives can be blamed upon their "awaiting final conclusions from research workers." He further stated that administrators share the blame by harboring the attitude that the manager's only well-spent day is the day in the woods.

The technical session on Conservation Information and Education proved to be one of the liveliest of all the special sessions. Dr. Joe Shomon's presentation should actually have followed Julian Smith's on Monday at the general session because they complemented each other beautifully.

Shomon said: "Modern conservation education needs a fresh, new approach in America. With 70 percent of our population now living in non-rural areas where people neither work on the land nor manage it, the conservation education concept of reaching and motivating those who live and work on the land, or manage natural resources, is no longer adequate. What is needed today is an effective mass approach to informing and educating our people in conservation . . . . . aimed largely . . . . . at the population centers of the country, since here is where our greatest problem lies and where we are weakest."

One of the intriguing new innovations was Cornell University's "Home Study Courses in Conservation," which will eventually include an expanded home study program for all New York State Conservation Department personnel at the non-professional level. Newly appointed State Game Protectors must now take these courses during the first six months of their employment.

One of the highly provocative presentations during this session came from an Ohio worker who challenged biologists to break the bottleneck which has kept them from attaining their rightful place in our conservation programs. He charged that very few I & E sections in the country today can effectively work toward developing an "ecological conscience" among their readers, because the men in charge are not trained biologists.

RECREATION'S FUTURE—WHOSE RESPONSIBILITY?

The final general session was one of the most constructive, forward-looking programs ever heard by a conservation audience. It set a standard for closing sessions that will be hard to match in the future.

Wisconsin's Intriguing Innovation:

Over the years these conferences have been honored by addresses from many outstanding governors. None of them has ever thrilled his audience with such a bold approach to problems of providing recreational opportunities for the masses and protecting scenic assets as the stirring address by Governor Gaylord Nelson of Wisconsin.

The Governor held that "government has failed miserably to meet its responsibilities. In the vast majority of cases, elected officials have clung to the discredited idea that America's outdoor resources are inexhaustible."

"The challenge is the boldness to act, and act now," he said. "From the public reaction to what we have done and proposed in Wisconsin, I believe that this is one area where the people have long been ahead of the politicians."

Governor Nelson then proceeded to outline Wisconsin's intriguing new innovation, a $50 million program, money derived from 1¢ per pack tax on cigarettes, to make certain that all values—recreational, scenic, hunting, fishing, camping. etc.—are preserved and developed to provide maximum public enjoyment, and stated that it is "essentially a partnership between state government and thousands of individuals who own the resources we seek to protect."

He made clear the fact that in addition to acquiring essential property outright (for more parks and state forest recreation areas, acquisition of fish and game habitats, permanent rights to protect scenery along some 3,000 miles of highways, youth conservation camps, new lakes in that part of the state devoid of them, etc.) the state will purchase easement rights on a large scale, thereby keeping the land on the tax rolls and avoiding erosion of the property tax base.

Your reporter predicts that many other states, probably some provinces, will adopt "The Wisconsin Plan" to protect important scenic assets and assure greatly expanded recreational opportunities for their people. Please note that Wisconsin's excellent program is based on a continuing tax, not a bond issue. This means that it is not a one-shot proposition.

Recreation on Private Lands:

If there is one sure way to learn first hand what owners of private lands think of recreationists of all kinds it is to be the managing editor of a widely circulated farm publication in the Heartland of America, the Great Midwest.

Mr. Alvin Bull's conclusions gave us much to ponder. A decade ago they would have been far less encouraging. It is a heartening report from a person who has such intimate contact with farmers.

None of us will disagree with his basic thesis that "government should do for people only those things which they cannot do efficiently for themselves," and he provided many of the answers to the question of how far private enterprise can go after governmental agencies have exhausted their efforts.

Mr. Bull cited the increasing cooperation of large holders of industrial lands, but called attention to the fact that farmers and ranchers own much larger acreages, and commented: "Right here in our own backyard lies perhaps the largest opportunity to provide recreation."

He called attention to the age-old problem of farmer-hunter relations which must be further improved, and concluded that, "The crying need is for enlightened cooperation between government agencies and between these agencies and private individuals."

What Recreation People Want:

"What the People Want for Recreation" was ably discussed by Joseph Prendergast. He brought out many interesting angles. "What people want for recreation can determine whether they will kill time or use it, whether our ever-increasing leisure becomes a source of national strength or national decay," he said.

He further commented that what people do for recreation is heavily influenced *by what is available,* and that what people want may be quite different from what they actually do. According to this speaker, many prefer recreation that is challenging, but increasing numbers prefer recreation that families can enjoy together, whether challenging or not—a most wholesome trend.

Getting On With the Job:

Your reporter's comments on Dr. Gabrielson's very excellent presentation at the opening session have deliberately been reserved until now. His topic "Getting on with the Job," fits better here as a what-to-do-about-it nightcap after hearing the views of experts from many disciplines.

His opening observation was dramatic, somewhat frightening. He said: "Outdoor recreation today is one of the most imperiled commodities in the natural resources market place." He then enumerated some of the many problems involved, how a few of the states are facing up to their recreational needs, recent action taken by the Federal Government, and where we as citizens sit in the picture.

Dr. Gabrielson praised the new policy, signed by the Interior and Army (Corps of Engineers) Departments recently, under which "the Federal Government once again recognized the need to obtain sufficient land around new reservoirs, and possibly some old ones, for public access and for requirements for outdoor recreation, fish and wildlife." He also lauded the newly issued directive of the Department of Defense setting forth specific objectives and instructions to base commanders relative to the recreational use of millions of acres administered by service agencies.

What the President Overlooked:

Next, Dr. Gabrielson commended the President's recent message to Congress on the subject of natural resources and recreation, then followed with the comment that "a disappointing feature about the Presidential message was its failure to mention the tremendous recreation potentials of the national land reserve . . . . . Nowhere in all of the suggestions that have been advanced is there any firm plan to develop the vast, untapped recreational potential of the public domain."

Following this critical appraisal, Dr. Gabrielson concluded that infinitely more recreation can be provided to more people at less cost, on the national forests, public domain, and military installations than any other lands administered by the Federal Government, and he deplored the niggardly approach so far made to accomplish that objective. Moreover, he warned that how well our recreational needs are met depends largely upon local agencies and the willingness of each of us to do the job necessary.

OVERALL APPRAISAL—SOME CRITICISMS

Having attended all but two of these conferences during the past 42 years, I believe I can evaluate the conference objectively. In my judgment it has been a rousing success and explored much new ground.

Those responsible for the planning and preparation of this conference deserve our highest praise. I particularly want to commend the program arrangement. The many related meetings were so scheduled that everybody was free to participate in the conference sessions.

Must Avoid Too Much Professionalism:

The constantly increasing number of well-trained young workers at these conferences gives all of us assurance that the future of the movement is in capable hands. This also brings me to a rather touchy subject. In the early days the conferences were attended largely by non-professional workers. They were the civic leaders of that day who were broadly concerned about the future of our natural resources, especially fish and wildlife.

The danger now, it seems to me, is to let the professionals monopolize the future programs. We need the leaders in industry, commerce, and other professions actively participating in these annual gatherings. Fortunately, we had a goodly number of them here throughout this conference.

More Lively Discussions Essential:

Then there are a few among us who question the wisdom of inviting eager young workers to lead discussions. True, some of them may not have reviewed fully all the literature, and they rehashed old ideas. But what of it? Remember, we older chaps also were youngsters once, and probably more brash, too.

One problem that concerns me greatly is the lack of lively discussions in some of the sessions, and questions from the floor. Without lively discussions the sessions become dull and lifeless. Have we become so highly specialized in our respective fields that we hesitate to contribute our views? Where are the Bill Adamses of yesteryear?

Attendance at Sessions Essential:

I commented earlier about the arrangement of the program so that all of us can attend the sessions. These sessions have been well attended. Yet there are still some who regularly travel long distances, often at public expense, then sit it out in the corridors visiting old friends. It would give the sponsors of the conference, the program committee and the speakers much encouragement if all sessions were attended to the bitter end.

In conclusion, let me assure you that the success of this great gathering is best attested by the enormous advancements in the field of wildlife restoration and natural resource management during the past 48 years. The future can be equally productive if we each do our part.

Thank you all, and good luck. I'll see you next year.

CLOSING STATEMENT

Vice President, Wildlife Management Institute, Washington, D. C.

Friends:

Even after hearing that excellent summarization and critique of the entire program of this large three-day conference by Seth Gordon, many of you still may not appreciate fully the work involved in that assignment. It is truly a staggering task, since the summarizer must continue to work throughout the conference down to the final wire. Seth, you did an outstanding job, and we are grateful to you.

In behalf of the Wildlife Management Institute, I wish to thank Mr. Gordon, and all of the other individuals who contributed to the success of this international meeting. Special thanks are due to the members of the Program Committee and to the organizations and agencies that they represent. Their names are listed in the program, and I wish that time permitted me to acknowledge all of them personally at this time.

I would like, however, to single out and thank Dr. Fred H. Dale who represented The Wildlife Society as the chairman of the technical program. That, too, is an arduous task, and I believe you agree that the results of Fred's performance were reflected in the quality of the highly commendable technical program that we had this year. Both he and the Society have our grateful appreciation for their help.

We wish to thank the working press for the coverage of the conference in local newspapers and by the wire services. I know that we have had good coverage.

The Institute also would like to acknowledge the services of Jack

Morton Productions for providing us with the entertainment at the banquet last night. Jack Morton has been producing these musical and variety shows for us for many years, and judging from the comments around here today, his effort last evening was pretty much up to his usual standards.

We are grateful to the management and personnel of the Denver Hilton Hotel for the competent manner in which they handled the needs of the conference. We also are indebted to the Denver Convention and Visitors Bureau for their efficient help and cooperation in handling the registration and banquet ticket sales.

Many of you appreciate the strain and worry that falls on the officers of the Institute in staging a large international meeting of this kind every year. The two gracious ladies who sustain Dr. Gabrielson and me so patiently during these affairs and throughout the year, certainly are deserving of special recognition. I would like to ask Mrs. Gabrielson and my wife Bess to stand and receive a deserved ovation.

Considering that this conference lies at a greater distance from other metropolitan centers when compared with those held in Washington or elsewhere in the East, I believe that the registered attendance is heartening and rewarding to all those involved directly in the staging of the conference. At my last check, 1,107 people had enrolled at the conference registration desk, and judging from past experience we know that the total attendance was fully 15 per cent higher than that figure. The only way that we could assure a 100 per cent registration would be to charge a registration fee, but the meetings always have been open to everyone without charge. The banquet was a big success with 660 persons in attendance.

The thing that makes these functions worthwhile is not the number who attend the sessions, but the interest and enthusiasm expressed by those present. By these standards as well as those of attendance, I feel sure that the Institute has been amply rewarded in taking this conference to the foot of the Rockies.

Definite arrangements have been made to hold the 28th North American Wildlife and Natural Resources Conference at the Statler Hotel in Detroit on March 4, 5, and 6, 1963. It is hoped that you will be able to get there. Many thanks, and a safe trip home.

REGISTERED ATTENDANCE AT THE CONFERENCE

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